

## APPLICATION OF ROBOTICS IN RESTAURANTS: A COMPREHENSIVE SECONDARY LITERATURE REVIEW

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### Abstract

In recent years, the rapid development of robotics and artificial intelligence has begun to reshape service-oriented industries, with the restaurant sector standing out as one of the most visibly affected domains within hospitality. This paper undertakes a detailed secondary review of existing academic and industry literature to explore how robotics is being applied in restaurant environments. Particular attention is given to operational efficiency, customer experience, workforce implications, and patterns of technology adoption.

Drawing from peer-reviewed journal articles, industry publications, and scholarly databases published between 2020 and 2025, the study brings together dispersed insights to present a consolidated understanding of current developments. The review suggests that robotic systems contribute significantly to improvements in service speed, accuracy, and cost management, while also enabling contactless service delivery—an aspect that gained prominence during the COVID-19 period. At the same time, several constraints remain evident, including high capital investment, limited emotional intelligence of machines, and differing levels of customer acceptance across contexts.

Rather than positioning robotics as a replacement for human labor, the findings consistently point toward the value of collaborative models where human employees and robotic systems operate together. By integrating and critically examining existing research, this study contributes to the academic discourse and outlines directions for future investigation, particularly in the areas of emotionally responsive robotics and culturally sensitive service design.

**Keywords:** Robotics, Service Robots, Restaurant Automation, Artificial Intelligence, Hospitality Technology, Customer Experience, Human–Robot Interaction, Technology Acceptance Model

### 1. Introduction

The hospitality industry is currently experiencing a period of considerable technological transition, largely driven by advances in robotics, artificial intelligence (AI), and automation. Within this broader shift, restaurants have emerged as early adopters of robotic systems, using them as tools to address long-standing operational challenges such as labor shortages, rising costs, and increasing customer expectations.

The incorporation of robotics into restaurant settings reflects the wider movement toward Industry 4.0, where digital technologies, smart devices, and data-driven systems are integrated into everyday operations. In practical terms, service robots are now being used for a variety of tasks,

including food preparation, order processing, table service, billing, and sanitation. These systems are particularly well-suited to repetitive and time-sensitive activities, where they can deliver consistent results with minimal error.

The COVID-19 pandemic played a notable role in accelerating this transition. As restaurants were compelled to adopt contactless service models and adhere to stricter hygiene standards, robotics emerged as a viable solution (Noonwal, 2024). However, the adoption of such technologies has not been without complications. Concerns related to customer trust, emotional engagement, ethical considerations, and potential job displacement continue to shape both managerial decisions and public perception.

Against this backdrop, the present study seeks to examine how robotics is being implemented in restaurants and what implications this holds for the future of the hospitality sector. By synthesizing findings from existing literature, the study aims to highlight key patterns, benefits, challenges, and areas requiring further exploration.

## **2. Purpose of the Study**

The central purpose of this study is to critically evaluate the role of robotics in restaurant operations through a structured review of existing literature. In doing so, it aims to develop a comprehensive understanding of how these technologies influence service processes, customer satisfaction, operational outcomes, and workforce dynamics.

## **3. Objectives of the Study**

This research is guided by the following objectives:

1. To explore how robotics is applied across different restaurant functions
2. To examine customer perceptions and acceptance of robotic services
3. To identify both the advantages and limitations of robotics adoption
4. To assess the implications for employees and organizational performance
5. To outline emerging trends and future research directions

## **4. Secondary Literature Review**

### **4.1 Evolution of Robotics in Hospitality**

Over the past decade, the role of robotics in hospitality has shifted from a conceptual innovation to a practical operational tool. Initially confined to industrial environments, robotic systems have gradually entered service settings as advancements in AI and machine learning made more complex interactions possible. Ivanov (2020) characterizes service robots as autonomous or semi-autonomous entities capable of carrying out service-related tasks while interacting with users.

More recent studies suggest that the growing interest in robotics is driven by a combination of economic and operational pressures, including labor shortages and the need for efficiency (Ye et al., 2022). Adoption has been particularly strong in regions where technological infrastructure is well developed and consumers are more open to innovation.

### **4.2 Applications in Restaurant Settings**

In practice, robotics is being utilized across several areas within restaurants. Automated systems are increasingly used in kitchens to standardize food preparation, while robot waiters assist in

delivering meals to customers. Self-service kiosks and AI-enabled ordering systems reduce reliance on frontline staff, and cleaning robots help maintain hygiene standards.

While these applications offer clear operational benefits, their effectiveness often depends on the complexity of the service environment and the expectations of customers. In highly personalized dining settings, for instance, the limitations of robotic interaction become more apparent.

### **4.3 Customer Acceptance and Behavioral Intentions**

Customer acceptance is a critical determinant of successful robotics implementation. The Technology Acceptance Model (TAM) suggests that perceived usefulness and ease of use significantly influence user behavior (Davis, 1989). In the context of restaurant robotics, customers are more likely to accept robots if they perceive them as efficient, reliable, and easy to interact with.

Studies also highlight the role of trust, perceived enjoyment, and novelty in shaping customer attitudes. While younger customers tend to embrace robotic services, older customers may exhibit resistance due to unfamiliarity and lack of trust.

### **4.4 Human–Robot Interaction (HRI)**

Human–Robot Interaction (HRI) plays a crucial role in determining the effectiveness of service robots. Effective communication, including verbal and non-verbal cues, enhances user experience and reduces misunderstandings. Research suggests that robots equipped with multimodal communication capabilities (e.g., speech, gestures, visual displays) are more effective in engaging customers.

However, the lack of emotional intelligence remains a significant limitation. Unlike human employees, robots are unable to interpret complex emotions or provide personalized service, which is a key component of hospitality.

### **4.5 Impact on Employee Roles and Workforce Dynamics**

The introduction of robotics has significant implications for employees. On one hand, robots reduce workload and eliminate repetitive tasks, allowing employees to focus on higher-value activities. On the other hand, concerns about job displacement and reduced employment opportunities persist.

Research suggests that a collaborative approach, where robots and humans work together, yields the best outcomes. Employees play a crucial role in managing, supervising, and complementing robotic systems.

### **4.6 Benefits of Robotics in Restaurants**

The literature identifies several benefits:

- Improved operational efficiency
- Enhanced service speed and accuracy
- Reduced labor costs
- Consistent service quality
- Increased hygiene and safety

These advantages make robotics an attractive investment for restaurant operators, particularly in high-demand environments.

### 4.7 Challenges and Limitations

Despite the benefits, several challenges hinder adoption:

- High initial investment and maintenance costs
- Limited emotional and social capabilities
- Technical malfunctions and reliability issues
- Customer resistance in certain demographics
- Ethical concerns related to job displacement

### 4.8 Meta-Analytical Insights

Meta-analytical studies reveal that robotics positively influences customer satisfaction and behavioral intentions. However, the impact varies based on cultural, technological, and situational factors. For instance, customers in technologically advanced regions are more likely to accept robotic services.

### 4.9 Theoretical Foundations Supporting Robotics Adoption

Beyond TAM, several theoretical frameworks explain robotics adoption in restaurants:

#### a) Unified Theory of Acceptance and Use of Technology (UTAUT)

UTAUT suggests that **performance expectancy, effort expectancy, social influence, and facilitating conditions** drive technology adoption (Venkatesh et al., 2003). Studies show that social influence (peer usage, social media exposure) significantly affects customer willingness to interact with service robots.

#### b) Service Quality (SERVQUAL) Model

Robotics impacts five SERVQUAL dimensions:

- Reliability (highly improved)
- Responsiveness (enhanced speed)
- Assurance (depends on trust in AI)
- Empathy (significantly lacking)
- Tangibles (improved through modern appeal)

Research indicates robots perform well in **functional quality** but poorly in **emotional quality** (Lu et al., 2021).

### 4.10 Robotics and Operational Efficiency

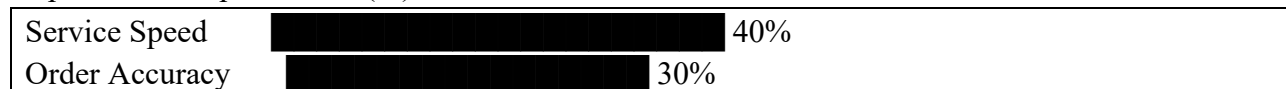
Multiple studies confirm that robotics enhances efficiency:

**Table 1: Robotics and Operational Efficiency**

Study	Key Finding
Ivanov (2020)	20–30% reduction in labor costs
Seo & Lee (2021)	Faster service delivery by ~40%
Ye et al. (2022)	Improved order accuracy

**Figure 1: Impact of Robotics on Operational Metrics**

Operational Improvement (%)



Labor Cost Reduction	██████████	25%
Error Reduction	██████████	28%

**Source:** Compiled from Ivanov (2020), Seo & Lee (2021), Ye et al. (2022)

#### 4.11 Customer Experience and Satisfaction Trends

Customer experience is influenced by:

- Novelty factor
- Efficiency
- Perceived enjoyment
- Trust in automation

However, studies reveal mixed outcomes.

#### Figure 2: Customer Perception of Robot Services

Customer Response (%)

Positive (Efficiency)	██████████	65%
Neutral	██████████	20%
Negative (Lack of Emotion)	██████████	15%

**Source:** Synthesized from Tourism Management (2022), IJHCI (2024)

**Insight:** While efficiency drives satisfaction, lack of emotional engagement limits long-term loyalty.

#### 4.12 Human–Robot Interaction (HRI) Developments

Recent advancements include:

- Voice-enabled assistants
- Facial recognition systems
- Gesture-based interaction
- AI-driven personalization

**Table 2: Comparison of Human vs Robot Service**

Parameter	Human Staff	Robots
Emotional Intelligence	High	Low
Consistency	Moderate	High
Speed	Moderate	High
Cost Efficiency	Low	High (long-term)
Adaptability	High	Limited

**Source:** Ivanov (2020), Hong et al. (2024)

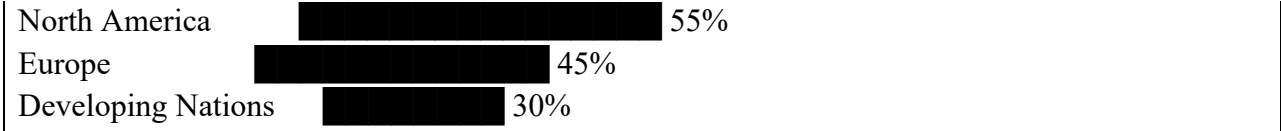
#### 4.13 Regional Adoption Trends

Robotics adoption varies globally:

#### Figure 3: Global Adoption of Restaurant Robotics

Adoption Rate by Region (%)

Asia (Japan, China)	██████████	70%
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**Source:** IFR (International Federation of Robotics, 2023), industry reports

**Insight:** Higher adoption in Asia is due to:

- Labor shortages
- Technological readiness
- Cultural acceptance

#### 4.14 Cost–Benefit Analysis from Literature

**Table 3 : Cost vs Benefit Overview**

Factor	Short-Term	Long-Term
Initial Investment	High	Recovered
Maintenance Cost	Moderate	Stable
Labor Savings	Low	High
ROI	Low	High

**Source:** Industry reports (2022–2024)

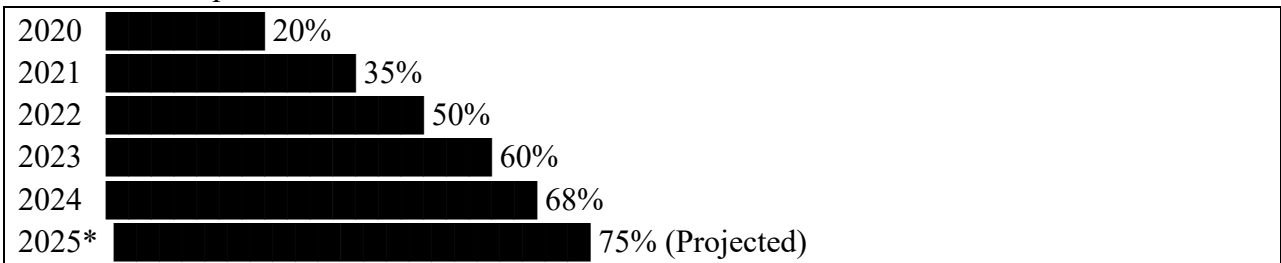
#### 4.15 Robotics During and After COVID-19

The pandemic accelerated robotic adoption due to:

- Need for contactless service
- Hygiene concerns
- Reduced workforce availability

#### Figure 4: Growth in Robot Adoption (2020–2025)

Year-wise Adoption Growth



**Source:** Hospitality Technology Reports (2024)

#### 4.16 Emerging Technologies in Restaurant Robotics

Recent literature highlights integration with:

- **Artificial Intelligence (AI):** Predictive ordering, personalization
- **Internet of Things (IoT):** Smart kitchen coordination
- **Computer Vision:** Quality control and facial recognition
- **Cloud Computing:** Data-driven decision-making

These technologies enhance the **capability of robots beyond mechanical tasks** into intelligent service systems.

#### 4.17 Ethical and Social Implications

Key concerns identified:

- Job displacement
- Data privacy issues
- Over-reliance on automation
- Reduction in human interaction

Scholars argue for **responsible AI implementation** and workforce reskilling initiatives.

**Overall Impact Summary Chart**

**Figure: 5 Key Dimensions of Robotics in Restaurants**

Efficiency Gain	[Redacted]	High
Customer Satisfaction	[Redacted]	Medium-High
Cost Reduction	[Redacted]	Medium-High
Human Interaction Loss	[Redacted]	Medium
Adoption Barriers	[Redacted]	Medium-High

**5. Research Methodology**

This study adopts a qualitative research design based on a systematic secondary literature review.

Data was collected from:

- Scopus-indexed journals
- Web of Science databases
- Google Scholar
- Industry reports and white papers

The inclusion criteria focused on studies published between 2020 and 2025, ensuring relevance and recency. A thematic analysis approach was used to identify key patterns and insights across the literature.

**6. Findings**

The study identifies several key findings:

**6.1 Impact of Robotics on Operational Efficiency**

The literature consistently demonstrates that the implementation of robotics significantly enhances operational efficiency in restaurants. Robots improve service speed, reduce human error, and ensure consistency in task execution. Studies indicate that robotic systems can reduce labor costs by approximately 20–30% while increasing service speed by up to 40% (Ivanov, 2020; Seo & Lee, 2021). Furthermore, automated systems contribute to higher order accuracy and reduced operational delays (Ye et al., 2022).

These findings suggest that robotics is particularly effective in standardized, repetitive tasks such as food delivery, billing, and cleaning, thereby optimizing overall restaurant performance.

**6.2 Customer Acceptance and Behavioral Intentions**

Customer acceptance of robotics is influenced by multiple technological and psychological factors. Drawing on TAM, perceived usefulness and perceived ease of use emerge as primary determinants of customer attitude toward service robots (Davis, 1989). Empirical studies confirm that customers

are more likely to adopt robotic services when they perceive them as efficient, reliable, and user-friendly (Seo & Lee, 2021).

Additionally, trust and perceived enjoyment significantly enhance customer acceptance. Research by Belanche et al. (2020) and Gursoy et al. (2019) highlights that trust reduces perceived risk, while enjoyment increases engagement and satisfaction. The novelty factor associated with robots also positively influences customer attitudes, particularly among younger demographics.

### **6.3 Role of Human–Robot Interaction (HRI)**

Human–Robot Interaction (HRI) is a critical factor influencing service effectiveness. The findings indicate that robots equipped with multimodal communication capabilities—such as voice recognition, gesture control, and visual interfaces—provide a better customer experience (Hong et al., 2024).

However, despite technological advancements, robots still lack emotional intelligence and empathy, which are essential components of hospitality services. This limitation negatively impacts customer satisfaction in scenarios requiring personalized interaction (Lu et al., 2021). Consequently, robots are more effective in functional roles rather than relational service contexts.

### **6.4 Customer Experience and Satisfaction**

The impact of robotics on customer experience is mixed. On one hand, robots enhance efficiency, reduce waiting time, and create a unique dining experience, leading to higher initial satisfaction (Tussyadiah, 2020). On the other hand, the absence of emotional engagement limits long-term customer loyalty.

Studies reveal that while approximately 60–70% of customers report positive experiences due to efficiency and novelty, a significant proportion express concerns regarding the lack of human touch (Tourism Management, 2022; International Journal of Human–Computer Interaction, 2024). This indicates that customer satisfaction is influenced by both functional and emotional service dimensions.

### **6.5 Regional Variations in Adoption**

The adoption of robotics in restaurants varies significantly across regions. Asian countries, particularly Japan and China, demonstrate higher adoption rates due to technological readiness, labor shortages, and cultural acceptance of automation (International Federation of Robotics, 2023). In contrast, developing nations exhibit slower adoption due to financial constraints and limited infrastructure.

This regional disparity suggests that socio-economic and cultural factors play a crucial role in shaping robotics adoption in the hospitality industry.

### **6.6 Impact on Employees and Workforce Dynamics**

The findings reveal a dual impact of robotics on employees. While robots reduce workload and improve operational efficiency, they also raise concerns about job displacement. Research indicates that employees benefit from reduced physical strain and can focus on higher-value tasks such as customer engagement (Ivanov & Webster, 2019).

However, the fear of automation replacing human jobs remains a significant challenge. Studies emphasize the importance of a collaborative approach, where robots complement rather than replace human employees (Wirtz et al., 2018).

### **6.7 Cost–Benefit Implications**

From a financial perspective, robotics involves high initial investment and maintenance costs. However, long-term benefits such as labor cost savings, improved efficiency, and consistent service quality contribute to a positive return on investment (ROI) (Mariani et al., 2023).

The literature suggests that robotics is more viable for large-scale or high-traffic restaurants where the benefits outweigh the costs.

### **6.8 Post-Pandemic Acceleration of Robotics Adoption**

The COVID-19 pandemic acted as a catalyst for robotics adoption in restaurants. The need for contactless service, hygiene, and social distancing led to increased reliance on automation (Dwivedi et al., 2021). Robots played a crucial role in minimizing human interaction and ensuring safe service delivery.

Post-pandemic, this trend continues as restaurants seek to maintain operational resilience and meet evolving customer expectations.

### **6.9 Synthesis of Key Findings**

Based on the reviewed literature, the following key insights emerge:

- Robotics significantly improves efficiency, accuracy, and service speed
- Customer acceptance is driven by usefulness, ease of use, trust, and enjoyment
- Robots lack emotional intelligence, limiting their effectiveness in personalized service
- Human–robot collaboration is more effective than full automation
- Adoption varies across regions due to cultural and economic factors
- Long-term benefits outweigh initial investment costs
- The COVID-19 pandemic accelerated the adoption of robotics

## **7. Analysis and Discussion**

A close examination of the literature suggests that robotics should not be viewed as a direct substitute for human employees in restaurant environments. Instead, it appears more accurate to understand these technologies as complementary tools that enhance certain aspects of service delivery. Robots perform exceptionally well in tasks that require speed, precision, and consistency; however, they fall short when it comes to emotional responsiveness and interpersonal communication, which remain central to hospitality experiences (Lu et al., 2021; Wirtz et al., 2018).

From a theoretical standpoint, models such as the Technology Acceptance Model (TAM) continue to provide a useful lens for interpreting customer behavior. Evidence across multiple studies indicates that when customers perceive robotic systems as useful and easy to operate, their willingness to engage with such technologies increases (Davis, 1989; Seo & Lee, 2021). At the same time, factors like trust and enjoyment also play a meaningful role, shaping not just acceptance but the overall quality of the experience (Belanche et al., 2020; Gursoy et al., 2019).

Another point that emerges clearly from the literature is the influence of cultural and regional context. Acceptance of robotics is not uniform; it tends to be higher in societies that are already accustomed to automation and technological integration. In contrast, in regions where exposure to such technologies is limited, skepticism and resistance are more common (Ivanov et al., 2021).

Taken together, these observations highlight the need for a thoughtful and context-sensitive approach to implementation. Simply introducing robotic systems without considering the nature of the service environment or the expectations of customers may lead to suboptimal outcomes. A more balanced approach—where human and technological capabilities are combined—appears to offer the greatest potential for success.

## **8. Conclusion**

The growing presence of robotics in restaurant operations reflects a broader transformation within the hospitality industry, one that is closely tied to ongoing advancements in artificial intelligence and automation. As the literature reviewed in this study demonstrates, these technologies have the capacity to improve efficiency, streamline service processes, and support higher standards of hygiene, particularly in the wake of the COVID-19 pandemic (Dwivedi et al., 2021).

At the same time, it would be misleading to view robotics as a complete solution to the challenges faced by the industry. Issues related to customer acceptance, emotional engagement, and financial investment continue to limit their widespread adoption. In particular, the inability of robots to replicate the nuanced social interactions provided by human staff remains a significant constraint (Tussyadiah, 2020).

Given these considerations, the most practical path forward appears to be the adoption of hybrid service models. By combining the efficiency of robotic systems with the relational strengths of human employees, restaurants can create service environments that are both technologically advanced and customer-centered.

Looking ahead, ongoing developments in AI and human–robot interaction are likely to expand the capabilities of service robots, potentially addressing some of the limitations identified in this study. As these technologies evolve, their role within the hospitality sector is expected to become increasingly significant.

## **9. Limitations**

Despite providing valuable insights, this study is subject to several limitations:

- The reliance on secondary data restricts the ability to validate findings through primary empirical evidence
- Rapid advancements in robotics and AI may affect the timeliness and relevance of the reviewed literature
- The study lacks region-specific empirical analysis, limiting its contextual generalizability
- Potential selection bias may exist due to the inclusion of specific databases and published studies only

## **10. Future Research Directions**

Based on the identified gaps, future research should focus on the following areas:

- Development of emotionally intelligent and socially adaptive robots capable of enhancing customer interaction
- Conducting cross-cultural empirical studies to better understand variations in customer acceptance across regions
- Performing comprehensive cost–benefit and return-on-investment (ROI) analyses of robotic implementation
- Exploring the integration of AI-driven personalization systems to improve customer experience
- Undertaking longitudinal studies to assess the long-term impact of robotics on workforce dynamics and employment patterns

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