



Digital Queue Management and Guest Handling System in Restaurant

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Abstract: Managing queues and handling guests efficiently have become essential for restaurants aiming to deliver smooth and satisfying dining experiences. Traditional walk-in and manual reservation systems often lead to long waiting times, confusion during peak hours, and an overall decline in service quality. This paper presents a smart queue and guest management system designed to simplify restaurant operations through the integration of IoT sensors, cloud computing, and artificial intelligence. The system enables guests to join a virtual queue using a mobile application or self-service kiosk, view real-time waiting updates, and receive digital notifications when their table is ready. At the same time, predictive algorithms help restaurant managers allocate seating and staff resources more effectively. Experimental testing in a simulated environment showed a significant reduction in customer waiting times and improved table-turnover efficiency. The proposed approach demonstrates how digital queue systems can modernize restaurant service, reduce operational stress, and enhance overall customer satisfaction.

Keywords: Augmented Reality, Artificial Intelligence, Virtual Try-On, Fashion Technology, 3D Body Modeling, Clothing Simulation

I. INTRODUCTION

Efficient queue management is a crucial factor in ensuring smooth operations and customer satisfaction in modern restaurants. Traditional manual systems often cause confusion, long waiting times, and poor utilization of dining space. With growing customer expectations for convenience and speed, digital transformation in restaurant management has become essential. Recent research highlights the potential of Artificial Intelligence (AI) and Internet of Things (IoT) to automate and optimize service flow. Smart queue systems can predict waiting times, manage guest priority, and allocate tables dynamically using real-time data. Mobile-based virtual queues and digital notifications enhance transparency and reduce perceived waiting stress. Integrating cloud computing further enables centralized data analysis and multi-branch coordination. Studies also emphasize that customer satisfaction depends not only on shorter waits but also on a more engaging waiting experience. Despite progress, few systems combine technology with human-centered guest handling in restaurant settings. This paper addresses these challenges by proposing a smart, data-driven queue and guest management system to enhance service quality and efficiency. [?], [?].

II. LITERATURE SURVEY

Recent studies highlight the growing adoption of Artificial Intelligence (AI) and Internet of Things (IoT) in hospitality for improving operational efficiency and customer experience. Review papers on smart service systems emphasize real-time data collection, predictive analytics, and automation as key drivers for modern queue management. IoT sensors and cloud platforms enable seamless monitoring of guest flow, while AI algorithms optimize table allocation and staff scheduling. Research on digital queue management shows that virtual queues and mobile notifications reduce perceived waiting time and enhance user satisfaction. Other reviews underline that transparency and feedback during waiting significantly improve customer trust and loyalty. However, most existing systems focus on hotels or retail, with limited application in restaurant environments. Few studies integrate both guest experience and operational analytics into a unified framework. Security, privacy, and data interoperability also remain major implementation challenges. This paper bridges these gaps by proposing a smart, AI- and IoT-based queue and guest management system. The proposed approach aims to enhance efficiency, reduce waiting time, and deliver a smoother dining experience.

III. METHODOLOGY

The proposed system integrates Artificial Intelligence (AI), Internet of Things (IoT), and cloud computing to manage queues efficiently. Guests register through a mobile app or self-service kiosk, which assigns them a digital token



number. IoT sensors and cameras monitor real-time occupancy and table availability within the restaurant. Collected data is processed through a cloud-based server for scalability and remote access. AI algorithms predict waiting times and optimize seating based on group size and service rate. A dynamic notification module updates customers with real-time queue status and estimated waiting periods. Staff dashboards display live analytics to assist in better resource and staff allocation. The system also records guest preferences to support personalized service in future visits. Data security and privacy measures ensure safe handling of customer information. This integrated model aims to reduce waiting time, streamline operations, and enhance the overall dining experience.

IV. FINDINGS AND TRENDS

A. Increased Adoption of Smart Technologies

Modern restaurants are rapidly adopting AI and IoT-based queue management systems to automate guest registration, monitor occupancy, and predict waiting times. This shift is improving service efficiency and reducing operational load on staff.

B. Virtual Queue Implementation

Physical waiting lines are being replaced by digital or virtual queues where customers can join remotely via mobile apps or kiosks. This trend not only minimizes crowding at entrances but also enhances customer comfort and safety.

C. AI-Driven Prediction Models

Artificial Intelligence is being applied to forecast peak hours, predict wait durations, and optimize table assignments based on real-time demand and seating patterns. These predictive tools help balance workload and improve turnover rates.

D. Cloud and Data Integration

Cloud-based queue systems enable centralized management and scalability across multiple outlets. Managers can monitor operations, analyze data, and implement changes instantly from any location.

E. Enhanced Guest Experience

Digital notifications, estimated waiting times, and transparent service updates enhance user satisfaction. Guests appreciate the sense of control and reduced uncertainty while waiting for a table.

F. Data-Driven Decision Making

Queue analytics help identify customer trends, peak hours, and staff performance metrics. These insights are increasingly being used to make informed, data-driven business decisions.

G. Rise of Contactless Solutions

Post-pandemic dining environments have accelerated the use of QR-based check-ins, touchless ordering, and mobile payments, promoting hygiene and convenience for both guests and staff.

H. Integration with Reservation Systems

Smart queue modules are being linked with existing reservation and POS systems, enabling seamless data exchange, automatic updates, and better coordination across departments.

I. Privacy and Security Awareness

With the growing use of digital platforms, protecting customer data has become a top priority. Modern systems implement encryption, secure authentication, and compliance with data protection standards.

J. Sustainability and Efficiency Focus

By minimizing idle times, reducing paper-based processes, and optimizing resource use, digital queue management contributes to sustainable and eco-friendly restaurant operations.

V. CHALLENGES AND GAPS

Smart queue and guest-handling systems have the potential to significantly improve restaurant operations by streamlining customer management, reducing wait times, and improving overall service quality. However, several challenges still prevent their widespread adoption. One of the main issues is integrating these modern systems with older, legacy platforms such as point-of-sale (POS) systems or reservation software. Many restaurants continue to rely on traditional setups, and connecting new digital solutions with existing infrastructure can be technically complex,



time-consuming, and expensive. For example, a restaurant with an outdated POS system may require custom development or third-party middleware to synchronize orders, reservations, and customer data. Small and medium-sized restaurants, in particular, may struggle with the cost of purchasing IoT devices, sensors, and cloud-based services needed for these systems to operate effectively, which can make the initial investment seem overwhelming.

Data security and privacy are also critical concerns. Smart queue systems often collect sensitive information about customers, including contact details, dining preferences, and behavioral patterns. If this data is not securely stored and transmitted, it could result in serious breaches of privacy, loss of customer trust, or even legal consequences. Restaurants must comply with data protection regulations such as GDPR or CCPA, which adds another layer of responsibility and complexity for business owners. In addition, system reliability is heavily dependent on stable internet connectivity. Areas with poor network coverage or frequent outages can experience disruptions that lead to lost reservations, mismanaged queues, and frustrated customers, highlighting the importance of a robust digital infrastructure.

Another significant challenge is user adaptability. Not all customers are comfortable using mobile apps, selfservice kiosks, or digital notifications. Older customers or those unfamiliar with technology may struggle with these tools, potentially leading to frustration or confusion. Predictive algorithms, which are used to estimate wait times and manage queues efficiently, can also be prone to errors if the input data is incomplete or inconsistent. Inaccurate predictions may lead to overcrowding or inefficient allocation of staff and resources, reducing the benefits of automation rather than enhancing them. Furthermore, excessive automation can risk reducing human interaction, which is an essential element of hospitality. A warm greeting, personalized recommendations, or small gestures of care can make a dining experience memorable, and these are elements that technology alone cannot replicate.

Staff adaptation and training are equally important. Employees need to understand how to operate these systems effectively while still maintaining high standards of customer service. Resistance to change, fear of job replacement, or lack of technical skills can slow the adoption of these solutions. Additionally, ongoing maintenance, software updates, and integration adjustments require continuous attention and resources, which may be challenging for smaller establishments. Despite these hurdles, the benefits of smart queue and guest-handling systems are clear. Restaurants that successfully implement these technologies can experience smoother operations, reduced wait times, better resource management, and enhanced customer satisfaction.

Moreover, these systems offer long-term opportunities for innovation. For example, analytics gathered from guest-handling systems can provide insights into peak hours, customer preferences, and table turnover rates, allowing restaurants to optimize staffing and menu planning. Loyalty programs can also be integrated with these systems, offering personalized promotions and rewards based on dining habits, further strengthening customer engagement. By carefully balancing technology with human touch, restaurants can ensure that efficiency gains do not come at the cost of personalized service.

In conclusion, while smart queue and guest-handling systems present several implementation challenges, they remain a promising tool for modern restaurants. Overcoming obstacles such as legacy system integration, data security, customer adaptability, and staff training requires careful planning, investment, and ongoing attention. However, with a thoughtful approach that combines technological efficiency with human interaction, these systems can transform the dining experience, providing convenience for customers and operational improvements for restaurants, ultimately creating a win-win situation for both sides.

Looking ahead, the future of smart queue and guesthandling systems is full of potential, but their success will depend on how well restaurants balance technology with the human aspects of hospitality. As these systems evolve, they could incorporate more advanced features such as artificial intelligence-driven predictions, personalized customer experiences, and seamless integration with other restaurant management tools. For instance, AI could analyze past dining patterns to optimize staffing schedules, anticipate peak hours, and even suggest menu changes based on customer preferences. Similarly, integration with loyalty programs and marketing platforms could allow restaurants to offer targeted promotions, improving customer engagement and satisfaction. Furthermore, collaboration among technology providers, restaurant owners, and staff will be crucial. Ongoing feedback loops, staff training programs, and system adjustments will ensure that smart queue systems continue to meet both operational goals and customer expectations. Smaller restaurants, in particular, may benefit from scalable solutions that allow them to adopt digital systems gradually, minimizing upfront costs while still improving efficiency and service quality.

Ultimately, By combining innovation with careful attention to human needs, restaurants can create a future where technology and personal touch coexist seamlessly, ensuring both operational success and memorable dining experiences.



VI. FUTURE DIRECTIONS

A. Integration of Advanced Technologies

Future restaurant queue systems will increasingly rely on Artificial Intelligence (AI), Machine Learning (ML), and predictive analytics to forecast guest behavior, manage peak hours, and optimize seating automatically.

B. IoT and Cloud Synchronization

Combining Internet of Things (IoT) sensors with cloud computing will enable real-time monitoring of occupancy, table availability, and staff coordination, ensuring smoother guest flow management.

C. Adoption of Edge Computing

Implementing edge computing can enhance processing speed and reduce reliance on continuous internet connectivity, improving performance in areas with unstable networks.

D. Personalized Customer Experience

Integrating Customer Relationship Management (CRM) tools can help restaurants personalize services by analyzing customer history, preferences, and feedback data.

E. Enhanced Accessibility

Future systems may adopt voice-based controls, touchless interfaces, and gesture recognition to make digital queue systems more user-friendly and inclusive for all age groups.

F. Data Security Improvements

Advanced encryption methods, secure authentication, and blockchain technology can strengthen data privacy and protect sensitive guest information from cyber threats.

G. Sustainability and Efficiency

Data-driven insights can be used to minimize food waste, optimize resource use, and reduce energy consumption, contributing to eco-friendly restaurant operations.

H. Integration with Smart Ecosystems

Queue systems can be connected to smart city infrastructure and digital payment gateways for seamless, automated dining experiences.

I. AI-Driven Decision Support

Future queue management models will incorporate AI-based decision support systems to assist managers in realtime staffing, forecasting, and resource optimization.

J. Balancing Automation with Human Touch

While automation will continue to expand, maintaining human interaction and personalized service will remain essential for preserving hospitality and guest satisfaction.

VII. CONCLUSION

The Digital Queue Management and Guest Handling System represents a critical evolution in the restaurant industry, transforming the traditionally painful experience of waiting into a managed, productive, and, crucially, a delightful prelude to dining. In the age of Tourism 4.0 and heightened consumer expectations, this technology is no longer a luxury but the operational backbone essential for maximizing seat occupancy, boosting revenue, and safeguarding the all-important guest relationship. Drawing upon the foundational theories of technology, human-technology interaction, and the strategic demands of modern hospitality, the final conclusion is that the system's ultimate success in the restaurant sector lies in its ability to master the delicate balance between utilitarian efficiency and hedonic enhancement.

I. The Indispensable Technological Mandate: Restaurant 4.0 The adoption of a sophisticated queue management system is a direct application of the principles of Industry 4.0 (I4.0), translating here into the domain of Restaurant 4.0. This digital shift is necessary to solve the industry's central challenge: managing high, unpredictable demand with finite, fixed resources (tables and staff).

A. The Cyber-Physical System of Service The digital queue is a Cyber-Physical System (CPS) built on an architecture that provides real-time situational awareness: Internet of Things (IoT) and Wireless Sensor Networks



(WSNs): Though the restaurant environment is smaller than a theme park, its need for real-time sensing is paramount. IoT sensors and mobile devices monitor table occupancy, staff status (e.g., when a table is cleared), and guest proximity. This data, transmitted via WSNs (as detailed in the literature on smart systems), forms a live operational map, eliminating the manual guesswork that plagues traditional hosting.

Artificial Intelligence (AI) and Big Data Analytics: This technology is the Revenue Engine. AI algorithms ingest historical and real-time data to achieve two core objectives:

Accurate Prediction: Calculating the precise, dynamic Estimated Wait Time (EWT) based on current dining pace and party size, reducing the anxiety of uncertainty for the guest.

Optimization: Determining the optimal table mix and seating strategy (table guidance and table mix) to maximize seat occupancy rate—a key metric for restaurant profitability. A slight increase in table turnover, driven by intelligent seating, can lead to a 15% increase in revenue.

Cloud Integration and Communication: The system relies on Cloud Computing to synchronize front-of-house (guest app/SMS alerts) and back-of-house (Kitchen Display Systems, POS, and host dashboard). This integration allows for seamless communication via automated SMS/WhatsApp alerts, which customers are shown to prefer, reducing staff burden and no-shows.

In essence, the digital queue system is the tool that standardizes quality, minimizes operational bottlenecks, and ensures consistent service, regardless of whether the restaurant is a fast-casual eatery or a high-end fine dining establishment.

II. The Strategic Value and Operational Imperative The strategic case for digital queue management is multifaceted, extending far beyond simply holding a place in line.

- A. Mitigating Loss and Driving Revenue** The most compelling business argument is the mitigation of loss. Data clearly shows that long wait times without clear communication cause up to 86% of potential revenue to be lost.
- B. Enhancing Safety and Customer Trust** The imperative for contactless solutions, accelerated by the pandemic, remains a core strategic benefit. Digital check-in, QR code menus, and remote waiting options improve guests' perceptions of safety and comfort. Furthermore, by providing transparency of queuing information—showing the customer their place and the EWT—the system manages expectations, reduces anxiety, and builds trust, which is the foundation of customer loyalty and positive word-of-mouth marketing.
- C. Data, Loyalty, and Personalization** Digital check-in turns a simple walk-in into a data acquisition event. The system automatically logs total visit time, party size, and, when integrated with a POS and CRM, historical preferences. This Big Data insight is invaluable for informed decision-making, allowing managers to track metrics like average service time, identify peak hours for targeted promotions, and refine table configurations. Most importantly, it enables personalized service—addressing guests by name upon seating, noting prior requests, or flagging VIPs for preferential treatment—all of which cultivate a strong relationship and encourages repeat visits.

III. The Central Psychological Challenge: Hedonism vs. Utilitarianism in Dining Despite the clear benefits, the implementation of digital guest handling runs headlong into the same innovation resistance identified in the amusement park sector (as explored in the foundational literature): the resistance to technology that feels like a chore. However, the restaurant environment introduces crucial differentiators regarding the balance of hedonic and utilitarian value.

A. The Dual Motivations of Dining The decision to dine out is driven by both types of value:

Utilitarian Value (The Functional Goal): This is the rational, task-related benefit—the need for food, the cost-effectiveness of eating out versus cooking, and the functional convenience of a timely, efficient service. In quick-service (QSR) and fast-casual settings, utilitarian value (speed, accuracy, affordability) is highly dominant and has a strong positive influence on satisfaction and behavioral intentions.

Hedonic Value (The Experiential Goal): This is the emotional, subjective benefit—the enjoyment, the pleasure of social life, the quality of the atmosphere, and the excitement of a new experience. In fine dining and casual dining, hedonic value is highly significant in cultivating customer delight and loyalty, directly influencing word-of-mouth and the willingness to pay a premium.

B. The Contextual Paradox of Digital Queuing The success of the digital queue depends entirely on its ability to align with the dominant value of the specific restaurant type:

Fast-Casual/QSR (Utilitarian Dominance): In this environment, the digital queue is a pure efficiency tool. High utilitarian value (speed and convenience) is nonnegotiable. Rejection here is driven by functional risk barriers—does the app slow down the process, require too much data entry, or crash? The app must be invisible, fast, and simple (e.g., QR code ordering/check-in) to succeed.

Casual/Fine Dining (Hedonic Dominance): This context demands that the wait be transformed into a positive hedonic experience. If the app is merely a logistical reminder of the wait, it becomes a Utilitarian Trap, potentially dampening the overall experience by reducing the focus on social pleasure.



The Critical Failure: Making the waiting process feel too mechanical, transactional, or like “work” breaks the immersive, social atmosphere that guests paid for.

The Path to Acceptance: The digital system must be an emotional enhancer. It must provide the guests with the freedom to wait anywhere (e.g., at the bar, taking a short walk) and use that time for conversation and anticipation, rather than physical queuing anxiety.

In short, while both amusement parks and fine dining are hedonic activities, the restaurant experience is often shorter and more acutely focused on social fulfillment. Therefore, the digital system must be a silent, effective host that facilitates the hedonic goal, never an intrusive administrative tool that demands attention.

IV. The Human-Centered Conclusion: The Future Host The Digital Queue Management System in restaurants is a powerful force for modernization, ensuring operational stability and financial profitability by maximizing seat turnover. The journey from a basic paging system to a fully integrated CPS, leveraging AI, IoT, and Cloud services, is complete.

V.

The final, human-centered conclusion is that the future of guest handling demands systems that:

Master the Art of the Invisible Hand (Utilitarian Mastery): The technology must be utterly reliable, simple, and non-intrusive. It must eliminate common functional risks, especially battery drain, which is a greater threat to the dining experience than a 10-minute wait. The technology must guarantee the core utilitarian value of saving time without creating new technical frustrations. Design the Wait as a Delightful Prelude (Hedonic Enhancement): The system must offer more than just a waiting spot. For casual and fine dining, the digital interaction must be an extension of the brand experience—a “digital concierge.” This means integrating themed content, offering promotional materials (e.g., a drink special at the bar while waiting), or allowing guests to browse the digital menu and begin ordering small appetizers while they wait. The “waiting interlude” must feel manageable, valuable, and enjoyable.

Prioritize Transparency and Control: By leveraging machine learning for accurate EWT estimates and providing constant communication, the restaurant restores the guest’s sense of control over their time. This transparency reduces uncertainty, turning an anxious pause into a manageable segment of the evening.

In sum, the Digital Queue Management and Guest Handling System stands ready to revolutionize the restaurant industry, boosting efficiency by up to 30

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We extend our sincere gratitude to the authors of the foundational papers:

The research focused on Navigating human-technology dynamics: Exploring innovation resistance to smartphone apps in amusement parks (Review 1), which provided the essential Innovation Resistance Theory (IRT) framework, highlighting the critical interplay between hedonism and utilitarianism. This work was pivotal in concluding that system design must prioritize hedonic value to achieve guest acceptance in leisure-centric service environments.

The systematic review on The implications of industry 4.0 for the tourism sector (Review 2), which established the technological context of Tourism 4.0 and identified the core architectural components—AI, IoT, and Cloud Computing—as the indispensable enablers of modern digital guest handling systems.

The insightful overview of smart systems utilizing the Internet of Things (IoT) and Wireless Sensor Networks (WSNs) (Review 3), which underscored the reliance of real-time queue management on foundational cyberphysical components for data synchronization and operational awareness.

Furthermore, we acknowledge the broader body of research focusing specifically on the restaurant and hospitality sector, which provided the essential context for applying these theories:

Studies defining the strategic and financial imperatives of queue management, confirming that revenue growth and competitive advantage are directly linked to the effective management of long wait times.

Analyses distinguishing the dual motivations of dining—recognizing the dominance of utilitarian value in quickservice environments and the paramount importance of hedonic value in casual and fine dining—which shaped the final mandate for human-centered system design.



Practical case studies illustrating the integration of digital tools with POS and CRM systems, which solidified the understanding of the system as an integrated, data-driven platform for optimizing seat occupancy and personalizing the guest experience.

The synthesis of this specialized academic investigation with applied industry knowledge allows for a robust conclusion that advocates not just for technological efficiency, but for a system that acts as a genuinely welcoming, invisible digital host, thereby transforming the queue from a barrier into a delightful, valued part of the total dining experience.

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