Journal of Applied Engineering and Technological Science
Vol 5(2) 2024: 1123-1141

APPLICATIONS OF IOT-ENABLED SMART MODEL: A MODEL FOR ENHANCING FOOD SERVICE OPERATION IN DEVELOPING COUNTRIES

Azmery Sultana[1]*, Md Masum Billah[2], Mir Maruf Ahmed[3], Rakin Sad Aftab[4], Mohammed Kaosar[5], Mohammad Shorif Uddin[6]
Department of Management Information Systems, American International University-Bangladesh, Bangladesh[1]
Department of Computer Science, American International University-Bangladesh, Dhaka, Bangladesh[2,3,4]
School of Information Technology, Murdoch University, Australia[5]
Department of Computer Science and Engineering, Jahangirnagar University, Bangladesh[6]
azmery@aiub.edu[1], billah.masumcu@aiub.edu[2], marufmir420@gmail.com[3], rakinsadaftab@gmail.com[4], mohammed.kaosar@murdoch.edu.au[5], shorifuddin@juniv.edu[6]

Received : 30 April 2024, Revised: 21 May 2024, Accepted : 01 June 2024
**Corresponding Author*

ABSTRACT
The dining sector in developing countries faces numerous challenges, including inefficiencies in order handling, resource management, and ensuring food quality and customer privacy. Traditional methods often lead to delays, errors, and dissatisfaction. This paper proposes a quick-witted, intelligent order-handling system utilizing the Internet of Things (IoT) to address these challenges and enhance the overall dining experience. We present a comprehensive approach to developing and implementing an IoT-based automated order-handling system tailored to restaurants' specific needs and challenges in developing countries, highlighting the importance of technology in enhancing operational efficiency and customer satisfaction. The proposed automated secure order-handling system using IoT demonstrates significant potential for improving efficiency and customer satisfaction in the dining sector. By addressing common problems through advanced technology, this system offers a sustainable solution that enhances the dining experience while ensuring food orders' validity, quality, and privacy. We analyzed the potential impact of implementing such a system in developing countries, focusing on economic and operational benefits.
Keywords: *Internet of Things (IoT), Order Management Systems, QR Code, Restaurant, Food Service*

1. Introduction

In the fast-paced food service industry, customer satisfaction heavily relies on the efficiency and quality of service restaurants offer. The increasing number of working individuals drives the demand for food services, especially in developing regions like Bangladesh. Current order-handling systems in restaurants often result in long wait times, order inaccuracies, and customer dissatisfaction. These inefficiencies highlight the need for innovative solutions that grasp technological advancements to streamline service delivery and enhance customer experiences.

The emergence of the Internet of Things (IoT) presents a promising solution for improving restaurant operations (Y. Khan et al., 2023). With IoT (Varriale et al., 2021), customers can quickly check the availability of food items and estimated delivery times, significantly enhancing the store's efficiency. This technology (P. W. Khan et al., 2020) helps reduce waiting times and order errors, ultimately increasing customer satisfaction and their return likelihood. To provide a comprehensive context (Bigliardi et al., 2022), it is essential to explore the current state-of-the-art IoT applications in smart city environments, specifically focusing on advancements and existing implementations in food supply chain management. The study by (Kodan et al., 2020), has demonstrated the significant impact of IoT on various sectors, including agriculture and food safety, where real-time monitoring and data analytics enhance operational efficiency (Nagarajan et al., 2022). Secure resource management and financial planning, critical for the sustainability of any business in a competitive world, can also benefit from these IoT-driven strategies.

Current systems in many restaurants are manual and labor-intensive, resulting in several challenges. Long waiting times for customers, often exacerbated by high demand during peak hours, are a significant issue. Additionally, high rates of order inaccuracies lead to customer frustration and reduced satisfaction. Inefficient resource management further causes increased operational costs and food waste. The inefficiencies and complexities in the current food supply chains, which affect food quality and safety due to inadequate tracking and management systems (Ben-Daya et al., 2020). Moreover, there is a limited availability of real-time data and feedback mechanisms, preventing timely responses to customer needs and preferences.

IoT sensors can monitor the temperature and humidity of food storage areas and preparation environments in real time. These sensors ensure food is stored and prepared optimally, reducing spoilage and maintaining quality. Customers' orders placed via mobile apps or websites are automatically integrated into the restaurant's order management system (Intal et al., 2020). This eliminates the need for manual entry and reduces the risk of errors. Customers and staff can track the status of orders in real time, from placement to preparation to delivery. This transparency improves customer satisfaction and operational efficiency.

This study proposes an IoT-enabled smart order-handling system designed to address these issues by automating various aspects of the restaurant service process. The system integrates IoT devices and mobile/web applications to streamline order placement, enhance inventory management, and provide real-time data on restaurant operations. Key features include QR code-based order placement to eliminate the need for wait staff involvement, real-time monitoring and tracking of orders and inventory using IoT sensors, automated notifications and updates to both customers and kitchen staff, and secure data management to ensure customer privacy and system integrity.

Integrating an IoT-enabled smart order-handling system in the food service sector, particularly in developing countries, addresses several critical issues that traditional systems still need to overcome. This system's necessity arises from the multifaceted challenges and opportunities in enhancing operational efficiency, food quality, customer satisfaction, and overall sustainability. Traditional order-taking processes are prone to errors, leading to incorrect orders and customer dissatisfaction. An automated system minimizes these errors by ensuring precise and accurate order placement. IoT-enabled devices facilitate seamless communication between kitchen staff, waiters, and management, leading to a more organized and efficient workflow. By providing real-time data on inventory levels, the system helps optimize resource usage, reduce waste, and ensure that the kitchen is always well-stocked. Automated order processing significantly reduces the time to place and prepare orders, leading to quicker service and higher table turnover rates.

2. Literature Review

A systematic literature review was conducted to ensure the study was comprehensive and reflected the current state of the art. The selection method employed a systematic and rigorous approach to ensure that the review was extensive and reflected the current state of the art in IoT-enabled smart order-handling systems for the food service industry. The author seeks input from IoT and food service management experts to ensure the comprehensive review covers emerging trends and technologies. The study ensured a thorough and up-to-date understanding of the topic by defining straightforward research questions, using multiple reputable databases, applying stringent inclusion and exclusion criteria, and continuously updating the review with new information.

Nowadays, web services technology is essential in developing the services of any food and restaurant sector. Overall customer satisfaction and the quality of services will be maintained with the help of an automated system integrated with the kitchen ordering systems and the customer satisfaction level. In (Kandasamy et al., 2023), people consider today's world technologically advanced. Owners of restaurants have attempted on multiple occasions to take advantage of information and communication technologies, including LANs, PDAs, and expensive touch defenses. to enhance eating encounters. The smartphone that runs Android and shows menu information is part of the suggested solution, which is placed on the client table. Both the kitchen display and the phone on the dining table are connected to Wi-Fi. Orders from

the guests will be promptly delivered to the culinary module. This intuitive wireless system saves time, lowers errors, and gathers guest input to improve hotel productivity and accuracy. This method is less expensive since it uses a one-time widget and effectively resolves the problem in an automated meal ordering system.

In (Ravi et al., 2019), restaurants welcome an automation system based on Android. Facilitating the management of restaurants is the primary goal of the project. Many restaurants these days order and deliver food by hand. This has several drawbacks, including a significant time commitment and the potential for customers not to receive the correct item at the proper time, which can lead to several issues. Therefore, we thought of automating this procedure using modern electrical technologies. A touch screen at every table in the restaurant serves as a distinct digital menu, simplifying the ordering process. Once customers have seen every meal choice and its associated cost, they can select an item from the digital menu. The orders are electronically transmitted from each table to the kitchen via Bluetooth (Bhuiyan et al., 2021). Using an Android touchscreen rolling screen, customers can select meals and examine each item's pricing and most recent availability from the computerized menu system. It shows the table number as well. The hotel staff can read the goods from each table by printing the bill from the kitchen on a thermal printer. An LED glow can indicate to the matching client table whether the meal is ready in the kitchen (Entreprene, 2023).

In (Islam Jubaid et al., 2023), the primary goal in the digital age is to automate anything that can be done to benefit human convenience. Commercial, industrial, and consumer applications are displaying signs of automation. Most restaurant meal orders are expected to depend on interactions with servers to get placed in the kitchen. Customer dissatisfaction results from this cooperation being difficult during peak hours. In addition, the system lacks hygiene, which is particularly problematic in a scenario like the COVID-19 pandemic. Considering this, the Smart Restaurant System has been suggested for this project. A clean food service system is generated by putting this system into place. Since the wireless system will handle the ordering, a waiter is unnecessary, which helps to lower the number of employees in the restaurant system. Even at pick-up hours, the restaurant owner can keep everything running properly. The primary function of the management system is controlled by an Arduino Nano.

In (C. H. Lee et al., 2020), one of the implementation problems for present and future scenarios of advanced digital technology (DT) for digital transformation is meeting client expectations while delivering value. To give new values while being environmentally conscious, valid digital transformation difficulties must be recognized. To effectively handle design knowledge in the conceptualization of innovations with a traceable path and abductive logic linking from customer concerns, business context, and technology digitization, the strategies of quality function deployment (QFD), theory of inventive problem solving (TRIZ), ontology-based design knowledge hierarchy (DKH), and laddering theory are applied.

In (Wen et al., 2018), the project's primary goal is facilitating restaurant management. These days, the majority of restaurants handle food ordering and delivery manually. This has several drawbacks, including a significant time commitment and the potential for unhappy patrons caused by incorrect orders being delivered at the wrong time. Therefore, we considered employing contemporary electronic technology to automate this process. The touch screens at each table correspond to each digital menu, making ordering easier. The computerized menu lets customers choose from various food products and view their costs. Bluetooth allows the kitchen to receive orders from each table wirelessly. The electronic menu system allows clients to pick what they want to eat from the rolling screen of an Android touchscreen, as well as examine the pricing and most recent availability of food items and table numbers. Hotel staff print the bill from the kitchen using a thermal printer and then use it to read the goods from each table. When the food is prepared in the kitchen, an LED glow on the corresponding customer's table signals (Tanizaki et al., 2020), (Yost et al., 2021).

In (Singh et al., 2022), when dining out, safety is now the main priority for customers in the modern era. Most meal orders at the restaurant are placed in the kitchen through interactions with waiters. Interacting with waiters and other restaurant staff members is uncomfortable because of the pandemic condition. The purpose of this system is to address such issues. This system uses a web application to handle every step of a restaurant's order procedure, including

interactions between the customer, the server, the chef, and the cashier. Additionally, by utilizing this method to evaluate the collected data, restaurant owners can increase sales. The old-fashioned manual ordering procedure will attempt to be replaced by this technology. Improved user experience with food.

In (Kocaman & Türkmen, 2022), this study examined restaurant management systems (RMSs) to improve service quality and commercial efficiency in restaurant operation and management activities. This study shows how RMSs affect restaurant operations from the employees' viewpoints. This study evaluated restaurant employees' opinions of restaurant management systems (RMS), considering their demographics.

In (Yi & Liu, 2020), the rapid development of mobile devices and wireless technologies significantly influences our daily lives. The hospitality business has seen early attempts to integrate and use both technologies. In addition to automating the restaurant's food ordering procedure, this research project attempts to enhance patrons' dining experiences. This study examines the development and execution of an automated ordering system for food that incorporates real-time consumer feedback for restaurants, known as AOS-RTF. This system implements wireless data connections to servers. All the menu information will be available through the user's Android app. The kitchen and cashier get wireless updates to the order details from the customer's mobile device, which are then sent to them, respectively. Restaurants can benefit from the wireless application on mobile devices, which saves time, lowers human error, and provides real-time client feedback while increasing efficiency and accuracy.

In (Li et al., 2021), this study examines the strong relationship between the use of advanced mobile applications (SPA) for eatery promotion and the acknowledgment by customers to choose an eatery. This is notable because the restaurant promotion data provided by the promoter is written as significant portions of the customer acknowledgment of using SPA as a blend of advertising and marketing tools for the restaurants. Thus, this paper contributes to a theoretical framework that considers restaurant advertising by combining information on food, pricing, site, and promotion as indicators of advanced smartphone applications' recognition by customers, and it offers directions for further study. Using cutting-edge smartphone applications for restaurant promotion, combined data is explored to enhance customer satisfaction with restaurants. The implementation of the mobile application to promote the business. Mobile applications are the primary criterion for restaurant management systems (Berezina et al., 2019).

An Android app will be developed and modified within the restaurant, and the automated system will maintain the order and the service level (Paul et al., 2020). After entering the restaurant, they often must wait for the servers to prepare the menu and place orders. But when the restaurant is overcrowded, they must wait for a long time. So, an automated system will maintain the consistency of the work even though the customers are not getting any waiters. With the help of a QR scan attached to the table, customers can place their order by registering themselves, and this order will instantly be transferred to the chef. The information will be saved and managed by the manager of the restaurant. The customer, the chef, and the manager can continue their work without delay (Alt, 2021).

In (Qamar, Tariq, et al., 2019), with the help of IR Proximity sensors, a developed Android application will enable the employees to do and maintain their work from outside. They can place an order, watch the vacancy, and measure the time. The IoT makes work easier and better. Nowadays, without an automated way, it is impossible to manage the system properly (Aytaç & Korçak, 2021). The cloud system will store the database to control the transactions. The system will be automated to produce a fruitful outcome (Aytaç & Korçak, 2021).

The interconnected and interoperated network is a blessing for managing the dining sector and customer service. With the help of this smart technology, any dining sector can enjoy interactive experiences. Personalized promotional messages based on the customer's location saved in the database will help the restaurant reach a target customer (Billah et al., 2021). Sensors attuned to customers' dining habits and purchasing behavior help to have real-time data. Robotic technologies will be used to cook and deliver food to the customer without the help of human beings (Kumar et al., 2021). These automated systems and the use of technology will not only improve the restaurant's service quality but also help the restaurant get real-time data

(Leung & Loo, 2022). The order management process and technology are now used in food processing packaging and departments using innovative packaging and materials, including nanoscience applications and technology, automation, control technology, standards, and application scenarios. The individual focus point on a particular department is not that efficient. With the help of automated systems and technology, a holistic approach can be implemented to have better outcomes (Trajkovska Petkoska et al., 2021).

In (Vemulapalli, 2023), customer-centric development of a customer-centric design is crucial to providing predictive analytics (PA) as a self-service technology (SST), even if efforts to date have focused on related technological issues. This research attempts to solve this by looking at the interdisciplinary area of service design, whose primary tool—the SB method—can support this customer-centric design. However, the field's historical focus on conventional, high-touch, low-tech services limit its applicability to SST design. The authors employ a design science methodology to improve the SB to overcome these traditional constraints and offer a more thorough solution. A novel multi-model is released, with an enhanced SB at its center, to assist design practitioners in addressing the challenges of these technologically sophisticated services. To make the suggested model easy to use, it will simply handle the issues of order management and meal delivery (Tanizaki et al., 2020).

In (Chavan et al., 2023), waiters must speak with patrons face-to-face before taking their orders in a traditional restaurant setting. Still, a top-notch CSR system would actively recognize clients and their preferred dishes and spending histories. To create an intelligent e-restaurant that prioritizes customer service, this project combines wireless local area network (WLAN), database technologies, radio frequency identification (RFID), and a menu recommendation subsystem. Waiters can now actively suggest the menu items that would be best for each customer by using RFID-based membership cards to identify them instantly. The suggested approach exhibits practical promise in delivering customer-centric service, as indicated by experimental findings from a restaurant case study. The discussed system, which uses RFID and WLAN, would track customers and serve them their favorite menu, indirectly increasing satisfaction. The main difference is that the proposed model will not trace the customer. The system will transfer the customer's order collected from the system to the restaurant's kitchen (Blöcher & Alt, 2021).

The cost, time, and order procedures in restaurants will all be decreased by the Internet of Things (IoT). Applications for the Smart Internet of Things include applications for innovative restaurants (Chochiang et al., 2020). The modern restaurant management system is a magnificent IoT facility connecting networks and sensors. Devices employ connected components for restaurant management systems. The sensors then use various processing modules, such as the Arduino Uno and Node MCU, to transmit the data to the smartphones. This method of tracking and optimizing restaurant problems is simple, energy-efficient, scalable, interoperable, cost-effective, and time-consuming (Billah et al., 2021).

In (Schmidt et al., 2022), one of the key components of demand prediction is a compelling yield and revenue management strategy for eateries. Sales forecasting is critical for restaurant chains as well as small eateries. This chapter presents a thorough analysis of the literature and classification of customer demand and restaurant sales strategies. Because of the influence of the internal and external environments, sales prediction is challenging. On the other hand, a solid sales forecasting technique can raise the caliber of a business plan. The literature provides a variety of forecasting approaches and models. These methods—including hybrid models—are divided into seven groups. A selection of pertinent publications is made, the technique for various analytical methods is briefly explained, and the benefits and downsides are explored.

In Table 1, we analyze the developed model of IoT in the food and dining sector and make a comparison, as well as the proposed additional benefit of this paper's developed IoT-based model of customer order handling. It also shows the missing and absent parts considered while initializing a new system. The most significant attribute of the newly proposed system will be how customers interact with it.

Table 1 - Contributions and limitations of existing systems.

References	Contributions	Limitations

(Aytaç & Korçak, 2021)	Digital transformation.	Digital transformation process.
(Qamar, Tariq, et al., 2019)	Automated meal order and process.	Expensive.
(Kumar et al., 2021)	Food recommendation.	Not collect more response.
(Leung & Loo, 2022)	Sales Prediction.	Not user-friendly.
(Trajkovska Petkoska et al., 2021)	Web service technology.	For particular customers.
(Islam Jubaid et al., 2023)	Reduce delivery time.	Expensive.
(Singh et al., 2022)	Interact with waiters and place orders.	Not user-friendly.
(Schmidt et al., 2022)	Sales forecasting system.	Not well-integrated.
(Kandasamy et al., 2023)	Accountability, sales forecasting.	Required all customer data.
(C. H. Lee et al., 2020)	Menu recommendation system.	Only menu recommendation.
(Chochiang et al., 2020)	Eatery promotion.	Based on promotional restaurant.
(Ravi et al., 2019)	Restaurant management systems.	Not user-friendly.
(Kocaman & Türkmen, 2022)	Smart food waste management.	Expensive.
(Li et al., 2021)	Restaurant management systems.	Not user-friendly
(Chavan et al., 2023)	Order fulfillment using robots.	Not user-friendly.
(Vemulapalli, 2023)	One-stop restaurant service app.	Order process time consuming.
(Marshall, 2023)	CAD based restaurant.	Handling customer process

The system will calculate the revisit ratio of the customer after being involved in the system to define the satisfaction stage. Figure 1 summarizes the key attributes of the system.

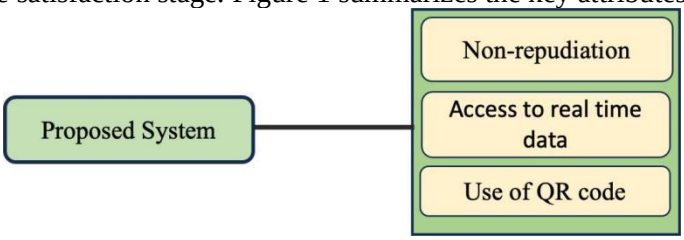

Fig. 1. Main attributes of the implemented system

3. Materials and Methods

The Internet of Things has played a vital role in developing a model for handling customer orders without making them dissatisfied with the services. An automated design of the smart customer order handling system has been developed, and the system architecture has been defined understandably. An overview of the whole design will be explained, and the system architecture and implementation criteria will be covered. A survey was conducted before welcoming the new system. We validated the system, a survey was conducted, and 600 people who usually visit restaurants participated. Based on their responses, the attributes have been developed.

In the study, a mixed-methods approach was employed, combining both qualitative and quantitative research methods, to thoroughly investigate the research problem. The mixed-methods approach was chosen to ensure a holistic understanding of the research problem. The quantitative survey provided statistical data to identify common issues and trends, while the qualitative interviews offered deeper insights into the reasons behind these issues and the feasibility of the proposed solution. The questionnaire analyzed the criteria, and respondents were provided with their answers. Six hundred people completed our questionnaire. Complete privacy has been maintained here; no conflict questions have been added. The people also gave their valuable suggestions. The questions were also answered by the people working in the restaurants.

The factors are selected attentively while collecting the data and responses based on which the proposed system will be developed. The first refers to the frequency of people visiting restaurants, which will modify the importance of welcoming the new model. If the existing system can manage customer orders, their proposed model will not be meaningful to this sector. The third factor is the on-time food delivery arrangement. The frequency of revisiting the restaurant has also been included.

The Statistical Package for Social Sciences (SPSS) was used to examine the collected data. While analyzing the data, the frequency and correlation were completed to determine the

customer's response to each question. The reliability test was also done, and the outcome was validated. 600 real customers participated in the survey. Many restaurants were taken into consideration while developing this model. Tasty Treat, Pizza Burg, Star Kabab and Restaurant, KFC, BFC, Nabob restaurant, Roadside Kitchen, Shawarma House, Kabab Ghor, Haji Biryani, and others also. These restaurants are famous among the people of Bangladesh, but there is no automated system for managing customer orders, and many people become dissatisfied with the service.

Table 2 - The frequency of customers visiting the restaurants.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Daily	15	2.5	2.5	2.5
	Monthly	261	43.5	43.5	46.0
	Never	3	0.5	0.5	46.5
	Seasonal	128	21.3	21.3	67.8
	Weekly	179	29.8	29.8	97.7
	Yearly	14	2.3	2.3	100.0
	Total	600	100.0	100.0	

In Table 2, the frequency of restaurant visits is represented among 600 respondents. 43.5% of people visit restaurants monthly, and around 30% visit weekly. Many people visit different restaurants very frequently. 22% of people visit there for any occasion, and most people now try to celebrate their special days in restaurants. The frequency of restaurant visits is significant, as is the need for an automated system to properly manage customer orders.

Table 3 - The presence of an automated system in the visited restaurant.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	413	68.8	68.8	68.8
	Yes	187	31.2	31.2	100.0
	Total	600	100.0	100.0	

The respondents in Table 3 must state whether their visited restaurants have an automated system for order management, which was conducted in our survey. Around 70% declared that the restaurants they visited had no automated systems to maintain order. Due to the absence of an automated system, 87% of respondents become dissatisfied with the overall system, which, in turn, adversely impacts the restaurant's reputation.

Table 4 - Impact of the implemented system on the revisit ratio of customers.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	79	13.2	13.2	13.2
	Yes	521	86.8	86.8	100.0
	Total	600	100.0	100.0	

From the customers' responses in Table 4, it is examined that, due to this system, customers willingly revisit the restaurants as it saves time, ensures quality, and manages the privacy level. But, around 14% of customers deny this statement because they feel uncomfortable with the system.

Table 5 - The responses of the customers to sharing the profile with the systems.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	425	70.8	70.8	70.8
	Yes	175	29.2	29.2	100.0
	Total	600	100.0	100.0	

Table 5 shows that people will accept the new automated system but will feel they need to be more secure while sharing their profiles and information with the systems. This attribute is a significant part of the whole system. The survey shows that around 71% of people do not go to the same dining sector after being dissatisfied.

The customer crowd can be maintained using an automated system. As with all orders, the required time for food availability will be given to customers, and based on that, they will stay at the restaurant. Figure 2 shows that around 57% of respondents strongly agree with the statement, and 36% are satisfied with the innovation.

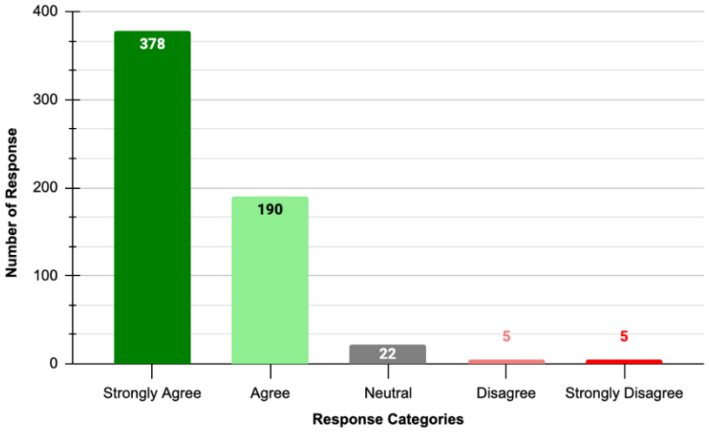

Fig. 2. The customers' viewpoint for developing the secured automated system

While maintaining the required attributes of the proposed system for the restaurants, some significant criteria have been discussed. As the new system is implemented, less manpower will be involved, and the price will decrease. Figure 3 visualizes the customers' responses to this statement.

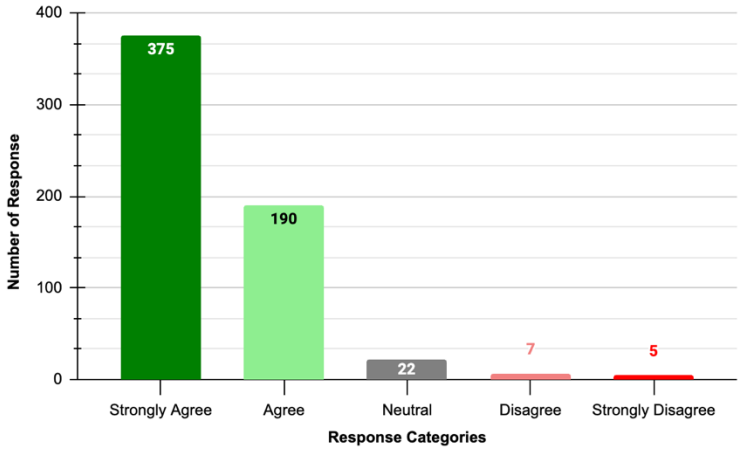

Fig. 3. The relationship between the system and the food price

The main attribute of the proposed restaurant system will be its overall user-friendliness. Three hundred eighty respondents strongly agree with these characteristics of the systems, whereas 170 respondents agree with the statement.

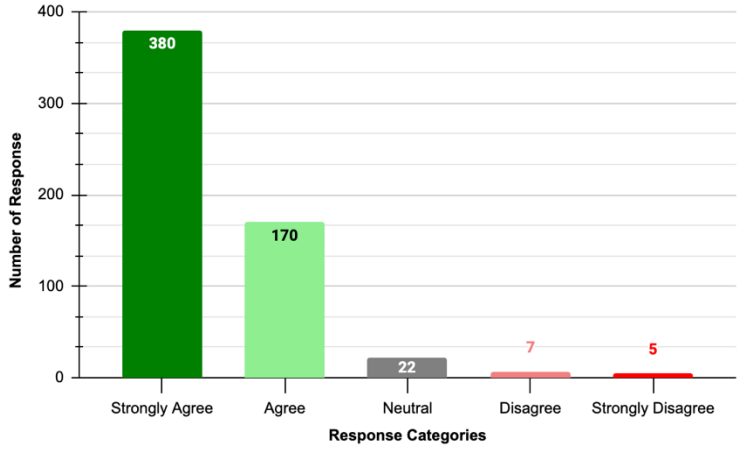

Fig. 4. The response rate on the user-friendliness of the system

Table 6 - The responses on the necessity of having an automated system.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	43	7.2	7.2	7.2
	Yes	557	92.8	92.8	100.0
	Total	600	100.0	100.0	

Based on the problems the customers face while availing of services in the dining sector, they feel the necessity of an automated system, including security attributes that will provide them with many advantages. 93% of respondents do feel the necessity of implementing this system. However, some customers have declined it because they do not want their information to be used by the restaurants for any promotional or extra benefits. Some may feel insecure and disturbed.

Table 7 - The reliability test of the responses.

Case processing summary			
		Cronbach's Alpha	No. of Items
	0.752	5	100.0
Cases	Excluded	0	0.0
	Total	600	100.0
a. Listwise deletion based on all variables in the procedure.			
Reliability Statistics			
Cronbach's Alpha		No. of Items	
0.752		5	

The survey was conducted by 600 respondents who regularly visit restaurants. A reliability test was conducted to verify the test. Table 7 illustrates the score of the reliability test is 0.752, which means that the consistency of the questions is good and acceptable. Using the consistency level, the proposed model is being designed.

3.1. Overall System Overview

First and foremost, the suggested goal of the Internet of Things system is to handle customers' orders securely and automatically without any physical service providers. Compared to the number of customers, the restaurant needs more helpers to handle the orders placed efficiently. So, to maintain the satisfaction level of the customers, this system will welcome an automated system where every activity will be performed, from order placement to food delivery, with the help of IoT. Figure 5 defines the proposed system implementation as containing user-friendly characteristics. Nowadays, every dining sector has an internet connection.

The restaurant's table will be attached with a particular QR code where the table number will be stored so that the order has been placed and the food provider can identify a specific table. The system does not require users to download or install any application on their phone to use the services. The actual flow of work is shown in Figure 5. To enjoy the system, a customer will access the internet connection and scan the QR code attached to their table. After scanning the QR code, the customer will be able to see the only available food items and the time for order fulfillment. This will indirectly make the customers adjust to the system. The placed order will go directly to the restaurant's kitchen management system. Whenever the food is ready, the restaurant dashboard will notify the table number from which the order has been placed. If the manpower is limited, customers will adopt a self-service approach.

As many customers show disinterest in storing or using their data, they can directly choose whether they want to have any promotional messages or any extra service for their revisit. Then the data storage module will store all the customer orders and maintain the queue based on the time of the placed order. The established order will be displayed on the screen for the customer, and they will know when their orders are ready to take place. The food provider or the kitchen department will have access to the data storage to maintain the queue. Whenever the placed order is ready, it will be shown or displayed on the screen, and a notification will be given to the customers who have placed the order.

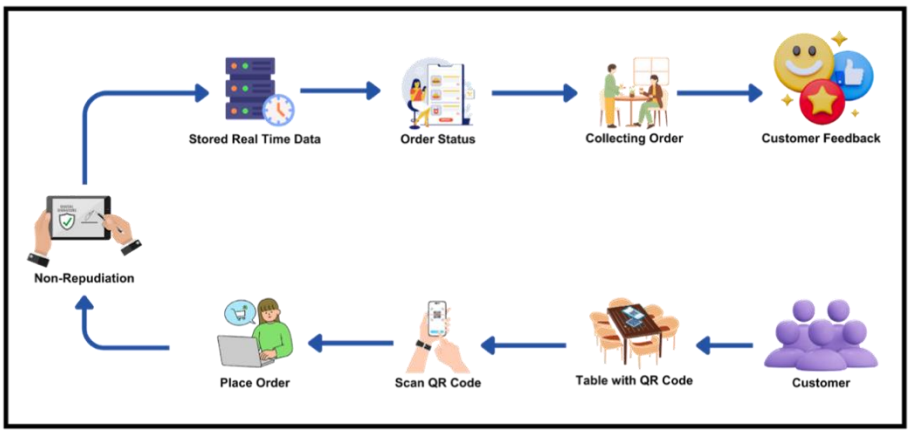

Fig. 5. Practical Scenario of The IoT-Based Customer Order Handling System

The system is automated, and no one must be physically or directly attached. The level of customer satisfaction does play a significant role in the success of any dining sector. The need for more helpers as well as more crowds will lower the satisfaction level of the customers. Through the utilization of the Internet of Things (IoT), an automated system will prevent all the possible obstacles both parties face. The computerized system will be based on customers' real-time data. The overall design will require a straightforward and user-friendly approach. Customers will not have to be knowledgeable about technology. Almost everyone uses a smartphone, so their phone will automatically connect to the internet. Using only their QR code, any customer can place an order. The screen will also display the approximate time for the delivery of the ordered food.

Overall, the automated system's configuration is not expensive. Any restaurant size can implement the system, as can the hardware or components have used in it. The components include a QR code, a dashboard displaying the order status, a monitor, and an online payment system. If the employees working in the restaurant and the customers going there become more friendly with the automated system, the outcome will be more effective.

3.2. Major Required Components

Though the attached QR Scan system is the main component of the overall design, some other elements are mandatory to run this automated system within the dining sector. Compared to the other IoT-based models for customer handling and restaurant management systems, this proposed system uses a limited number of components that can be described as user-friendly and understandable. The major components used are a stable internet connection, a table attached with a QR code, a centered or viewable kitchen system, a big screen, a digital payment system, notification systems, and a user manual system. Table 8 will define the components used in the proposed system and the primary setup cost.

Table 8 - List of hardware components and price of the items.

Serial	Item Description	Quantity	Price (BDT)
1	Arduino Uno	1	1500
2	Node MCU module	1	1250
3	Wire Set	3	1580
4	Display	1	20000
5	Buzzer	1	750
6	Switch	2	500
7	Integration	1	30000

Considering the benefits, the restaurant will be able to enjoy itself here, but the cost is minimal. With this automated system's help, the user's satisfaction level and maintenance can be appropriately managed.

3.3. System Design

Combining insights from IoT, data analytics, and food service management, the study contributes to multidisciplinary research, fostering a deeper understanding of how technology

can transform traditional service sectors. The study enriches the academic knowledge of technology's role in transforming service sectors by advancing theoretical models on IoT integration, resource optimization, customer experience, and data security. It provides actionable strategies and tools for enhancing operational efficiency, customer satisfaction, quality assurance, cost management, and sustainability. With the help of the cloud, the activities' security and automation can be done and controlled mainly (Bhuiyan et al., 2021),. Maintaining the satisfaction level of customers is the primary purpose of this proposed system. Due to the insufficient number of helpers and the increased crowd of customers, the food delivery system cannot satisfy the customers. The customer must wait for such a long time, leading to dissatisfaction. So, the automation system of the developed model will decrease the problem.

There are three modules, which are visualized in Figure 6. These are the data processing, storage, and interaction modules. Each module has its own attributes and functions. The main components used are an internet setup, the environment, the QR code attached tables, the big display screen of the status of the placed order, and the digital payment systems with real-time feedback. This module will work with the customers' real-time data.

Here, the customer must have smartphones, which has become a widespread issue. Every type of person who usually comes to the restaurant to avail of the food service uses a smartphone. In the data processing module, whenever the customer is connected to the network.

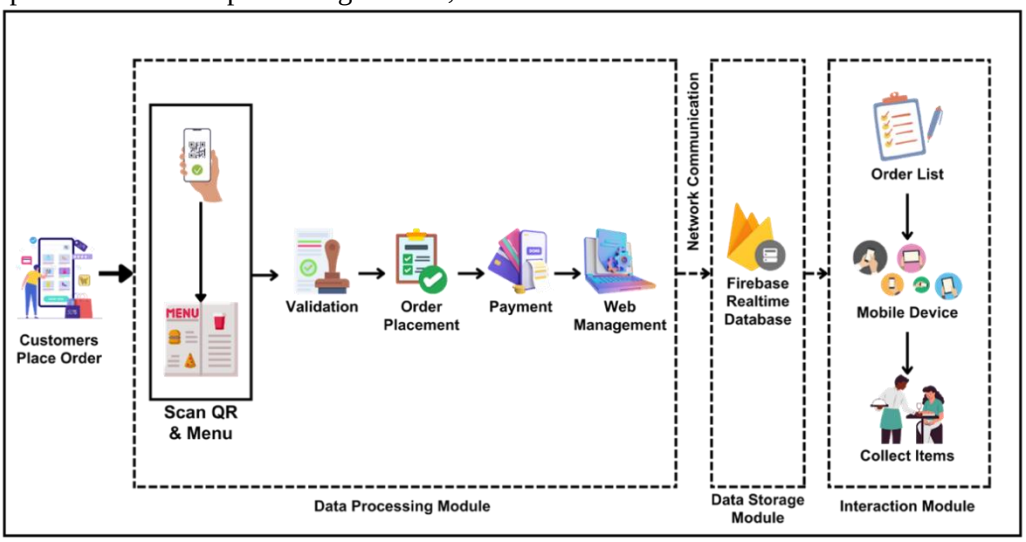

Fig. 6. System architecture of IoT-based smart customer order handling system

At the restaurant, the QR code will be scanned, and the menu list will be displayed on the screen of their phones. The customers don't have to go to the main table or wait for the service provider. He can choose the food from the list himself. This system will also display the available food and the approximate waiting time. Based on availability and time, the customer can choose their food. Then, it will be directly transferred to the kitchen's primary system. From there, the restaurant's food maker will learn about the items the customer wants and from which table the order has been placed. The food maker will update the name of the items being made, and the screen will display the food items being processed.

The customer will see the food they ordered and the time they allocated for delivery. The display will show the details of the ordered items and the time. Based on that, the customer will decide whether to place the order. Whenever the food is ready, the display will show a notification.

In the next interaction module, two-way communication will be between the customer and the restaurant. When the customer places an order, it is communicated to the system, and the kitchen person gets to know the order and the quantity. After making the order, the food makers update the system, which is delivered to the screen. The customer from the display will get to know you and make a mandatory comment while receiving the order. These comments will be delivered directly to the restaurant's storage system. These are the three modules of the overall system.

4. Implementation

Any proposed system must be user-friendly and approachable to everyone; otherwise, not everyone will accept this. While planning for this new proposed system, the first characteristic must be the user-friendly attributes with simple steps. At the stage of implementation of the system within the restaurant, Figure 7 will give a visual representation of the block diagram of the actual system.

In the implementation stage, all practical steps are displayed in Figure 4. The actual work starts with the customers scamming the QR code. While scanning the code, the menu list will be displayed to them digitally, and from there, in the next step, the customer will place the order. The cloud system will store all the transactions for future use of the restaurant and list down the likes and dislikes of the customers. The customers can see the order status and manage the schedule based on that. This attribute can maintain the satisfaction level of the customers. After receiving the order, the customer must give mandatory feedback so the restaurant can figure out the shortage and improve the fields. This IoT-based innovative system is not that expensive. Any type of restaurant can set up this system. Figure 7 shows the complete practical mention of the proposed system. The implementation phase is divided into hardware implementation and software implementation since the complete operation of the system that is suggested has been organized using a hardware device and an application interface. The restaurant kitchen and caretakers may get the requested information in real-time through the suggested IoT-based solution. To order and monitor in an intelligent environment, the suggested system has been created utilizing Arduino UNO, Node MCU, and Global System modules (Bhuiyan et al., 2022).

Fig. 7. Block Diagram of Proposed Model

4.1. Hardware Implementation

The collecting data processing module, an essential part of the system, is represented by the hardware implementation in the "System Design" section. Sensor data is collected for the processing module, analyzed, and transmitted to a cloud server. Multiple hardware components were combined to create this multi-functional device. The necessary hardware components implement interconnected hardware devices to peer at the system design and configure the microcontroller of the IoT board.

The sensor configuration, Arduino, node MCU module, LED, buzzer, and other major electrical circuit components are shown in the circuit diagram. The circuit diagram was created using ‘Proteus Design Suite" software. The primary controller board for the system is an Arduino Uno. For powering, the Arduino is used. The controller board node MCU ESP8266 is combined with the Arduino to provide WIFI functionality and expand the number of digital board pins and analogs using the Arduino in conjunction, making two-way serial communication possible. To enable serial communication between the node MCU and the Arduino in the software serial library for the Arduino. The baud rate is selected to maintain a consistent data transfer rate between the Arduino and node MCU. The system's processing unit is a shared MCU ESP8266 node and Arduino. The circuit was then completed by connecting all of the grounds and adding resistors where necessary. The C++ code is uploaded to the Arduino IDE after the circuit is finished, and the PC is through a Universal Serial Bus port. The real-time

food item is shown on the monitor and the mobile application when sensors are connected to the user's device.

4.2. Software Implementation

The data storage and interaction modules mentioned in the "System Design" section are software implementations. The two modules oversee storing the customer-ordered data in the cloud server and showing it in the mobile application. The data storage module is implemented by employing Google's Firebase cloud infrastructure. The Back-end-as-a-service (BaaS) platform delivers NoSQL databases, tools, and back-end functionalities to developers to create mobile and web apps. Firebase offers two types of databases: 1) The Firebase real-time database, which enables users to sync and save data instantly, and 2) Firebase cloud Fire store allows users to store, sync, and query data on a massive scale. In our created system, we used both sorts of databases. The customer-ordered data from the hardware device to the fire-base cloud server is initially saved in the real-time database. The fire-store database contains all organized data records, preserving the patient's medical history. The interaction module for the mobile application is created in Android Studio, Google's official IDE for the Android operating system. It is a dependable IntelliJ IDEA-powered IDE designed for faster mobile application development. We used Google Firebase as the back-end server for the mobile application and Java as the programming language. Scanned users can log in with their application to view the real-time restaurant menu of the product carrying the sensing device. Customers can also access an interface for the sorted history, which displays their records for each hour of the day.

4.3. Experiment Result Analysis

The proposed system has been implemented in several restaurants to verify the customer's acceptance and satisfaction level. Table 9 represents the price status and defines the ratio of the customers' revisit to the restaurants with the new automated system. We have implemented the system in several restaurants, from budget-friendly to high-pricing, and have taken their average prices. The table shows the reduced prices of most of the restaurants that were experimented with. Though the reduced price is not that high compared to the previous ones, this is the result of the average pricing of the restaurants. Due to the system, the necessity of having manpower has been reduced, and the reduced price has been adjusted to the current price after the system implementation. The key results include improved operational efficiency, enhanced customer satisfaction, better quality and safety assurance, cost savings, scalability, and valuable data-driven insights. These findings underscore the potential of IoT technology to transform the food service industry, providing a robust framework for future implementation and further research in this area.

Table 9 - Experimented dataset of the restaurants.

Category no.	Average price before the system (BDT)	Average price after the system (BDT)	Revisit ratio (Monthly)
1	575	490	75%
2	850	790	25%
3	1500	1260	28%
4	890	860	68%
5	780	800	45%
6	999	899	12%
7	670	690	43%
8	2500	2350	17%
9	6000	6300	34%
10	7500	7100	28%

Figure 8 represents the outcome of the system analysis in several restaurants. The revisit ratio varies from one restaurant to another. We have collected data from the restaurant's storage system. Based on the actual data, the system successfully increases the customer's revisited status.

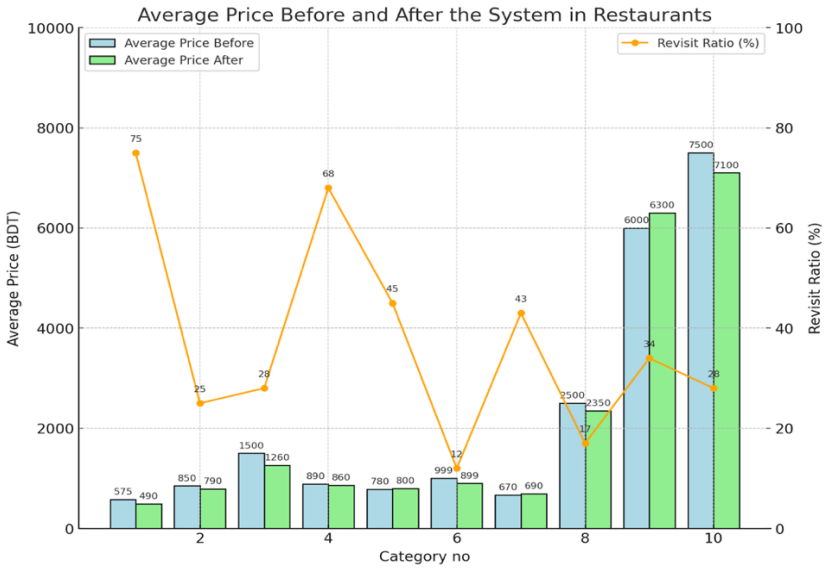

Fig. 8. System implementation outcome analysis

Table 10 conducts the cost-benefit analysis of the proposed automated solution identified calculated through cost-benefit analysis. Our system has been implemented in several restaurants. Compared to the installation and maintenance costs, the benefits from the systems are much higher. Depending on the cost-benefit analysis of the system.

Table 10 - Cost benefit analysis of system implementation.

Proposed action	Benefits	Benefit Impact High = 3 Med = 2 Low = 1	Costs	Costs Impact High = 3 Med = 2 Low = 1	Ratio Benefit/ Costs
Internet Connections	Connections of customers	3	Installation & regular costs	1	Benefits
QR code attachment	Easily order placement	3	Installation cost	1	Benefits
Digital Display Screen	Order tracking	2	Maintenance cost	1	Benefits
User Manual	Customer Assistance	2	Installation cost	1	Benefits
Real-time stored information	Customer tracking and advertisement	3	Maintenance cost	2	Benefits
Customer revisit ratio or tendency	Increased revisit ratio	3	System maintenance costs	1	Benefits
Changed food price	Adjusted to system	3	Increased particular food prices	3	Neutral position
Required employees	Decreased Employees	3	System installation	2	Benefits
Customers Comfort	Increased satisfaction	3	Maintenance cost	2	Benefits
Time Management	Decreased Time	2	System Maintenance costs	1	Benefits
	Total Benefits	27	Total Cost	15	Overall Benefits

5. Discussion

The results of this study indicate that the implementation of an IoT-enabled automated order handling system significantly improves both customer satisfaction and operational efficiency in restaurants. This finding aligns with previous studies but also provides new insights into the specific benefits and practical applications of such systems in developing countries like Bangladesh.

Compared to (Kandasamy et al., 2023), who found that wireless systems for menu ordering save time and reduce errors, this study extends these findings by demonstrating how real-time data monitoring and QR code integration enhance order accuracy and customer satisfaction. Similarly, (Ravi et al., 2019) highlighted the benefits of Android-based restaurant automation systems for reducing human error and improving service speed. This study corroborates these benefits and shows that adding IoT components further improves operational efficiency.

The qualitative data gathered from restaurant staff supports (Islam Jubaid et al., 2023), who emphasized reducing human intervention to maintain hygiene and efficiency during peak hours. Additionally, (C. H. Lee et al., 2020) discussed the potential of digital transformation to meet client expectations and deliver value. This research confirms this potential, showing significant increases in customer satisfaction, high revisit ratios, and positive feedback with IoT systems. (Wen et al., 2018) and (Yi & Liu, 2020) both discussed the drawbacks of manual order systems, such as time commitment and incorrect orders. This study reaffirms these drawbacks and offers a practical solution through an automated system that minimizes these issues. Table 11 shows the comparison between the proposed system and the existing system.

Table 11 - A comparison between the system and the existing systems.

Ref.	QR-Code Scanner	Required tech knowledge	User-Friendly	Automated Payment System	Secured & privacy maintenance	Cost	Real-time feedback
Proposed System	Yes	No	Yes	Yes	Yes	Cost Effective	Yes
(Deng et al., 2019)	No	Yes	No	Yes	Yes	Expensive	No
(Ben Ayed & Hanana, 2021)	No	Yes	Yes	Yes	Not mentioned	Low Cost	Yes
(Qian et al., 2020)	Yes	Yes	No	Yes	Yes	Expensive	No
(Paul et al., 2020)	No	Yes	No	No	Not mentioned	Low Cost	Yes
(Y. K. Lee, 2021)	No	Yes	Yes	Yes	Not mentioned	Expensive	No
(Jeon et al., 2020)	No	Yes	No	Yes	Yes	Expensive	Yes
(P. W. Khan et al., 2020)	No	Yes	No	Yes	Not mentioned	Low Cost	Yes
(Taillon & Huhmann, 2019)	Yes	Yes	No	No	Yes	Expensive	Yes
(Bellini et al., 2022)	No	Yes	Yes	Yes	Not mentioned	Low Cost	No

The implementation of an IoT-enabled automated order handling system in restaurants significantly enhances customer satisfaction and operational efficiency. This study provides strong evidence that such systems are particularly beneficial in developing countries, where resource management and customer service can be major challenges. By integrating real-time data monitoring, QR code technology, and cloud-based data storage, restaurants can streamline their operations, reduce errors, and improve the overall dining experience for their customers. The findings of this study not only support previous research but also offer new insights into the practical applications and benefits of IoT technology in the food service industry.

6. Conclusion

This study demonstrates that implementing an IoT-enabled automated order handling system can significantly enhance both customer satisfaction and operational efficiency in the restaurant industry, particularly in developing countries like Bangladesh. By integrating QR code technology, real-time data monitoring, and cloud-based storage, the system addresses common challenges such as long wait times, order inaccuracies, and the need for extensive manpower. Our findings show a marked improvement in customer satisfaction, evidenced by higher revisit ratios and positive feedback, as well as operational benefits, including reduced costs and improved resource management. These outcomes suggest that adopting such technology can provide a competitive edge for restaurants, ensuring a smoother and more efficient dining experience for customers while optimizing business operations. This study not only corroborates previous research but also offers new practical insights into the deployment and benefits of IoT solutions in the food service sector, making a compelling case for their broader implementation. The results can significantly impact theoretical frameworks and practical applications in the field. The study offers actionable strategies and tools for improving efficiency, customer satisfaction, quality control, cost management, and scalability. The positive outcomes observed, such as increased customer revisit rates and improved order accuracy, suggest that investing in such technology can lead to higher customer retention and better resource management, ultimately boosting profitability.

In the academic field, this study adds to the growing body of literature on IoT applications in the service industry, providing empirical evidence of their benefits and practical applications. It opens avenues for further research into optimizing these systems and exploring their impact in different contexts and regions. Additionally, the study highlights the importance of user-friendly design and cost-effectiveness in the successful adoption of new technologies, offering valuable insights for developers and researchers working on similar innovations.

While there is consensus on the benefits of IoT in enhancing restaurant operations, existing research often presents conflicting findings regarding the cost-effectiveness and scalability of such systems. Additionally, there is a notable gap in addressing the specific needs of developing countries, where technological infrastructure and financial constraints pose significant challenges. Unanswered questions include how IoT systems can be designed to be both inexpensive and user-friendly, what measures can be implemented to ensure the privacy and security of customer data in automated systems, and how real-time feedback and data analytics can be seamlessly integrated into restaurant operations.

By identifying these gaps and unanswered questions, this study justifies the need for a comprehensive IoT-enabled smart order-handling system that is tailored to the unique challenges of developing countries. The proposed solution aims to provide practical, scalable, and secure automation that enhances both operational efficiency and customer satisfaction, ultimately contributing to the broader goal of sustainable development in the food service industry.

References

Alt, R. (2021). Digital Transformation in the Restaurant Industry: Current Developments and Implications. *Journal of Smart Tourism*, *1*(1), 69–74. https://doi.org/10.52255/smarttourism.2021.1.1.9

Aytaç, K., & Korçak, Ö. (2021). IoT based intelligence for proactive waste management in Quick Service Restaurants. *Journal of Cleaner Production*, *284*. https://doi.org/10.1016/j.jclepro.2020.125401

Bellini, P., Nesi, P., & Pantaleo, G. (2022). IoT-Enabled Smart Cities: A Review of Concepts, Frameworks and Key Technologies. In *Applied Sciences (Switzerland)* (Vol. 12, Issue 3). MDPI. https://doi.org/10.3390/app12031607

Ben Ayed, R., & Hanana, M. (2021). Artificial Intelligence to Improve the Food and Agriculture Sector. In *Journal of Food Quality* (Vol. 2021). Hindawi Limited. https://doi.org/10.1155/2021/5584754

Ben-Daya, M., Hassini, E., Bahroun, Z., & Banimfreg, B. H. (2020). The role of internet of things in food supply chain quality management: A review. In *Quality Management*

Journal (Vol. 28, Issue 1, pp. 17–40). American Society for Quality. https://doi.org/10.1080/10686967.2020.1838978

Berezina, K., Ciftci, O., & Cobanoglu, C. (2019). Robots, artifiial intelligence, and service automation in restaurants. In *Robots, Artificial Intelligence and Service Automation in Travel, Tourism and Hospitality* (pp. 185–219). Emerald Group Publishing Ltd. https://doi.org/10.1108/978-1-78756-687-320191010

Bhuiyan, M. N., Rahman, M. M., Billah, M. M., & Saha, D. (2021). Internet of things (IoT): A review of its enabling technologies in healthcare applications, standards protocols, security, and market opportunities. *IEEE Internet of Things Journal*, *8*(13), 10474-10498.

Bhuiyan, M. N., Billah, M. M., Bhuiyan, F., Bhuiyan, M. A. R., Hasan, N., Rahman, M. M., ... & Niu, M. (2022). Design and implementation of a feasible model for the IoT based ubiquitous healthcare monitoring system for rural and urban areas. *IEEE Access*, *10*, 91984-91997.

Bigliardi, B., Bottani, E., & Filippelli, S. (2022). A study on IoT application in the Food Industry using Keywords Analysis. *Procedia Computer Science*, *200*, 1826–1835. https://doi.org/10.1016/j.procs.2022.01.383

Billah, M. M., Bhuiyan, M. N., & Akterujjaman, M. (2021). Unsupervised method of clustering and labeling of the online product based on reviews. *International Journal of Modeling, Simulation, and Scientific Computing*, *12*(2). https://doi.org/10.1142/S1793962321500173

Blöcher, K., & Alt, R. (2021). AI and robotics in the European restaurant sector: Assessing potentials for process innovation in a high-contact service industry. *Electronic Markets*, *31*(3), 529–551. https://doi.org/10.1007/s12525-020-00443-2

Chavan, S., Chaudhari, P., Gade, K., Sharma, K., M, S., & D.B., P. (2023). Next Generation Electronic Waiter: Wireless Menu Ordering & Serving Robot. *International Conference on Edge Computing and Applications (ICECAA)*.

Chochiang, K., Ung, P., & Bunsaman, N. (2020). One Stop Restaurant Service Application. *17th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)* .

Deng, B., Li, S., Zhang, B., Wang, F., Li, D., & Lin, H. (2019, October 22). Iot Intelligent Restaurant System Design. *ACM International Conference Proceeding Series*. https://doi.org/10.1145/3331453.3361284

Entreprene. (2023). An overview of the restaurant industry in Bangladesh. Retrieved from https://www.thestrategywatch.com/restaurant-industry-bangladesh/

Intal, L., Payas, J., Fernandez, L., & Domingo, B. (2020). Restaurant Information System (RIS) with QR Code to Improve Service Operations of Casual Fine Dining Restaurant. *7th International Conference on Industrial Engineering and Applications*, 1054–1059.

Islam Jubaid, M. J., Haque Chowdhury, M. S., Islam, M., Joy, P. P., Ahmed Hmu, S. E., Abrar, F., Hossain, M. M., & Alam, J. (2023). Design And Construction of a Smart Restaurant Service Using Conveyor Belt. *IEEE International Conference on Advances in Electronics, Communication, Computing and Intelligent Information Systems, ICAECIS 2023 - Proceedings*, 265–270. https://doi.org/10.1109/ICAECIS58353.2023.10170087

Jeon, H. M., Sung, H. J., & Kim, H. Y. (2020). Customers' acceptance intention of self-service technology of restaurant industry: expanding UTAUT with perceived risk and innovativeness. *Service Business*, *14*(4), 533–551. https://doi.org/10.1007/s11628-020-00425-6

Kandasamy, A., Shanmugam, T., Theethan, D., & Palaniappan, G. (2023). Smart restaurant menu ordering system using Arduino. *AIP Conf. Proc.*

Khan, P. W., Byun, Y. C., & Park, N. (2020). IoT-blockchain enabled optimized provenance system for food industry 4.0 using advanced deep learning. *Sensors (Switzerland)*, *20*(10). https://doi.org/10.3390/s20102990

Khan, Y., Su'ud, M. B. M., Alam, M. M., Ahmad, S. F., Ahmad, A. Y. A. B., & Khan, N. (2023). Application of Internet of Things (IoT) in Sustainable Supply Chain Management. In *Sustainability (Switzerland)* (Vol. 15, Issue 1). MDPI. https://doi.org/10.3390/su15010694

Kocaman, E., & Türkmen, B. (2022). The Effects of Use of Restaurant Management Systems Perceived by the Personnel According to Their Demographic Characteristics. *IGI Global*.

Kodan, R., Parmar, P., & Pathania, S. (2020). Internet of Things for Food Sector: Status Quo and Projected Potential. In *Food Reviews International* (Vol. 36, Issue 6, pp. 584–600). Taylor and Francis Inc. https://doi.org/10.1080/87559129.2019.1657442

Kumar, I., Rawat, J., Mohd, N., & Husain, S. (2021). Opportunities of Artificial Intelligence and Machine Learning in the Food Industry. *Journal of Food Quality*, *2021*. https://doi.org/10.1155/2021/4535567

Lee, C. H., Chen, C. H., & Lee, Y. C. (2020). Customer requirement-driven design method and computer-aided design system for supporting service innovation conceptualization handling. *Advanced Engineering Informatics*, *45*. https://doi.org/10.1016/j.aei.2020.101117

Lee, Y. K. (2021). Transformation of the innovative and sustainable supply chain with upcoming real-time fashion systems. *Sustainability (Switzerland)*, *13*(3). https://doi.org/10.3390/SU13031081

Leung, R., & Loo, P. T. (2022). Co-creating interactive dining experiences via interconnected and interoperable smart technology. *Asian Journal of Technology Innovation*, *30*(1), 45–67. https://doi.org/10.1080/19761597.2020.1822748

Li, J. (Justin), Bonn, M., Wang, J., & Cho, M. (2021). Food delivery application user segmentation in the mobile marketing world in China. *Journal of the Asia Pacific Economy*.

Marshall, L. (2023). Restaurant Management and Operations: A Tourism Virtual Experience. *The Internet and Travel and Tourism Education*.

Nagarajan, S. M., Deverajan, G. G., Chatterjee, P., Alnumay, W., & Muthukumaran, V. (2022). Integration of IoT based routing process for food supply chain management in sustainable smart cities. *Sustainable Cities and Society*, *76*. https://doi.org/10.1016/j.scs.2021.103448

Paul, R., Bhandopia, R. R., Patil, R. D., Raut, D. J., & Gotmare, D. A. (2020). An Efficient Digital Ordering System for Restaurant. *International Journal of Research in Engineering, Science and Management* , *3*(3), 391–395.

Qamar, T., Tariq, S., Aqeel, A., Jaffri, F., & Hussain, T. H. (2019). SMARTABLE-Digital Ordering System for Restaurant Using Android. *1st International Conference on Computational Sciences and Technologies*.

Qian, J., Wu, W., Yu, Q., Ruiz-Garcia, L., Xiang, Y., Jiang, L., Shi, Y., Duan, Y., & Yang, P. (2020). Filling the trust gap of food safety in food trade between the EU and China: An interconnected conceptual traceability framework based on blockchain. *Food and Energy Security*, *9*(4). https://doi.org/10.1002/fes3.249

Ravi, R., Amrutha, R., Amritha, E., Haneena.P, & Jaseena.T. (2019). An Android Based Restaurant Automation System with Touch Screen. *International Conference on Inventive Systems and Control (ICISC 2019)*, 438–442.

Schmidt, A., Kabir, M. W. U., & Hoque, M. T. (2022). Machine Learning Based Restaurant Sales Forecasting. In *Machine Learning and Knowledge Extraction* (Vol. 4, Issue 1, pp. 105–130). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/make4010006

Singh, R., Sonje, R., Salkar, S., & Jadhav, A. (2022). Smart QR-based Restaurant Dine-in System with Sales Analysis. *ITM Web of Conferences*, *44*, 03014. https://doi.org/10.1051/itmconf/20224403014

Taillon, B. J., & Huhmann, B. A. (2019). Strategic consequences of self-service technology evaluations. *Journal of Strategic Marketing*, *27*(3), 268–279. https://doi.org/10.1080/0965254X.2017.1411387

Tanizaki, T., Hoshino, T., Shimmura, T., & Takenaka, T. (2020). Restaurants store management based on demand forecasting. *Procedia CIRP*, *88*, 580–583. https://doi.org/10.1016/j.procir.2020.05.101

Trajkovska Petkoska, A., Daniloski, D., D'Cunha, N. M., Naumovski, N., & Broach, A. T. (2021). Edible packaging: Sustainable solutions and novel trends in food packaging. In

Food Research International (Vol. 140). Elsevier Ltd. https://doi.org/10.1016/j.foodres.2020.109981

Varriale, V., Cammarano, A., Michelino, F., & Caputo, M. (2021). Sustainable supply chains with blockchain, IoT and RFID: A simulation on order management. *Sustainability (Switzerland)*, *13*(11). https://doi.org/10.3390/su13116372

Vemulapalli, G. (2023). Self-Service Analytics Implementation Strategies for Empowering Data Analysts. *International Journal of Machine Learning and Artificial Intelligence*. https://jmlai.in/

Wen, Z., Hu, S., De Clercq, D., Beck, M. B., Zhang, H., Zhang, H., Fei, F., & Liu, J. (2018). Design, implementation, and evaluation of an Internet of Things (IoT) network system for restaurant food waste management. *Waste Management*, *73*, 26–38. https://doi.org/10.1016/j.wasman.2017.11.054

Yi, S., & Liu, X. (2020). Machine learning based customer sentiment analysis for recommending shoppers, shops based on customers' review. *Complex and Intelligent Systems*, *6*(3), 621–634. https://doi.org/10.1007/s40747-020-00155-2

Yost, E., Kizildag, M., & Ridderstaat, J. (2021). Financial recovery strategies for restaurants during COVID-19: Evidence from the US restaurant industry. *Journal of Hospitality and Tourism Management*, *47*, 408–412. https://doi.org/10.1016/j.jhtm.2021.04.012