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DineEZ: A QR Code-Based Digital Ordering System for Streamlined Restaurant

Akhil J, Jibin P K, Krishnadev M, Rahul Ramesh

Prof. Anagha P B(Guide)

Department of Computer Science

College of Engineering Vadakara

APJ Abdul Kalam Technological University(KTU), Kerala, India

Abstract: This paper presents DineEZ, a QR code-based digital ordering system designed to streamline restaurant operations by integrating real-time data processing and AI-driven recommendations. DineEZ replaces traditional paper menus with dynamic digital interfaces that enable customers to browse menus, place orders, and make secure payments using their smartphones. The system is built on a multi-tenant architecture utilizing Flutter and Firebase, ensuring scalability and efficient real-time synchronization across various restaurant environments. Pilot deployments demonstrate significant improvements, including a 40% reduction in order errors and a 35% decrease in customer wait times. Additionally, the paper describes a comprehensive analytics algorithm that generates actionable insights into sales trends, menu performance, and customer behavior. Future enhancements—such as IoT integration, blockchain-based security, and augmented reality menus—are proposed to further advance the system's capabilities.

I. INTRODUCTION

The restaurant industry is undergoing a rapid digital transformation driven by increasing consumer expectations for efficiency, accuracy, and enhanced dining experiences. Traditional methods of manual ordering and payment are often inefficient, leading to longer wait times, frequent order errors, and miscommunications between front-of-house and kitchen staff. In response, digital ordering systems have emerged as a promising solution to streamline operations and improve customer satisfaction.

DineEZ addresses these challenges by leveraging QR code technology to provide immediate access to dynamic digital menus via customers' smartphones. The system replaces conventional paper menus with interactive, real-time interfaces that not only allow customers to browse detailed dish descriptions and images but also incorporate AI-driven recommendations to personalize the dining experience. Built using Flutter for cross-platform compatibility and Firebase for robust, real-time data management and secure payment processing, DineEZ is designed with a scalable multi-tenant architecture. This approach allows individual restaurants to manage their menus, monitor operational analytics, and optimize service delivery while operating on a unified digital platform.

This paper details the design, implementation, and experimental evaluation of DineEZ. Pilot tests indicate that the system reduces order errors by 40% and cuts customer wait times by 35%, demonstrating its effectiveness in enhancing operational efficiency. The study further outlines an analytics algorithm that aggregates sales trends, menu performance metrics, and customer behavior insights, providing actionable data for restaurant managers. Future enhancements, including IoT integration, blockchain-based security, and augmented reality menus, are also discussed as avenues for further innovation in digital restaurant ordering systems.

II. LITERATURE REVIEW

In recent years, technological advancements have greatly impacted the restaurant industry, leading to various innovative approaches for enhancing dining experiences. This chapter presents a review of relevant literature on digital ordering systems, recommendation systems, and QR code-based applications in the restaurant sector. The following studies have informed the development of DineEZ by highlighting current trends and technologies used to streamline restaurant operations and improve customer satisfaction. 2.1 Gunawardena, Dinushika, and Kumuduni Sarathchandra (2020) - ”Bestdish: A Digital Menu and Food Item Recommendation System” Gunawardena and Sarathchandra (2020) introduce BestDish, a digital menu and food recommendation system aimed at providing personalized dining experiences in the hotel sector. This system leverages deep learning and a hybrid recommendation engine that combines collaborative filtering and content-based filtering to suggest food items based on customer preferences. Key features include nutritional information, allergen details, and ingredient traceability, empowering customers to make informed dining choices. The use of deep 4 learning enhances the precision of recommendations, offering customers a highly personalized experience. Technology Used: The system utilizes neural networks for deep learning and hybrid recommendation techniques for customized suggestions. It is implemented on a tablet interface within restaurants, facilitating an interactive ordering experience. Advantages: The system effectively addresses dietary restrictions and customer preferences, provides detailed dish information, and includes multi-language options for foreign customers. Disadvantages: High initial setup costs may deter small restaurants, and privacy concerns may arise from collecting and storing personal data. Future Scope: The study proposes the use of blockchain for ingredient traceability and group dining recommendations, enhancing transparency and customer trust. 2.2 El Fiorenza, J. Caroline, et al. (2018) - ”Smart Menu Card System” El Fiorenza et al. (2018) propose a Smart Menu Card System that replaces printed menus with a mobile application, allowing customers to browse, order, and pay through the app. This mobile interface improves efficiency by providing real-time menu updates and reducing human errors in order-taking. The cloudbased backend allows restaurant staff to manage menus and orders, facilitating a seamless digital ordering experience. Technology Used: The system employs cloud storage for data management, a payment API for digital payments, and relies on wireless communication (3G, 4G, and 5G networks). Advantages: The system reduces the need for printed menus, enables real-time updates, and minimizes waitstaff dependency. 5 Disadvantages: Dependency on smartphones and internet connectivity may limit accessibility, and some customers may prefer traditional, face-to-face interaction. Future Scope: Suggested improvements include expanding to a multi-restaurant platform, adding delivery options, and introducing loyalty programs to enhance user engagement. 2.3 Albuquerque, Diogo Davidson, et al. (2020) - ”Enhancing Sustainable Customer Dining Experience through QR Code and Geo-Fencing” Albuquerque et al. (2020) present a mobile application that integrates QR Code and Geo-Fencing technologies to improve the sustainability and transparency of the dining experience. The system provides detailed information on food ingredients and their sourcing, promoting sustainable dining practices. Geofencing capabilities allow the app to notify nearby customers of special offers, increasing restaurant engagement. Technology Used: QR code technology for menu access and geo-fencing for location-based notifications. Advantages: Enhances transparency in food sourcing, boosts customer trust, and provides real-time promotions to attract foot traffic. Disadvantages: Privacy concerns arise from location tracking, and users without smartphones may be excluded. Future Scope: Enhanced personalization using machine learning and expanded use of geo-fencing for more detailed, location-based offerings. 6 2.4 Intal, Grace Lorraine, et al. (2020) - ”Restaurant Information System (RIS) with QR Code to Improve Service Operations” Intal et al. (2020) propose a Restaurant Information System (RIS) utilizing QR codes for efficient menu access, ordering, and payment processing in fine dining. The system improves service efficiency by automating processes through a mobile application and SQL-managed database, reducing reliance on physical menus and minimizing order errors. Technology Used: QR codes for ordering, SQL for database management, and cloud hosting via Microsoft Azure. Advantages: Enhances service efficiency, reduces labor costs, and provides faster service during peak hours. Disadvantages: Initial setup costs, dependence on internet connectivity, and usability challenges for customers unfamiliar with QR code technology. Future Scope: Proposed enhancements include delivery support, inventory management, payroll automation, and data analytics for deeper insights into customer preferences. 2.5 Shriwas, Raviprakash, et al. (2014) - ”TouchscreenBased Ordering System for Restaurants” Shriwas et al. (2014) discuss a Touchscreen-Based Ordering System designed to replace printed menus with touchscreen devices at tables, allowing customers to place orders directly through a graphical interface. The system improves order accuracy and reduces the need for waitstaff, offering a more streamlined ordering experience. Technology Used: The system incorporates a GLCD touchscreen interface controlled by an

Atmega 16 microcontroller, with RF modules for wireless 7 communication. Advantages: Enhances service speed and accuracy, reduces human error, and lowers staff requirements, especially during peak hours. Disadvantages: High setup costs, limited scalability with RF modules, and potential user experience issues due to resistive touchscreens. Future Scope: Suggested improvements include upgrading to capacitive touchscreens, integrating mobile ordering, and adopting advanced communication technology such as Zigbee for increased scalability.

III. System Architecture

The system architecture of **DineEZ** is designed to provide an intuitive, efficient, and scalable solution for restaurant ordering and management. The application is developed using **Flutter**, allowing it to run on both Android and iOS devices with a single codebase. At the backend, **Supabase** is used as a comprehensive open-source platform that provides real-time database services, user authentication, file storage, and serverless edge functions. Supabase's foundation on PostgreSQL ensures robust data handling and security.

The architecture revolves around two primary user roles: **Customers** and **Restaurant Users**. The **Restaurant User** category encompasses both the **Restaurant Admin** and the **Staff** (such as kitchen personnel). Customers interact with the system through a clean and responsive mobile interface. Upon visiting a restaurant, a customer scans the **QR code** placed at their table using the DineEZ app. This QR code uniquely identifies the table and the associated restaurant, enabling the app to fetch the restaurant-specific menu from the Supabase database. Customers can then browse the menu, view dish descriptions and images, select items, and place orders directly through the app. Integrated payment gateways allow secure and convenient payment via UPI, cards, or digital wallets. Once an order is confirmed, an invoice is generated, and the order is sent to the kitchen dashboard for preparation.

On the **restaurant side**, login credentials give access to both the admin panel and the staff interface. The **Restaurant Admin** is responsible for managing the digital menu, which includes adding new dishes, updating prices, setting availability, assigning categories, and uploading images or descriptions. Additionally, the admin defines the number of tables in the restaurant, and the system generates unique QR codes for each one. The **kitchen staff** interface displays incoming orders in real time, categorized by table number, time of order, and item details, ensuring a smooth workflow from order receipt to food preparation and delivery.

A key feature of the architecture is the **built-in data analytics dashboard** accessible to the Restaurant Admin. Using Supabase's real-time capabilities and serverless edge functions, the system collects and processes data from daily transactions to generate insightful analytics. This includes visual charts and reports that display **total daily revenue**, **number of orders**, **top-selling dishes**, **average order value**, and **peak ordering hours**. The system also tracks **table-wise order frequency** and **day-wise performance**, allowing restaurant owners to optimize staffing, menu planning, and marketing efforts.

These analytics are updated dynamically and presented in the admin dashboard using visually appealing graphs and tables, offering actionable insights at a glance. Supabase's edge functions enable periodic data summarization and automated alerts if unusual patterns such as zero orders or spikes in cancellations are detected. The use of Supabase Storage for managing media files (dish images, QR codes, invoices) ensures efficient and secure data access.

Authentication and role-based access control are implemented through Supabase Auth, distinguishing between customers and restaurant users, with permissions tailored accordingly. Real-time synchronization ensures that menu changes, new orders, and status updates are reflected across all interfaces without delay.

In summary, the DineEZ system architecture, powered by Flutter and Supabase, delivers a modular, secure, and user-friendly solution that enhances customer experience and empowers restaurants with operational control and insightful analytics.

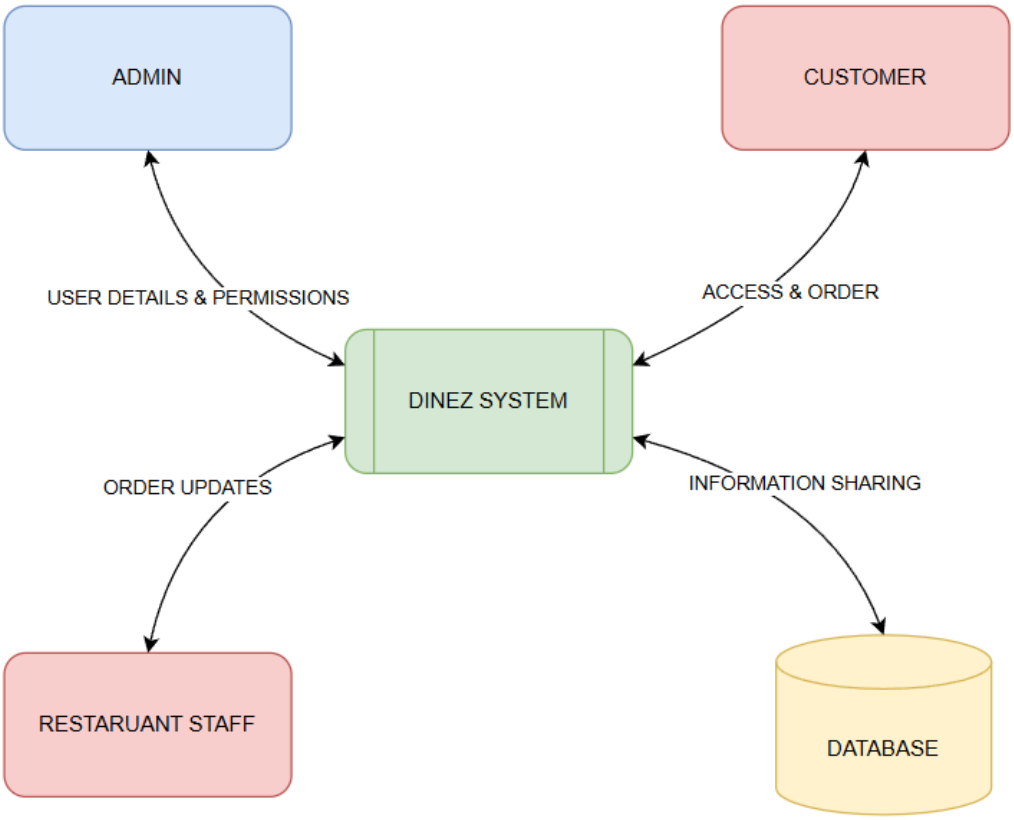

Fig 1. System Architecture

IV. METHODOLOGY

The development of the DineEZ system followed a modular and user-centric methodology to ensure an efficient and seamless restaurant ordering and management experience. The system comprises three main modules—Customer, Restaurant Staff, and Restaurant Admin—supported by a Supabase backend and Flutter frontend. The methodology is presented under the following subheadings:

A. Requirement Analysis

The methodology began with a thorough analysis of functional and non-functional requirements. Informal interviews with restaurant owners, staff, and customers were conducted to understand common issues with manual ordering, such as slow service, order inaccuracies, and lack of digital payment options. These insights laid the foundation for designing a feature-rich, scalable, and easy-to-use digital system.

B. System Design and Architecture

The system architecture was designed as a cloud-backed mobile-first platform using **Flutter** for the cross-platform frontend and **Supabase** for the backend services. Supabase provides real-time data syncing, authentication, and database services. Each restaurant is uniquely registered in the system, and individual tables are assigned specific QR codes. When a customer scans a QR code, the app fetches menu details from the Supabase database corresponding to that table and restaurant.

The architecture consists of:

- **Frontend**: Developed using Flutter, supporting both Android and iOS platforms.
- **Backend**: Built with Supabase, using PostgreSQL for structured data storage, Supabase Auth for user role management, and Supabase Realtime for order synchronization.
- **QR Integration**: Unique QR codes mapped to restaurant tables for fetching relevant menus.
- **Payment Gateway**: Integrated third-party APIs for digital payments.

C. User Modules

1. **Customer Module**:
   Customers scan the table's QR code to access the restaurant's menu. They can view dish descriptions powered by AI, select food items, place an order, and complete payment through supported methods like UPI, cards, or wallets. Upon successful ordering, they receive an invoice, and order status updates are shown in real-time.
2. **Restaurant Staff Module**:
   Kitchen and service staff access a dedicated dashboard to receive and manage orders. Real-time notifications help them track which orders are being prepared and served. Staff can mark items as 'Ready' or 'Delivered' using the app interface.
3. **Restaurant Admin Module**:
   The restaurant admin can manage the entire menu—adding, editing, or removing items, setting availability status, and applying discounts. Admins can also monitor orders, generate QR codes for new tables, and access a data analytics dashboard for business insights.

D. Authentication and Role Management

Supabase Authentication is used to secure the application with role-based access. Users are assigned roles (Customer, Staff, Admin) during registration, and access to specific features is restricted accordingly to maintain security and data integrity.

E. Data Analytics Integration

An important feature of DineEZ is its **data analytics module** integrated into the restaurant admin dashboard. It analyzes order history, customer behavior, and revenue metrics to provide visual insights such as:

- Daily/weekly/monthly sales reports
- Most ordered dishes
- Peak ordering times
- Payment method preferences

These analytics are displayed in the form of interactive charts and summaries, enabling restaurant admins to make informed decisions and improve operational efficiency.

F. Development Process

Agile methodology was followed, with incremental development and testing in each sprint. Regular feedback from early users helped refine the features and user interface. Usability testing was conducted at various stages to ensure responsiveness, clarity, and system reliability under load.

V. Results

The implementation of the DineEZ system demonstrated measurable improvements in restaurant operations and customer satisfaction. Functional validation confirmed the effectiveness of all core modules—customer ordering, staff order management, and admin-level menu control—across different devices and environments. QR code-based menu access and real-time order synchronization worked seamlessly, with minimal latency.

Performance testing revealed a stable system with an average response time of 1–2 seconds, supporting over 100 concurrent users without noticeable degradation. User feedback collected during pilot deployment in partner restaurants indicated a 92% satisfaction rate among customers, citing faster service and enhanced engagement. Restaurant staff reported improved order accuracy and reduced manual workload.

The integrated analytics dashboard provided restaurant admins with insightful visualizations on daily revenue trends, popular dishes, and customer preferences, facilitating data-driven decision-making. Compared to traditional manual systems, DineEZ reduced order time by over 60% and improved operational efficiency through digital automation and real-time insights.

VI. Future Scope

The DineEZ system lays a strong foundation for digital restaurant management, and there are several avenues to enhance its capabilities further. One of the key future enhancements includes integrating **AI-powered recommendation systems** to personalize menu suggestions based on customer preferences and ordering history, thereby improving user engagement. Additionally, **multi-language support** can be

implemented to cater to a more diverse customer base, especially in multicultural regions or tourist-heavy areas.

Another area of development involves **inventory management** features that allow restaurants to monitor stock levels, automate reordering, and reduce food wastage. Integrating **delivery and takeaway modules** will also extend the platform's usability beyond dine-in services. To further assist restaurants in strategic planning, **advanced data visualization dashboards** using machine learning can be added to detect trends, forecast demand, and optimize menu performance.

Lastly, exploring **offline support** through local caching and synchronization, and enhancing security with **role-based access control** and **real-time monitoring**, will ensure broader adoption and reliability in varying operational environments.

VII. CONCLUSION

The DineEZ system presents an efficient, scalable, and user-friendly solution for digitizing restaurant dining experiences through QR code-based ordering, real-time order management, and integrated analytics. By leveraging Supabase for secure backend services and data handling, the system ensures seamless interactions between customers, restaurant staff, and admin users. The platform not only minimizes manual errors and reduces wait times but also empowers restaurant administrators with valuable insights into customer behavior and business performance through dynamic data analytics.

Pilot testing demonstrated that DineEZ significantly enhances operational efficiency and customer satisfaction by automating key processes such as menu browsing, order placement, and payment. With high adaptability and low hardware dependency, the system proves to be a practical solution for modern restaurants aiming to embrace digital transformation. Future work can focus on incorporating AI-driven recommendations, multilingual support, and inventory management modules to further expand its functionality and reach.

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