Review Article

The Automated System's Diverse Uses and Effects on Restaurant Services

[1]Abubakar Surajo Imam, [2]Sarafadeen Leye Lawal, [3]Livingston Sunday Aduku, [4]Muhammad Ahmad Baballe*

[1, 2, 3, 4]Department of Mechatronics Engineering, Nigerian Defence Academy (NDA), Kaduna, Nigeria.

*Corresponding author: **Muhammad Ahmad Baballe**
Department of Mechatronics Engineering, Nigerian Defence Academy (NDA), Kaduna, Nigeria.
ORCID: 0000-0001-9441-7023

Abstract
The use of equipment and technology to improve overall efficiency in restaurant management, decrease human labor, and streamline procedures is known as restaurant automation. It entails combining hardware, software, and additional tools to automate a number of formerly manual activities. Automating restaurants is not a brand-new idea; it has been in use for a number of years. However, restaurant operators are now more than ever using automation techniques due to technological improvements and the growing customer desire for quicker service and convenience.

Keywords: *Artificial Intelligence (AI), Restaurant, Automation, Radio Frequency Identification (RFID), Internet of Things (IoT), Services.*

I. INTRODUCTION

The implementation of process automation in business nowadays is increasing, as it enables specific actions to be performed more efficiently, faster, or using fewer resources [1-3]. Digitization of business processes allows executing specific processes digitally using informational technologies and creating control mechanisms, monitoring, and increasing data and information transparency in order to analyze business processes more efficiently and detect weak points. Customer support in the restaurant industry, digitalization is a step toward more effective service. Overall system automation that enables patrons to put orders straight from the table while informing chefs is currently uncommon. When a waiter provides manual customer service in a restaurant, there are multiple times when a customer must wait while specific tasks are completed.

II. LITERATURE REVIEW

Combining kitchen and management maintenance systems with touchscreen devices on restaurant tables that allow patrons to digitally peruse the menu and place their orders is a practical method of automating restaurant operations and making them more efficient, adaptable, and economical [5]. Use of suitable equipment that is very durable, less susceptible to filth, and scratch-resistant is required. In addition to having a fast response time and general reliability, the screen must be sufficiently transparent to display the menu [4]. The system includes all aspect of restaurant ordering in the research publications the authors analyzed, from waiter and client orders to kitchen and cashier applications [4]–[7], [8]–[12]. It is typically advised that customers utilize tablet applications running the Android operating system to place orders at the table [4], [6], [10]–[12]. Primarily designed for mobile and tablet devices, the Android operating system is the most widely used Linux-based operating system. From the perspective of the developer, it is less expensive than iOS. The characteristics of the system vary depending on the literary source. One option, for instance, is to use two Android operating system applications: a restaurant application and a customer application. The restaurant application is designed for restaurant employees and has three user types (Customer, Cashier, and Kitchen) with the previously mentioned functions, while the customer application contains information about the precise location of the table to trace it when the customer is placing the order [4]. A different approach uses four types of applications: customer and waiter applications, restaurant web applications, and management applications [6]. In this case, the waiter application is defined separately and contains several functions, for example, additional information about the order, grouping of the payments, as well as

order confirmation before it is transferred to the kitchen. The waiter application is also used to receive information about ready orders from the kitchen, unlike the approach described above, in which this function is intended only for the manager. A similar system is also described in papers [11], [12]. The choice of system application user types depends on the specific restaurant business and its customer service. In restaurants where the cashier's and ordering duties are performed only by waiters, it would be more convenient to use a system that provides more functions in the waiter application, though in cases where the service process is organized with the involvement of the manager, a system can be used in which the manager also acts as a middleman between the kitchen and waiters. Based on one of the research approaches in restaurant automation, the GSM layer is used for data transmission. The authors conclude that it has lower costs, improved quality performance, a large transmission range (1000+ meters), and a high level of reliability. If a GSM module is used, several modules can be used in the same range, unlike RF modules that do not work if there are more than three modules in one area. GSM bandwidth is 900 MHz, and the communication format does not require a large channel bandwidth. As a result, the number of channels increases significantly and, thus, the efficiency. It is possible to add additional channels using CDMA technology [4]. The Liquid Crystal Display (LCD) screen is most often used for better review of orders in the kitchen area. To connect the Android app used by the chef with the LCD screen, it is possible to use the Arduino tool, which uses a Bluetooth connection to mirror application information on the LCD monitor. Arduino is an open-source physical computing platform, which is based on a simple microcontroller board and is used as an environment for adding software. Likewise, there is a logical queuing system that allows chefs to see orders in a specific order. Arduino uses a wireless Bluetooth connection to transmit order information to the LCD monitor [4]. Radio Frequency Identification RFID-based technology integrated with WLAN and database technology is also used for data transfer in the automated system of restaurant processes. It is used to develop an e-restaurant system for customer-oriented services. In this case, RFID-tagged customer cards can be used that allow waiters to immediately identify customers and then provide customized services [6]. The architecture of restaurant customer service systems is usually created using a centralized database. Such a system contains a database server with restaurant menus and all of the information regarding ordering logic. Devices can be connected using a secure and private WLAN network [5]–[7], [9]–[12]. It is also possible to use real-time data reading when the customer application is connected to a database server and downloads restaurant menus in real time [6]. Another approach to send customer order data to the server is to use the already described wireless GSM connection [4]. In addition to the existing functionality, it is possible to add video cameras in the kitchen in order to let customers see how their order is being prepared in real time [9]. Customers can retrieve information directly from the database using touchscreen devices in the comprehensive restaurant service system. The menu list can be designed to call PHP functions to extract information from the database and save it to an XML file. The order information selected by the customers can then be stored as data objects in the database [5]. Zend Framework is one of the frameworks that can be used to develop a comprehensive automated restaurant service system. It provides wide component libraries for the functional web management system development. The Zend framework provides many modules and classes developed over the years by the open-source community, and it is easily extensible [5]. Using the framework, it is possible to develop the required controllers with individual methods—login authentication and user type classification, menu updating, display daily messages, database retrieval operations, and order generation according to received requests, as well as order accounting and queuing to display in the kitchen [5]. Extending the architecture of the considered automated system with Internet of Things (IoT) devices, or, in other words, sensors, it is possible to achieve additional system functionality in the case of long queues, where customers are waiting for the available table. Use of the sensors can significantly improve customers' experience, promote the restaurant brand value, increase the overall level of service quality, as well as improve effectiveness and decrease the expenses. Sensors can serve as a basis for a smart queuing and reservation system. An existing WeChat application with sub-software can be used, which can also serve as a website where, for example, with the help of a QR code developed by a restaurant, a customer can occupy the queue and come to the restaurant only when the table is available. Besides, it is possible to use a sub-software of the WeChat application in order to develop the restaurant menu environment, which can be used by customers through touchscreen tablets installed in the restaurant [8]. Extending automation to restaurant warehouse processes makes it possible to use RFID technology in order to label goods in the restaurant warehouse in order to make the management of raw materials more efficient and ease the purchase process by digitalizing information about expiry dates of goods [8]. Robots equipped with various necessary sensors, as well as RFID readers, can be used for kitchen warehouse service management, as well as for waiter functions [8]. Robotic systems of IoT technologies are used to replace the traditional workforce, to make various activities more efficient, and to reduce the mistakes made by employees, which are often caused by long working hours of waiters. Using robots to accept and deliver orders to customers is another possible approach to automating the overall restaurant service system. Specialized robots with laser scanners and ultrasound sensors can be developed in order to recognize their location in the restaurant. When the restaurant is being scanned by sensors, it is possible to give a voice command to move the robot to a previously defined place in a restaurant. Likewise, it is possible to teach the robot different types of voice commands. Voice commands can also be used to move the robot or interact with another robot's software. By adding a serving tray to a robot, it can also be used to deliver orders to a customer [6]. In this case, a robot can partially replace the waiter's job responsibilities while not losing the usual restaurant concept in accepting customer orders. However, the use of such robots is not common worldwide, and they do require full digitization of the customer service system. It is important not only to digitize the customer service process

but also to implement automatic inventory and control of raw materials in restaurants with high turnover and demand. A specialized order management system for this function is able to determine the necessary raw materials for the dishes ordered by customers, thus facilitating the work not only for the cook but also for the manager [13]. The most widely used device for processing customer orders in restaurants is the personal digital assistant (PDA). It is used to automate part of the overall service process, as this device is usually designed for waiters who accept orders from customers. Afterwards, data can be transferred to the cash register system and the kitchen [7]. Such systems allow speeding up service time, increasing service efficiency and the accuracy level of orders. PDA systems typically use a wireless network for data transmission [7]. However, it does not offer separate customer and overall management applications, which means all of the processes cannot be automated. The potential reduction in customer waiting times will be less than using a comprehensive digital restaurant system. The strengths of the PDA system are the reduction of the waiter's service time, the reduction of errors, and others that focus directly on the waiter's duties. The weakness is its inability to support and to be integrated into other business processes [7]. In order to identify potential benefits for restaurants, the study suggests a smart restaurant system and evaluates its merits. One of the primary factors that may be changed to improve customer service speed and draw in more customers to a restaurant is service time. The system is developed by analyzing solutions from software, scientific literature, and their various architectures. The average restaurant service load time can be reduced by 52.76%, according to research. To ascertain how a smart restaurant service system might boost a chef's productivity and how the application of various algorithms can lessen a chef's workload during peak hours, two hypotheses have been put out for additional study [15]. In this study, robotics in food processing is thoroughly reviewed, and its analysis is examined in relation to the degree of automation used in different food processing industries. In the food industry, food robots are expected to retrieve different materials and form them into a finished product using an efficient protocol [16]. This study proposes an automated meal ordering system that will intelligently track user orders. In essence, we will put in place a system that will allow customers to place orders or create custom meals with just a single click for a variety of restaurant kinds. An Android application for tablet PCs will be used to build this system. A MySQL database will be used at the backend, while Java and Android will be used to construct the front end [17].

III. WITH THE HELP OF THIS DETAILED GUIDE, YOU CAN SUCCESSFULLY INTEGRATE AUTOMATION INTO YOUR BUSINESS AND ENJOY ITS ADVANTAGES FOR MANY YEARS TO COME

Step 1: Identify Areas for Automation
Determine which parts of your restaurant require automation the most before implementing it. Order taking, payment processing, and inventory management are a few examples of such duties. Identifying pain points and doing an analysis of your present operations can help you determine which procedures should be automated first.

Step 2: Choose the Right Technology
It's time to choose the best technology for your restaurant's requirements after you've determined which areas need automation. There are many software programs and WordPress plugins on the market made especially for restaurants. Popular choices include inventory management software, point-of-sale (POS) systems for processing orders and payments, kitchen display systems (KDS) for expediting food preparation and delivery, and the WPCafe, Five Star, or Orderable plugin for automated restaurant management.

Step 3: Integrate Your Systems
All of your systems must work together harmoniously if you want automation to maximize efficiency. For instance, in order to deliver orders in real time via tableside tablets or mobile devices, your POS system and your KDS system should be able to connect. Wait times are decreased and inaccuracies in human data entry are eliminated through system integration.

Step 4: Train Your Staff
Training is crucial when introducing any new technology in a restaurant. Ensure that every employee is aware of the new systems' operation and their specific responsibilities for maintaining them. This will minimize interruptions during service hours and guarantee a seamless rollout.

Step 5: Monitor Performance & Make Adjustments
Automation is a process that needs to be continuously monitored and adjusted in order to maximize its performance. To find areas that could have more improvement, monitor performance indicators like inventory levels, table rotation rate, and order processing time.

Step 6: Embrace Customer Feedback
Remember to ask your patrons for their opinions on the automated procedures in your restaurant. To guarantee their general pleasure with the eating experience, use their feedback to make any necessary adjustments or enhancements [14].

IV. DEPENDING ON THE UNIQUE REQUIREMENTS AND OBJECTIVES OF A GIVEN ESTABLISHMENT, A VARIETY OF RESTAURANT AUTOMATION STRATEGIES MIGHT BE USED. THESE CONSIST OF

1. Online Ordering & Delivery Automation

The process of receiving and processing orders from various online platforms is streamlined by online ordering and delivery automation. By integrating with delivery services, it guarantees that orders are precisely recorded, monitored, and delivered on schedule.

Benefits include improved customer satisfaction through seamless service, lower labor expenses, and increased order accuracy and efficiency.

2. Customer-Facing Display

Digital screens that offer customers promotions, order data, and other pertinent information are known as customer-facing displays. These can be set up at the counter or at self-service kiosks.

Benefit: By offering real-time order updates, cutting down on perceived wait times, and encouraging upsell chances, it improves the customer experience.

3. QR Code Menu Automation

Without using paper menus or interacting with employees, clients can see and place orders using QR code menus by scanning a code with their cellphones.

Benefits include fewer points of contact, better hygiene, and an easy-to-use, interactive ordering system that may boost sales.

4. Reservation System

Through customer confirmations and reminders, automated reservation systems optimize table distribution, handle reservations, and lower no-show rates.

Benefits include expediting the reservation process, optimizing table usage, and raising customer satisfaction through shorter wait times.

5. Kitchen Display System

Digital screens in the kitchen are used by Kitchen Display Systems (KDS) to prioritize chores and display order details in place of conventional paper tickets.

Benefits include improved communication between the front and back of the house, decreased errors, and increased kitchen efficiency, all of which result in quicker service.

6. Geo-location Food Menu

Local specialties and limited-time deals are among the personalized menu selections that geo-location food menus offer based on the customer's location.

Benefit: By offering individualized menu selections, it improves the consumer experience and may boost sales and loyalty.

7. Inventory Automation System

Real-time stock level tracking, automated reordering, and low-stock item alerts are all features of inventory automation systems.

Benefits include waste reduction, ingredient supply assurance, and time savings on manual inventory checks, all of which improve cost control.

8. Point-of-Sale (POS) Systems

In order to manage sales, inventory, and customer data from a single platform, modern point-of-sale (POS) systems integrate with a variety of additional automation technologies.

Benefits include streamlining processes, accelerating transactions, and offering insightful data on consumer preferences and sales patterns.

9. Customer Relationship Management (CRM) Software

CRM software gathers and examines consumer information to enhance customer connections and tailor marketing campaigns.

By enabling users to bookmark their favorite products, a WooCommerce Wishlist enables companies to monitor client preferences. In addition to improving customer satisfaction, this function offers insightful data for focused marketing initiatives.

Benefit: Increases revenue and repeat business by strengthening client loyalty through tailored experiences and targeted incentives.

10. Restaurant Robots

A variety of automated devices that can greet customers, bring food to tables, and even prepare meals are referred to as restaurant robots. The overall efficiency of services can be enhanced by these robots' ability to work either alone or under human supervision.

Benefit: It boosts productivity and offers a distinctive, cutting-edge dining experience that may draw clients. Automated robots can also do monotonous duties and ensure constant quality, freeing up human employees to work on more intricate and engaging roles [14].
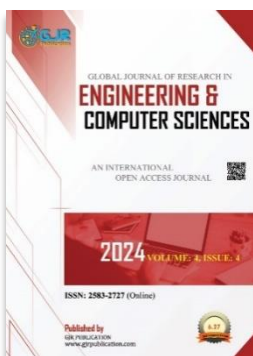
V. CONCLUSION

We have read a lot of publications about restaurant automation systems for this study. In the current technological era, we have witnessed a number of breakthroughs. Additionally discussed are factors to take into account while putting the current restaurant automation system into practice.

REFERENCES

1. T. O'Grady, H.-Y. Chong, and G. M. Morrison, "A systematic review and meta-analysis of building automation systems", Building and Environment, vol. 195, p. 107770, May 2021. https://doi.org/10.1016/j.buildenv.2021.107770.
2. T. Samad, P. McLaughlin, and J. Lu, "System architecture for process automation: Review and trends", Journal of Process Control, vol. 17, no. 3, pp. 191–201, Mar. 2007. https://doi.org/10.1016/j.jprocont.2006.10.010.
3. L. Ivančic, D. S. Vugec, and V. B. Vukšic, "Robotic process automation: Systematic literature review", in Lecture Notes in Business Information Processing, pp. 280–295, 2019. https://doi.org/10.1007/978-3-030-30429-4_19.
4. K. Mishra, B. S. Choudhary, and T. Bakshi, "Touch based digital ordering system on Android using GSM and Bluetooth for restaurants", in 2015 Annual IEEE India Conference (INDICON), New Delhi, 2015, pp. 1–5. https://doi.org/10.1109/INDICON.2015.7443374.
5. S. N. Cheong, W. W. Chiew, and W. J. Yap, "Design and development of multi-touchable E-restaurant management system", in 2010 International Conference on Science and Social Research (CSSR 2010), Kuala Lumpur, Malaysia, 2010, pp. 680–685. https://doi.org/10.1109/cssr.2010.5773867.
6. S. Pieskä, M. Liuska, J. Jauhiainen, A. Auno, and D. Oy, "Intelligent restaurant system Smartmenu", in 2013 IEEE 4th International Conference on Cognitive Infocommunications (CogInfoCom), Budapest, 2013, pp. 625–630. https://doi.org/10.1109/CogInfoCom.2013.6719177.
7. M. Prasad, E. Scornavacca, and H. Lehmann, "Using wireless personal digital assistants in a restaurant: impact and perceived benefits", in International Conference on Mobile Business (ICMB'05), Sydney, NSW, 2005, pp. 69–74. https://doi.org/10.1109/icmb.2005.112.
8. B. Deng, S. Li, B. Zhang, F. Wang, D. Li, and H. Lin, "Iot intelligent restaurant system design"' in ACM International Conference Proceeding Series, 2019, pp. 1–7. https://doi.org/10.1145/3331453.3361284.
9. YongChai Tan, KienLoong Lee, ZhiChao Khor, KaeVin Goh, KhimLeng Tan and BentFei Lew, "Automated food ordering system with interactive user interface approach", in 2010 IEEE Conference on Robotics, Automation and Mechatronics, Singapore, 2010, pp. 482–485. https://doi.org/10.1109/RAMECH.2010.5513147.
10. A. B. Amir, Mohd Syazwan Nazmi Bin Abul Kassim, and Mohamad Ikhsan Bin Johari, "Automated food ordering system", School of Computer Sciences, University Sains Malaysia,11800, Penang, Malaysia. [Online]. Available: https://www.academia.edu/31094268/Automated_ Food_Ordering_System.
11. Baranwal, A. Srivastava, B. Rani, "An innovative approach for online food order management system", International Journals of Advanced Research in Computer Science and Software Engineering, vol. 8, no. 3, Mar. 2018, pp. 19–23.
12. M. M. Chouhan, A. Tiwari, N. Agarwal, P. Patkar, N. Kumbhar, and P. S. Kulkarni, "Automated table ordering system", International Journal of Advance Research and Development, Computer Science, vol.2, no. 4, pp. 72–76, 2017. [Online]. Available: https://www.ijarnd.com/manuscripts/v2i4/V2I4-1154.pdf.
13. Deng, F. Wang, B. Zhang, D. Li, S. & Lin, H., "Internet of things smart restaurant design scheme", in ACM International Conference Proceeding Series, no. 38, Oct. 2019, pp. 1–4. https://doi.org/10.1145/3331453.3361283
14. https://themewinter.com/best-ten-restaurant-automation/.
15. L. Deksne, et al., "Automated System for Restaurant Services", Information Technology and Management Science, ISSN 2255-9094 (online) 2021, vol. 24, pp. 15–25 https://doi.org/10.7250/itms-2021-0003, https://itms-journals.rtu.lv.
16. Y. B. Wakchaure, B. K. Patle, S. Pawar, "Prospects of robotics in food processing: an overview", Journal of Mechanical Engineering, Automation and Control Systems, June 2023, Volume 4, Issue 1. https://doi.org/10.21595/jmeacs.2023.23209.
17. R. Kavade, V. Pansare, P. Kunjir, G. Gavande, "Proposed Automated Food Ordering System Using Data Mining Techniques", Journal of Emerging Technologies and Innovative Research (JETIR) www.jetir.org, March 2016, Volume 3, Issue 3.

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