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# A Systematic Literature Review on Digital Technology and Automation Innovation in the Food and Beverage Industry: Enhancing Service Efficiency and Customer Experience

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**ABSTRACT**

The food and beverage (F&B) industry is undergoing a profound transformation driven by digital technology and automation, revolutionizing service efficiency and customer experience. Despite the increasing adoption of artificial intelligence (AI), robotics, self-service technologies, and digital payment solutions, there remains a critical gap in understanding their comprehensive impact on operational performance, customer satisfaction, and long-term industry sustainability. This study conducts a systematic literature review (SLR) to synthesize key advancements, challenges, and future opportunities in the digitalization of F&B services. Utilizing an extensive search strategy across Scopus and Web of Science databases, 1,543 studies were initially identified and rigorously filtered using the PRISMA framework, resulting in 32 high-quality primary studies for analysis. The findings are categorized into three themes: (1) Smart Technologies and Automation, (2) Enhancing Customer Experience through Digital Innovation, and (3) Challenges and Future Opportunities in Digital Transformation. They emphasize that AI-powered service robots, automated self-ordering kiosks, and smart kitchen technologies significantly improve service speed, accuracy, and personalization. Furthermore, predictive analytics and big data applications enable businesses to refine customer engagement strategies through personalized recommendations and real-time operational insights. However, several challenges persist, including consumer resistance to automation, cybersecurity vulnerabilities, and concerns regarding the depersonalization of service interactions. While automation offers undeniable efficiency gains, achieving an optimal balance between technological innovation and human-centric service delivery remains imperative for sustainable industry growth. This study provides a critical synthesis of digital transformation trends in the F&B sector, offering valuable insights for industry practitioners, policymakers, and researchers. Future research should explore hybrid service models that integrate AI-driven automation with personalized human interactions to ensure a seamless, customer-oriented digital transition.

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## 1. Introduction

The food and beverage (F&B) industry is undergoing a profound transformation fueled by digital technology and automation, reshaping both service efficiency and customer experience. Technological advancements such as artificial intelligence (AI), robotics, smart self-service systems, and digital payment solutions have significantly improved speed, accuracy, and personalization in service delivery [1]. The COVID-19 pandemic further accelerated this shift, increasing the demand for contactless services, digital platforms, and robotic assistance to ensure customer safety and operational resilience [2]. Today, AI-powered service robots, digital menus, and self-ordering kiosks are not only enhancing operational efficiency but also redefining customer interactions in restaurants, hotels, and food delivery services [3]. Studies indicate that digital transformation plays a crucial role in optimizing food service quality, improving customer engagement, and fostering long-term brand loyalty [4]. The adoption of machine learning, predictive analytics, and big data enables F&B businesses to offer personalized recommendations, improving overall customer satisfaction [5]. As a result, the digitalization of the F&B industry represents a shift from traditional service models to AI-driven, data-enhanced experiences that are more efficient, personalized, and customer-centric.

The role of automation and AI in F&B service efficiency is increasingly evident. AI-powered chatbots, robotic waitstaff, and smart kitchen technologies are being integrated into restaurant operations to enhance efficiency, minimize human error, and improve productivity [6]. Empirical data highlights that robotic systems significantly improve perceived service reliability in urban food chains [7]. Additionally, AI-driven self-service technologies (SSTs), such as mobile ordering systems and interactive kiosks, provide greater customer autonomy and customization, influencing purchase decisions [8]. Research highlights that consumer engagement with self-service kiosks is driven by ease of use, perceived control, and service customization [9]. Beyond customer-facing innovations, AI-powered solutions are also transforming restaurant management by improving inventory tracking, waste reduction, and supply chain efficiency [10]. However, despite its many benefits, technology anxiety, user resistance, and concerns about impersonal service experiences remain key challenges in the adoption of F&B automation [11]. The successful implementation of digital solutions will ultimately depend on businesses' ability to balance automation with a human-centric service approach, ensuring that technology enhances rather than replaces meaningful customer interactions.

Beyond operational efficiency, digital transformation is reshaping the customer experience in unprecedented ways. Recent studies in Malaysian hospitality sectors emphasize the integration of AI and self-service kiosks to improve contactless service and speed [12]. Studies suggest that robotic service quality directly influences customer trust and revisit intentions, particularly in automated dining environments [13]. Additionally, digital menu innovations and interactive ordering interfaces are enhancing how consumers perceive service quality, leading to increased engagement [14]. AI-powered customer feedback systems allow businesses to track real-time sentiment analysis, making it easier to address concerns and optimize service quality [15]. However, while automation significantly improves efficiency, concerns regarding service authenticity, data privacy, and the potential dehumanization of customer interactions persist [16]. Despite growing interest in the digital transformation of the food and beverage (F&B) industry, existing studies often adopt a fragmented approach, focusing on isolated technologies or specific operational outcomes. There is a notable lack of comprehensive synthesis that integrates the multidimensional impacts of digital technologies and automation innovations—particularly in terms of their combined influence on service efficiency, customer experience, and long-term industry sustainability. Additionally, limited attention has been given to the interplay between technological adoption, customer acceptance, and service

authenticity in automated F&B environments. This study addresses these gaps by conducting a systematic literature review that holistically examines technological advancements, consumer responses, and organizational challenges. In doing so, it provides a structured understanding of how digital and automated solutions are reshaping service delivery in the F&B sector, offering a foundation for future research and practical implementation.

## 2. Material and methods

A Systematic Literature Review (SLR) is a structured, comprehensive, and reproducible research methodology used to synthesize existing knowledge by systematically collecting, evaluating, and analyzing relevant studies. In the context of "Digital Technology and Automation Innovation in the Food and Beverage (F&B) Industry," an SLR aims to identify key trends, such as the adoption of AI, robotics, self-service technologies, digital payment systems, and smart kitchens in enhancing service efficiency and customer experience. Additionally, it seeks to analyze challenges associated with digitalization, including technological barriers, customer acceptance issues, operational inefficiencies, cybersecurity risks, and ethical concerns. Lastly, an SLR explores future opportunities by examining emerging innovations like predictive analytics, AI-driven personalization, metaverse dining, and blockchain for food safety, assessing their potential impact on the industry.

To align with the goals of the study, there are three specific research questions (RQs):

i) What are the key digital technologies and automation innovations transforming service efficiency in the food and beverage industry?
ii) How does the adoption of digital technology and automation impact customer experience, engagement, and satisfaction in the F&B industry?
iii) What are the main challenges and future opportunities in integrating digital technology and automation in the food and beverage industry?

### *2.1 Identification*

The identification phase in the Systematic Literature Review (SLR) process ensures a systematic gathering of relevant studies on "Digital Technology and Automation Innovation in the Food and Beverage Industry: Transforming Service Efficiency and Customer Experience." A comprehensive search using Scopus and Web of Science (WoS) databases yielded 986 records from Scopus and 557 records from WoS, totaling 1,543 studies. Scopus, being a vast interdisciplinary database, provided diverse research across business, hospitality, AI, automation, and consumer behavior, while WoS focused on high-impact publications related to automation, robotics, and digital service technologies in the F&B sector. The combination of these databases enhances credibility and comprehensiveness, ensuring no significant studies are overlooked. The large dataset highlights the growing academic interest in AI-driven service robots, self-service technologies, predictive analytics, and smart kitchen innovations. However, not all studies are directly relevant, as some focus on general automation, unrelated technologies, or non-English publications. The next step involves screening based on title, abstract, keywords, and full-text relevance, applying inclusion and exclusion criteria to refine the dataset (Table 1). This systematic filtering process ensures a solid foundation for analyzing trends, challenges, and future opportunities in digital transformation within the F&B industry.

**Table 1**
Table of screening based on title, abstract, keywords, and full-text relevance, applying inclusion and exclusion criteria to refine the dataset

| | |
|---|---|
| Scopus | ( TITLE-ABS-KEY ( "Artificial Intelligence" OR "Machine Learning" OR "AI" OR "Robotics" OR "Automation" OR "Technology" ) AND TITLE-ABS-KEY ( "Food Service" OR "Restaurants" ) AND TITLE-ABS-KEY ( "Customer Experience" OR "Consumer Satisfaction" OR "Service Quality" ) ) AND PUBYEAR > 2021 AND PUBYEAR < 2025 AND ( LIMIT-TO ( PUBSTAGE,"final" ) ) AND ( LIMIT-TO ( SUBJAREA,"SOCI" ) OR LIMIT-TO ( SUBJAREA,"BUSI" ) ) AND ( LIMIT-TO ( DOCTYPE,"ar" ) ) AND ( LIMIT-TO ( LANGUAGE,"English" ) )<br>**Date of Access: February 2025** |
| Wos | (TS=("Artificial Intelligence" OR "Machine Learning" OR "AI" OR "Robotics" OR "Automation" OR "Technology")) AND (TS=( "Food Service" OR "Restaurants")) AND (TS=("Customer Experience" OR "Consumer Satisfaction" OR "Service Quality"))<br>**Date of Access: February 2025** |

## *2.2 Screening*

After the identification phase, the Systematic Literature Review (SLR) process proceeded with screening and refinement to ensure the inclusion of only high-quality, relevant studies. From the 1,543 initially identified records (986 from Scopus and 557 from Web of Science (WoS)), a rigorous filtering process was applied based on predefined inclusion and exclusion criteria (Table 2). This led to the removal of 1,221 records that did not meet the criteria, including non-English studies, publications before 2022, conference proceedings, book chapters, review papers, and in-press articles. After screening, 188 records from Scopus and 134 from WoS were retained, resulting in a final dataset of 322 studies for further qualitative analysis. This systematic exclusion process ensures that the selected literature is recent, peer-reviewed, and methodologically robust, focusing on empirical studies and theoretical advancements in digital technology, automation, and customer experience within the food and beverage (F&B) industry. The refined dataset highlights the latest technological innovations, including AI-driven service robots, self-service kiosks, predictive analytics, and smart food service systems, providing a current and globally accessible perspective. Furthermore, the exclusion of conference proceedings and in-press articles enhances the academic rigor of the study by ensuring that only validated research contributes to the findings. Moving forward, the data extraction and synthesis phase will systematically analyze key trends, technological impacts, challenges, and future opportunities, establishing a strong foundation for understanding how digital transformation and automation are reshaping service efficiency and customer experience in the F&B industry.

**Table 2**
The selection criterion is searching

| Criterion | Inclusion | Exclusion |
|---|---|---|
| Language | English | Non-English |
| Time line | 2022 – 2024 | < 2022 |
| Literature type | Journal (Article) | Conference, Book, Review |
| Publication Stage | Final | In Press |
| Subject | Social science, Business, Management and Accounting | Besides Social science, Business, Management and Accounting, |

### *2.3 Eligibility*

Following the initial screening, 296 articles were accessed for full-text eligibility assessment. A rigorous exclusion process was conducted based on relevance to the research objectives. Articles were excluded if they were outside the field of study, had titles lacking significant relevance, contained abstracts misaligned with the study's objectives, or if full-text access was unavailable. As a result, 264 articles were removed, leaving 32 studies for qualitative analysis. This refined selection ensures that only highly relevant, peer-reviewed research contributes to the Systematic Literature Review (SLR), providing insights into the impact of digital technology and automation innovation on service efficiency and customer experience in the food and beverage (F&B) industry.

### *2.4 Data Abstraction and Analysis*

The data abstraction and analysis phase employed an integrative synthesis approach, systematically combining qualitative and quantitative research to ensure a comprehensive understanding of digital technology and automation innovation in the food and beverage (F&B) industry. The qualitative synthesis involved thematic analysis, identifying key patterns related to service efficiency and customer experience, while the quantitative synthesis extracted statistical trends, empirical findings, and performance metrics from prior studies. This dual approach facilitated a holistic examination of the interplay between automation technologies and their impact on business operations and consumer satisfaction (see Figure 1).

A thematic classification process was implemented to categorize studies based on their methodology, research focus, and contribution to the discourse. Studies were grouped into three primary themes: technological advancements (e.g., AI, robotics, process automation), operational efficiency (e.g., service optimization, cost reduction), and customer experience (e.g., satisfaction, behavioral impact). Each category was assessed based on methodological rigor, including experimental validity, case study reliability, and survey-based generalizability. The classification ensured a structured evaluation of diverse research perspectives while maintaining thematic coherence.

The analysis process followed a systematic documentation framework, ensuring the traceability and reliability of extracted data. Relevant studies were cross-referenced, and key findings were synthesized into a structured database, facilitating comparative analysis. Data refinement involved iterative validation, ensuring alignment between identified themes and research objectives. Any discrepancies were resolved through consensus-based discussion among reviewers. To validate thematic accuracy, an expert review process was conducted involving specialists in digital transformation, service innovation, and F&B management. Experts assessed thematic clarity, alignment with industry trends, and methodological soundness, ensuring the integrity of the findings. Feedback was incorporated to refine categorizations and enhance analytical depth. Ultimately, the structured thematic framework strengthens the study's contribution to social science, business, management, and accounting by offering a rigorous and methodologically precise synthesis of existing knowledge. This systematic approach enhances scholarly discourse and provides a robust foundation for future research in technology-driven service innovation.

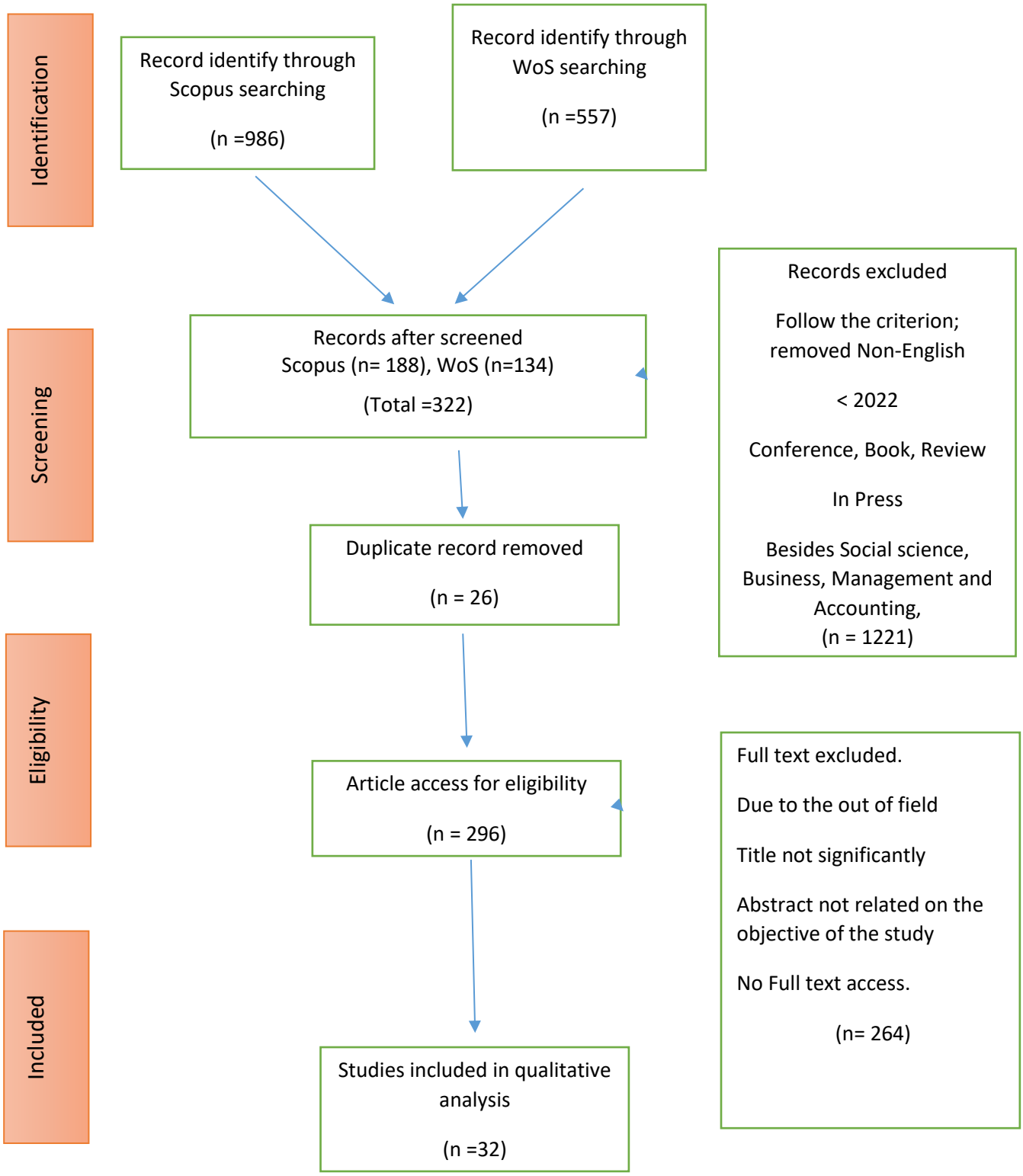


**Fig. 1.** Flow diagram of the proposed searching study

## 3. Result and Finding

### *3.1 Comprehensive Analysis of Smart Technologies and Automation in the Food and Beverage Industry*

The integration of smart technologies and automation in the food and beverage (F&B) industry has significantly transformed service efficiency and customer experience. Research in this domain emphasizes the role of AI-driven service robots, self-service technologies (SSTs), and digital automation in enhancing operational effectiveness, reducing human error, and improving service speed. A study by Song and Kim [1] explored the impact of humanoid retail service robots (RSRs) and found that usefulness, social capability, and robot appearance positively influence human-robot interaction (HRI), service quality perception, and eventual acceptance of robotic services. Similarly, Sharma *et al.,* [17] examined customer experiences in robotic dining environments and revealed that perceived enjoyment, speed, and novelty are key drivers of customer satisfaction, with trust playing a mediating role in repeat dining intentions. The study further highlighted that machine learning models, including Artificial Neural Networks (ANNs) and Support Vector Machines (SVMs), can predict consumer behavior, providing insights for service optimization. In a similar vein, Pitardi et al., [7] focused on the role of service robots in uncomfortable service encounters, revealing that robotic service reduces customer anxiety and enhances engagement by eliminating meta perception processing.

Self-service technologies (SSTs) have become a cornerstone of digital transformation in F&B establishments, providing customers with greater autonomy and convenience in service interactions. Hong and Ahn [8] examined the psychological aspects of SST usage and found that autonomy, competence, and relatedness strongly influence customer motivation and satisfaction when interacting with self-service kiosks and AI-powered ordering systems. The study also identified that customers with low technology anxiety exhibit higher adoption rates compared to those with higher resistance to digital interfaces. Expanding on this, Marinakou *et al.,* [3] analyzed the adoption of self-ordering kiosks (SOKs) in fast-food restaurants and found that service quality dimensions, perceived value, and customer experience significantly impact satisfaction and reuse intention. Additionally, Pai *et al.,* [18] highlighted the role of social media-based self-service technologies (SSTs) in enhancing functional value and customer retention, emphasizing the growing reliance on contactless service delivery models in the industry. The impact of robotic service authenticity on customer engagement and loyalty has also been extensively studied.

Song *et al.,* [13] employed cognitive appraisal theory to investigate robotic service quality and authenticity in restaurant settings, demonstrating that functional service quality influences customer perceptions of robotic service authenticity, which in turn enhances revisit intention. Similarly, Ma *et al.,* [11] conducted a cross-cultural comparative study between the U.S. and Chinese robotic restaurants, concluding that robotic applications across different product levels affect customer dining experiences in distinct ways. The study reinforced the importance of service personalization in robotic dining environments to mitigate potential resistance and increase acceptance levels. Complementing this, Qu [19] conducted a SWOT analysis of AI-driven restaurant services in Bangkok, revealing that efficiency, novelty, and brand differentiation are key advantages of automation, while technology malfunctions and dehumanization concerns remain challenges that restaurant operators must address.

While automation and smart technologies improve service efficiency and cost-effectiveness, challenges related to technology acceptance, cybersecurity risks, and workforce adaptation persist. Labus and Jelovac [9] applied the Technology Acceptance Model (TAM) to evaluate customer adoption of digital wine menu applications in hotel restaurants, revealing that perceived usefulness,

ease of use, and enjoyment drive positive behavioral intentions. However, concerns about perceived risks and lack of human interaction were identified as barriers to widespread adoption. Additionally, Xie *et al.,* [16] explored the value co-creation process in robotic services, demonstrating that customer inspiration and engagement levels are strongly linked to the perceived novelty and effectiveness of robotic assistance. To overcome resistance to AI-driven automation, Yang *et al.,* [20] introduced the Person-Environment Fit Theory, showing that customers evaluate robotic service authenticity based on task complexity and human-robot interaction quality, influencing their overall acceptance of AI-powered service solutions.

The findings from these studies provide a comprehensive perspective on smart technologies and automation in the F&B industry, demonstrating the increasing importance of AI, robotics, and digital transformation in enhancing operational efficiency and customer satisfaction. However, while technological advancements continue to optimize service quality, it is imperative to address challenges related to customer trust, user adaptability, and service personalization to ensure a seamless transition toward fully automated dining experiences (see Table 3)

**Table 3**
Smart technologies and automation in the food and beverage industry

| Article Title | Author(s) | Year | Findings |
|---|---|---|---|
| The role of the human-robot interaction in consumers' acceptance of humanoid retail service robots | Song and Kim [1] | 2022 | Usefulness, social capability, and robot appearance positively impact human-robot interaction (HRI), service quality perception, and acceptance of robotic services. |
| Robotic dining delight: Key factors driving customer satisfaction in service robot restaurants | Sharma *et al.,* [17] | 2023 | Perceived enjoyment, speed, and novelty are major satisfaction drivers, with trust mediating repeat dining intentions. Machine learning models (ANNs, SVMs) predict consumer behavior for service optimization. |
| Metaperception benefits of service robots in uncomfortable service encounters | Pitardi *et al.,* [7] | 2024 | Robotic service reduces customer anxiety and enhances engagement by eliminating meta-perception processing. |
| The role of autonomy, competence, and relatedness in motivation to use self-service technology (SST) | Hong and Ahn [8] | 2023 | Autonomy, competence, and relatedness strongly influence customer motivation and satisfaction in self-service interactions, with lower technology anxiety linked to higher adoption rates. |
| Customer intention to reuse self-ordering kiosks in fast-food restaurants | Marinakou *et al.,* [3] | 2023 | Service quality, perceived value, and customer experience significantly impact satisfaction and reuse intention of self-ordering kiosks. |
| Social media-based self-service technologies (SSTs) and customer retention | Pai *et al.,* [18] | 2022 | Social media-based self-service technologies enhance functional value and customer retention, with increased reliance on contactless service models. |
| Robotic service quality, authenticity, and revisit intention in restaurants | Song *et al.,* [13] | 2023 | Functional service quality influences customer perceptions of robotic service authenticity, enhancing revisit intention. |
| Comparative analysis of robotic dining experiences in the U.S. and China | Ma *et al.,* [11] | 2023 | Different product levels of robotic applications impact customer satisfaction and adaptation strategies across cultural contexts. |
| SWOT analysis of AI-driven restaurant services in Bangkok | Qu [19] | 2024 | Efficiency, novelty, and brand differentiation are key benefits of automation, while technology malfunctions and dehumanization concerns remain significant challenges. |

| | | | |
|---|---|---|---|
| Customer acceptance of digitalization in hotel restaurants: Applying the Extended Technology Acceptance Model | Labus and Jelovac [9] | 2022 | Perceived usefulness, ease of use, and enjoyment encourage digital menu adoption, but concerns about security and lack of human interaction hinder widespread acceptance. |
| The mechanism of value co-creation in robotic services: Customer inspiration from robotic service novelty | Xie *et al.,* [16] | 2022 | Customer inspiration and engagement are linked to perceived novelty and effectiveness of robotic assistance. |
| Utilitarian vs. hedonic roles of service robots and customer stereotypes | Yang *et al.,* [20] | 2024 | Customers evaluate robotic service authenticity based on task complexity and human-robot interaction quality, influencing acceptance levels. |

### *3.2 Comprehensive Analysis of Enhancing Customer Experience through Digital Innovation in the Food and Beverage Industry*

The integration of digital technologies and automation in the food and beverage (F&B) industry has revolutionized customer experience and service delivery. Research highlights the significance of self-service technologies (SSTs), AI-powered chatbots, smart dining innovations, and robotic service assistants in enhancing customer engagement and satisfaction. Hong and Ahn [8] examined the psychological impact of SST adoption, revealing that autonomy, competence, and relatedness strongly influence customer motivation and interaction quality with digital systems. Similarly, Marinakou *et al.,* [3] investigated self-ordering kiosks (SOKs) in fast-food restaurants and found that service quality, perceived value, and customer experience significantly influence satisfaction and reuse intention. Furthermore, Pai *et al.,* [18] explored the adoption of social media-based SSTs, emphasizing the role of contactless service models in improving functional value and customer retention.

AI-driven service robots and chatbots have transformed guest interactions and service personalization. Song and Kim [1] examined the acceptance of humanoid retail service robots (RSRs), concluding that usefulness, social capability, and appearance enhance human-robot interaction (HRI), service perception, and adoption likelihood. Similarly, Hlee *et al.,* [21] analyzed AI-powered service robots in restaurants, demonstrating that functional and emotional engagement, such as perceived friendliness and efficiency, significantly improve customer attitudes and experiential outcomes. Moreover, Gupta *et al.,* [5] introduced Genie, an AI-driven chatbot designed for restaurant order management, showing that Natural Language Processing (NLP) techniques significantly enhance response accuracy, customer satisfaction, and service efficiency.

Robotic service quality and authenticity play a crucial role in customer trust and revisit intention. Song *et al.,* [13] analyzed cognitive appraisal theory in robotic service settings, concluding that functional service quality positively impacts service authenticity, which directly influences customer loyalty and repeat visits. Similarly, Ma *et al.,* [11] conducted a cross-cultural study on robotic dining experiences, revealing that robotic applications at different service levels affect customer satisfaction and adaptation strategies. Expanding on this, Qu [19] performed a SWOT analysis of AI-driven restaurant services, identifying efficiency, novelty, and service differentiation as key strengths while highlighting technology malfunctions and lack of human touch as notable limitations.

Smart restaurant technologies and digital service models are shaping customer perceptions of service quality and engagement. Wong *et al.,* [6] introduced the 5-S Smart Service Quality (SSQ) model, emphasizing s-servicescape, s-assurance, s-responsiveness, s-reliability, and s-empathy as critical dimensions in smart restaurant experiences. Similarly, Lin *et al.,* [14] examined the transformation from paper-based to digital menus, demonstrating that video-based digital menus

generate stronger behavioral intentions compared to traditional formats. Furthermore, Yoon and Yu [22] explored restaurant-menu curation chatbots, concluding that perceived usefulness, engagement, and experience characteristics significantly influence customer adoption and long-term utilization intentions.

While digital innovation enhances customer experiences, challenges related to technology resistance, cybersecurity risks, and regulatory compliance persist. Labus and Jelovac [9] applied the Technology Acceptance Model (TAM) to assess customer adoption of digital wine menu applications, revealing that perceived ease of use, usefulness, and enjoyment drive positive behavioral intentions despite concerns about data security and impersonal service experiences. Additionally, Ma *et al.,* [23] examined the impact of self-service technology regulations, emphasizing that intrinsic and extrinsic motivations, along with environmental factors such as crowd density and time pressure, influence customer adoption of digital service tools. Lastly, Talukder *et al.,* [4] explored IT applications in food service quality, concluding that digital innovations do not directly influence revisit intentions but significantly enhance guest confidence and service perception, which indirectly affect long-term engagement.

The findings from these studies provide a structured analysis of how digital innovation enhances customer experience in the F&B industry, demonstrating the increasing role of AI, robotics, self-service technologies, and smart dining solutions in shaping customer engagement, operational efficiency, and service personalization. However, while these technologies significantly improve service speed and customer autonomy, it remains essential to address barriers related to trust, security, and the balance between automation and human interaction to ensure sustainable digital transformation in the industry (see Table 4).

**Table 4**
Enhancing customer experience through digital innovation in the food and beverage industry

| Article Title | Author(s) | Year | Findings |
|---|---|---|---|
| The role of autonomy, competence, and relatedness in motivation to use self-service technology (SST) | Hong and Ahn [8] | 2023 | Autonomy, competence, and relatedness significantly influence customer motivation and interaction with self-service technologies. |
| Customer intention to reuse self-ordering kiosks in fast-food restaurants | Marinakou *et al.,* [3] | 2023 | Service quality, perceived value, and customer experience strongly affect the satisfaction and reuse intention of self-ordering kiosks. |
| Social media-based self-service technologies (SSTs) and customer retention | Pai *et al.,* [18] | 2022 | Contactless service models improve functional value and customer retention, reinforcing reliance on digital self-service tools. |
| The Role of the human-robot Interaction in Consumers' Acceptance of Humanoid Retail Service Robots | Song *et al.,* [13] | 2022 | Usefulness, social capability, and robot appearance enhance human-robot interaction (HRI), improving service perception and adoption rates. |
| Understanding customer engagement with AI-powered service robots | Hlee *et al.,* [21] | 2023 | Functional and emotional engagement, such as friendliness and efficiency, significantly enhance customer attitudes and experiences with robotic services. |
| Genie: Enhancing information management in the restaurant industry through AI-powered chatbot | Gupta *et al.,* [5] | 2024 | AI-powered chatbots improve service accuracy, customer satisfaction, and overall restaurant efficiency using Natural Language Processing (NLP). |
| Robotic service quality, authenticity, and revisit intention in restaurants | Song *et al.,* [31] | 2023 | Functional service quality in robotic settings enhances service authenticity, strengthening customer trust and increasing repeat visits. |

| | | | |
|---|---|---|---|
| Comparative analysis of robotic dining experiences in the U.S. and China | Ma *et al.,* [11] | 2023 | Different robotic service levels influence customer satisfaction and adaptation strategies across cultural contexts. |
| SWOT analysis of AI-driven restaurant services in Bangkok | Qu [19] | 2024 | Efficiency, novelty, and service differentiation are key advantages, but technology malfunctions and lack of human touch present challenges. |
| The 5-S Smart Service Quality (SSQ) model in smart restaurant experiences | Wong *et al.,* [6] | 2022 | Smart service quality depends on s-servicescape, s-assurance, s-responsiveness, s-reliability, and s-empathy. |
| Digital menus and consumer behavior: The impact of video-based menu design | Lin *et al.,* [14] | 2023 | Video-based digital menus generate stronger behavioral intentions compared to traditional formats. |
| Impact of customer experience on attitude and utilization intention of a restaurant-menu curation chatbot service | Yoon and Yu [22] | 2022 | Perceived usefulness, engagement, and customer experience significantly influence chatbot adoption and long-term usage. |
| Customer acceptance of digitalization in hotel restaurants: Applying the Extended Technology Acceptance Model | Labus and Jelovac [9] | 2022 | Perceived ease of use, usefulness, and enjoyment improve digital menu adoption, but concerns about security and impersonal service remain. |
| The impact of self-service technology regulations on digital service adoption | Ma *et al.,* [11] | 2024 | Intrinsic and extrinsic motivations, alongside factors like crowd density and time pressure, influence customer adoption of self-service tools. |
| Information Technology, Food Service Quality, and Restaurant Revisit Intention | Talukder *et al.,* [4] | 2023 | IT applications do not directly influence revisit intentions but enhance customer confidence and perceived service quality, indirectly boosting engagement. |

### *3.3 Comprehensive Analysis of Challenges and Future Opportunities in Digital Transformation in the Food and Beverage Industry*

The rapid adoption of digital transformation in the food and beverage (F&B) industry presents numerous challenges and opportunities for both businesses and consumers. One significant challenge identified is customer acceptance and technology adoption resistance. Labus and Jelovac [9] analyzed customer attitudes toward digital menu applications in hotel restaurants, revealing that while perceived ease of use, usefulness, and enjoyment positively impact behavioral intention to return, perceived risks associated with digitalization, such as security concerns and lack of human interaction, pose barriers to widespread acceptance. Similarly, Ma *et al.,* [23] examined the impact of self-service technology (SST) regulations and found that intrinsic and extrinsic motivations, along with environmental factors such as crowd density and time pressure, significantly influence customer adoption of SSTs. Moreover, Van Ninh and Danko [12] emphasized the role of e-marketing and digital transformation strategies in enhancing sales efficiency and customer engagement, suggesting that strategically crafted digital marketing techniques can mitigate adoption resistance.

Another pressing issue in digital transformation is cybersecurity risks and data privacy concerns. Cheung *et al.,* [10] investigated the impact of mobile payment adoption in restaurants, highlighting that while perceived enjoyment and service quality enhance customer satisfaction, concerns over privacy and security risks negatively affect long-term adoption. Zibarzani *et al.,* [2] further analyzed consumer preferences using machine learning and text mining techniques, revealing that COVID-19 safety regulations moderated customer satisfaction with digital services, particularly regarding online transactions and AI-driven service quality management. Additionally, Gupta *et al.,* [5] explored the

role of AI-powered chatbots, demonstrating that advanced Natural Language Processing (NLP) techniques can enhance customer experience while also requiring robust cybersecurity frameworks to protect consumer data and ensure trust in AI-driven interactions.

Despite these challenges, significant opportunities exist to enhance customer experiences and operational efficiency through robotic service automation and AI-driven innovations. Song *et al.,* [13] analyzed cognitive appraisal theory in robotic restaurant settings, finding that functional service quality and authenticity positively influence customer engagement and revisit intentions. Expanding on this, Pitardi *et al.,* [7] demonstrated that service robots mitigate customer discomfort in uncomfortable service encounters, leading to improved satisfaction and behavioral outcomes. Similarly, Yang *et al.,* [20] examined the utilitarian versus hedonic roles of service robots, showing that customer stereotypes and perceived authenticity of robotic services shape their acceptance and long-term feasibility in restaurant environments. These findings suggest that robotic service deployment, when optimized for customer interaction and authenticity, can significantly enhance service quality.

Another emerging opportunity in digital transformation is the integration of blockchain technology for food traceability and supply chain management. Qu [19] conducted a SWOT analysis of AI-driven restaurant services in Bangkok, identifying efficiency, service differentiation, and sustainability as key advantages. However, technology malfunctions, high costs, and the risk of dehumanization were noted as limitations. Moriuchi and Murdy [24] further explored human-robot interaction, finding that while customers generally prefer human service delivery, they are more receptive to robotic services in casual dining environments, where efficiency and novelty play a greater role. Additionally, Hlee *et al.,* [21] investigated the impact of AI-powered service robots and revealed that perceived friendliness, competence, and service efficiency drive positive attitudes toward robotic dining experiences, further supporting the case for continued investment in AI-driven hospitality solutions.

While digital transformation introduces operational efficiency, it also raises concerns regarding workforce adaptation and employment displacement. Wiastuti and Rashid [25] examined the perception of Generation Z toward restaurant innovation, revealing that technology-based service innovativeness significantly influences customer expectations and experience. However, balancing automation with human-centric service remains crucial to sustaining employment levels and customer satisfaction. Xie *et al.,* [16] explored the value co-creation process in robotic services, demonstrating that customer inspiration and engagement depend on the level of human-robot collaboration, highlighting the need for a hybrid service model that integrates both AI and human interaction.

The findings from these studies provide a comprehensive perspective on the challenges and future opportunities in digital transformation within the F&B industry. While technology adoption resistance, cybersecurity risks, and workforce adaptation remain significant concerns, AI-driven automation, blockchain for traceability, and enhanced customer service innovations offer substantial potential for industry growth. Addressing these challenges through strategic digital marketing, robust cybersecurity frameworks, and a hybrid service model will be crucial in maximizing the benefits of digital transformation in the food service sector (see Table 5).

**Table 5**
Challenges and future opportunities in digital transformation in the food and beverage industry

| Article Title | Author(s) | Year | Findings |
|---|---|---|---|
| Customer acceptance of digitalization in hotel restaurants: Applying the Extended Technology Acceptance Model | Labus and Jelovac [9] | 2022 | Perceived ease of use, usefulness, and enjoyment drive digital menu adoption, but security concerns and lack of human interaction hinder acceptance. |
| The impact of self-service technology regulations on digital service adoption | Ma *et al.,* [11] | 2024 | Intrinsic and extrinsic motivations, along with crowd density and time pressure, significantly influence customer adoption of self-service technologies. |
| The role of e-marketing and digital transformation in enhancing sales efficiency | Van Ninh and Danko [12] | 2023 | Strategically crafted digital marketing techniques improve sales efficiency and customer engagement, reducing adoption resistance. |
| Consumer behavior and mobile payment: An empirical study of the restaurant industry | Cheung *et al.,* [10] | 2022 | Mobile payments enhance convenience but are affected by cybersecurity risks and data privacy concerns, reducing long-term adoption. |
| Machine learning and consumer preferences: Impact of COVID-19 regulations on digital services | Zibarzani *et al.,* [2] | 2022 | COVID-19 safety regulations influenced customer satisfaction with AI-driven service quality management, particularly in online transactions. |
| Genie: Enhancing information management in the restaurant industry through AI-powered chatbot | Gupta *et al.,* [5] | 2024 | AI-powered chatbots improve customer experience but require strong cybersecurity frameworks to ensure data protection and trust. |
| Robotic service quality, authenticity, and revisit intention in restaurants | Song *et al.,* [13] | 2023 | Functional service quality and authenticity in robotic restaurants improve customer engagement and revisit intentions. |
| Metaperception benefits of service robots in uncomfortable service encounters | Pitardi *et al.,* [7] | 2024 | Service robots reduce customer discomfort in high-stress interactions, leading to improved satisfaction and behavioral outcomes. |
| Utilitarian vs. hedonic roles of service robots and customer stereotypes | Yang *et al.,* [20] | 2024 | Customer acceptance of robotic services depends on perceived authenticity and stereotypes, shaping long-term feasibility. |
| SWOT analysis of AI-driven restaurant services in Bangkok | Qu [19] | 2024 | Efficiency, service differentiation, and sustainability are benefits, but technology malfunctions and the risk of dehumanization pose challenges. |
| The role of robots in the service industry: Factors affecting human-robot interactions | Moriuchi and Murdy [24] | 2024 | Customers generally prefer human service but accept robots in casual dining where efficiency and novelty are prioritized. |
| Understanding customer engagement with AI-powered service robots | Hlee *et al.,* [21] | 2023 | Perceived friendliness, competence, and efficiency of AI-powered robots positively influence customer attitudes toward robotic dining experiences. |
| Evaluating restaurant innovativeness: The Generation Z perspective | Wiastuti and Rashid [25] | 2024 | Technology-based service innovation significantly influences Generation Z's expectations, but a balance between automation and human service is essential. |
| The mechanism of value co-creation in robotic services: Customer inspiration from robotic service novelty | Xie *et al.,* [16] | 2022 | Customer engagement in robotic services depends on the level of human-robot collaboration, emphasizing the need for hybrid service models. |

## 4. Discussion and Conclusion

The adoption of smart technologies and automation has brought transformative changes to the food and beverage industry, significantly improving service efficiency and customer experience. Additionally, to ensure a more inclusive understanding of consumer responses to digital transformation, future studies should incorporate insights from diverse demographic groups. Variables such as age, culture, gender, digital literacy, and socio-economic status significantly shape perceptions and acceptance of technologies like AI-driven kiosks, chatbots, and robotic servers. For example, Generation Z consumers tend to embrace technology-based service innovations more readily due to greater digital exposure, as evidenced by Wiastuti and Rashid [25]. In contrast, older generations may experience technology anxiety or exhibit preference for human interaction, impacting adoption rates. Furthermore, cross-cultural perspectives, such as those in Ma *et al.,* [11], reveal differing expectations and adaptation strategies in robotic dining experiences across regions like the U.S. and China. Including these diverse viewpoints will help tailor digital innovations to meet varied consumer needs and expectations, fostering more equitable, user-centric, and sustainable digital transitions in the food and beverage industry. AI-powered service robots, self-service technologies, and automated systems have enhanced operational effectiveness by minimizing human error, expediting service speed, and increasing customer engagement [26]. The implementation of humanoid robots and AI-driven customer interactions has proven to be effective in fostering trust, enhancing service perception, and increasing consumer satisfaction, particularly in robotic dining environments. Moreover, predictive analytics and machine learning applications have facilitated service optimization by accurately anticipating consumer preferences and behavioral patterns. The increasing prevalence of self-service technologies, including digital kiosks and AI-driven ordering systems, has also empowered customers by offering convenience and autonomy, fostering greater satisfaction and reuse intention.

Psychological factors such as autonomy, competence, and relatedness have played a crucial role in technology adoption, with lower technology anxiety correlating with higher acceptance of digital interfaces. Furthermore, the integration of AI-powered customer service solutions and social media-based self-service platforms has reinforced the industry's shift toward contactless service models. However, despite these advancements, challenges related to robotic service authenticity, consumer acceptance, and workforce adaptation remain significant. While the adoption of smart technologies has significantly improved operational efficiency and customer engagement in the F&B industry, the path toward full digital transformation is fraught with critical challenges that must be addressed for sustainable implementation. One of the most pressing concerns is service authenticity, especially in robotic or AI-assisted service environments. Customers often associate authentic service with emotional intelligence, empathy, and personalized human touch—qualities that current AI-driven systems struggle to replicate. The perceived lack of warmth and human connection in interactions with service robots or digital kiosks can diminish customer satisfaction, particularly in fine-dining or hospitality-focused settings where experience and ambiance play a crucial role.

Dehumanization of service interactions presents another fundamental challenge. As businesses increasingly replace front-line employees with automation, there is growing concern that the human element of hospitality such as empathy, cultural nuance, and spontaneous responsiveness, which may be vanished. This shift risks creating sterile, transactional service environments that could alienate customers who value personalized interaction. For many, human engagement remains central to trust-building and emotional comfort, especially during problem resolution or special requests. This necessitates the design of hybrid service models where automation complements, rather than replaces, human staff.

In addition, data privacy and cybersecurity issues have become increasingly significant as digital technologies rely heavily on customer data for personalization and predictive analytics. The collection, storage, and use of sensitive information such as payment details, preferences, and behavioral patterns raise concerns about potential misuse or data breaches. Customers are becoming more cautious about how their data is handled, and regulatory compliance—such as adherence to GDPR or local data protection laws—is becoming a prerequisite for trust and long-term adoption. The failure to implement robust cybersecurity protocols can not only erode customer confidence but also result in legal and financial repercussions for businesses.

Moreover, technology acceptance resistance of stemming from digital illiteracy, generational divides, or psychological barriers like technology anxiety. This likely continues to affect adoption rates, especially among older or less tech-savvy customer segments. Overcoming this resistance requires targeted user education, intuitive interface design, and the inclusion of optional human assistance to ease the transition. To navigate these challenges effectively, food and beverage organizations must strategically balance automation with human-centric values. Emphasizing emotional engagement, ensuring ethical data handling, and designing inclusive, customer-friendly technologies will be key to overcoming adoption barriers. Only by addressing these nuanced challenges can the industry fully realize the potential of digital transformation without compromising service quality or consumer trust. While this review presents a comprehensive overview of digital transformation in the food and beverage industry, future research would benefit from a more focused scope, such as targeting specific technologies or application domains. For instance, studies could explore in greater depth the effectiveness of AI powered chatbots in managing online food orders, or the customer perception of robotic servers in casual versus fine dining environments. The focused analyses would allow for a more granular understanding of technological impacts on operational performance, user behavior, and service personalization. Additionally, narrowing the scope could facilitate more precise measurement of outcomes such as customer satisfaction, cost efficiency, and return on investment, thereby offering practical insights for industry implementation. This approach would also help bridge existing research gaps related to the nuanced operational and psychological factors influencing the success of individual technologies. Service personalization has been identified as a key factor in mitigating customer resistance to robotic applications, with studies emphasizing the importance of maintaining authenticity and enhancing emotional engagement in AI-driven service environments [27].

Although automation presents undeniable advantages in terms of efficiency, novelty, and brand differentiation, concerns regarding technological malfunctions, cybersecurity risks, and perceived dehumanization of service interactions continue to hinder widespread adoption. Additionally, perceived risks associated with digital technologies, including security vulnerabilities and the lack of human interaction, have been highlighted as barriers to consumer acceptance [28]. Addressing these challenges requires a balanced approach that integrates automation while preserving essential human touchpoints to ensure that AI-driven innovations align with customer expectations. The ongoing evolution of smart restaurant technologies underscores the necessity for continuous improvements in service reliability, data security, and AI-human interaction design. As the industry moves toward a more digitalized and automated future, striking a balance between technological efficiency and personalized customer engagement remains critical to achieving long-term success in the food and beverage sector.

The integration of digital technologies and automation has reshaped service delivery and customer interactions in the food and beverage industry. The implementation of self-service technologies, AI-driven chatbots, and robotic service assistants has led to significant improvements in customer engagement and satisfaction [29]. Digital ordering kiosks and smart service interfaces

provide users with enhanced autonomy and convenience, contributing to a more seamless dining experience. The psychological impact of these innovations has been explored, revealing that ease of use, perceived value, and technological familiarity influence adoption rates and long-term utilization.

AI-powered service robots and automated customer assistance tools have further personalized service delivery, improving operational efficiency while simultaneously fostering positive emotional responses. AI-driven chatbots and intelligent order management systems enhance response accuracy and streamline service interactions, ensuring that digital transformation extends beyond convenience to create more engaging and personalized experiences [30]. While robotic service solutions have introduced new opportunities in hospitality, their effectiveness depends on maintaining authenticity, service quality, and consumer trust. Studies have demonstrated that perceived authenticity in robotic service environments strengthens customer loyalty, increasing the likelihood of repeat visits. However, challenges such as technological malfunctions, limitations in AI-human interactions, and the potential for service dehumanization require further refinement of these innovations.

In addition to functionality, digital service models shape perceptions of service quality, with video-based digital menus, AI-powered curation tools, and smart restaurant systems influencing customer decision-making and behavioral intent. Although technological advancements continue to enhance customer experiences, concerns related to cybersecurity, data privacy, and the impersonal nature of digital services remain significant. Ensuring long-term adoption requires addressing these issues while balancing automation with human-centered service interactions. While digital transformation presents substantial advantages in efficiency, personalization, and customer engagement, a strategic approach is necessary to mitigate risks, improve acceptance, and maintain service authenticity.

The rapid evolution of digital transformation in the food and beverage industry has introduced both challenges and opportunities, reshaping service efficiency and customer engagement. The integration of AI-driven automation, self-service technologies, and blockchain solutions has significantly enhanced operational processes, yet concerns regarding consumer acceptance, data security, and workforce displacement remain substantial. Resistance to adopting digital menu applications and self-service technologies has been linked to perceived risks such as cybersecurity threats, data privacy vulnerabilities, and a decline in human interaction, factors that influence customer trust and willingness to engage with automated service models. Regulatory frameworks and environmental variables, including crowded service environments and time-sensitive transactions, further affect digital adoption rates. While cybersecurity risks continue to pose barriers to digital service expansion, the deployment of AI-powered chatbots and intelligent customer service systems has demonstrated significant potential in improving response accuracy, streamlining order management, and fostering customer loyalty, provided that stringent security measures safeguard consumer data. The application of robotic service assistants has emerged as a pivotal innovation, contributing to reduced customer anxiety, heightened service efficiency, and enhanced brand differentiation [31]. The effectiveness of robotic services, however, largely depends on perceived authenticity, customer stereotypes, and the degree of interaction between humans and automated systems. In addition to AI and robotics, blockchain technology has been identified as a valuable tool for improving supply chain transparency, food traceability, and operational sustainability, though the costs and complexity associated with its implementation remain limiting factors. Despite the efficiencies gained from automation, concerns over employment displacement and the diminishing role of human service providers in hospitality settings persist, necessitating a balanced approach that integrates technological advancements with human-centric service experiences. The adoption of a hybrid service model that combines automation with personalized customer interactions presents a

viable strategy for ensuring the long-term success of digital transformation in the industry. Strengthening cybersecurity measures, fostering consumer trust, and refining AI-human collaboration models will be essential in addressing existing challenges while capitalizing on the opportunities that digital innovation presents for the evolving foodservice landscape.

The adoption of smart technologies and automation has reshaped the food and beverage industry, enhancing service efficiency and customer experience. AI-powered service robots, self-service technologies, and predictive analytics have optimized operations, reducing human error and personalizing interactions. However, challenges such as robotic service authenticity, cybersecurity risks, and consumer resistance persist. Balancing automation with human-centric service is critical to ensuring long-term adoption [32]. This study contributes to the literature by highlighting the role of AI-driven solutions in improving operational efficiency and customer engagement while addressing psychological and technological barriers to adoption. Theoretically, it expands the understanding of consumer perceptions toward robotic service and digital transformation in the food and beverage industry. Practically, it offers insights for businesses to implement automation while maintaining service authenticity and trust. Future research should explore strategies to mitigate service dehumanization, enhance AI-human collaboration, and address ethical concerns surrounding data privacy and workforce adaptation. Investigating the impact of hybrid service models that integrate automation with personalized human interactions will be crucial in shaping the next phase of digital transformation in the hospitality sector.

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