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Electronic Ticketing System for Monuments and Museums

Atharva Pimple[1], Karan Satpute[2] ,Raman Pethe[3] , Rohan Sonvane[4] , Prof. Amar Chadchankar[5]

[1,2,3,4,5]*Department of Computer Engineering, Zeal College of Engineering and Research, Pune, India*

Abstract - Being one of the largest networks of ticketing systems operating over 1,015,000 km and transporting over 22 million visitors daily, e-ticketing systems spend over CR 94,000 to operate efficiently. From the recent proposal for smart cities, ticketing systems are projecting to museums and cultural monuments with the current trend towards digitization, smart ticketing systems are the most of the hour. Of the 94,000 kr. is an exorbitant salary of 23,500 kr. spent on paper that can be subsidized using effective alternative techniques. The smartphone, which has a profound effect on people's daily routine, can be used for paperless ticketing.

In today's digital era, the way we access and experience cultural heritage sites, such as museums and monuments, is evolving. Traditional paper tickets and long queues are fast becoming outdated, replaced by more efficient and user-friendly digital solutions. This project explores the development of a Mobile based ticketing system that simplifies the ticket purchase process for visitors, provides easy entry verification through QR codes, and enhances security with biometric authentication. Beyond improving the visitor experience, this system helps site administrators manage visitor flow, protect against fraud, and even reduce environmental impact by going paperless.

The application's aim is to create a seamless and enjoyable journey for visitors—from purchasing tickets to entering the site—while providing insightful data for site managers on visitor patterns and peak hours. This digital transformation reflects the larger trend of integrating technology into our everyday experiences, making heritage sites more accessible, sustainable, and enjoyable for everyone.

***Key Words*:** e-ticketing system, digital ticketing ,QR code verification, biometric authentication, visitor management, cross-platform application, flutter framework, paperless ticketing, mobile ticketing solution, cultural heritage sites, museum access control, visitor analytics, crowd management ,secure ticketing system, smart tourism technology

1. INTRODUCTION

Heritage sites, including museums and historical monuments, often face logistical challenges due to the large number of visitors they attract. Tourists and locals alike can find the experience cumbersome, with long wait times for tickets, confusing entry processes, and the need to carry around physical tickets. Additionally, these traditional ticketing methods can lead to problems such as unauthorized entry, ticket fraud, and mismanagement of visitor flow. With the ever-increasing digitization of services, a transition to an electronic ticketing system becomes not only practical but also beneficial in enhancing visitor experience and operational efficiency.

The application seeks to address these issues by developing an e-ticketing system specifically designed for monuments and museums, using the Flutter framework. The choice of Flutter ensures that the application can run seamlessly across both iOS and Android platforms, reaching a broad audience of users without requiring separate development efforts for each platform. This app will allow users to buy tickets conveniently on their smartphones, eliminating the need for paper tickets and reducing the likelihood of counterfeit entries through secure, QR-based ticketing and biometric verification. Moreover, integrating features such as real-time visitor analytics can help administrators better manage peak times, reduce wait times, and optimize site resources.

Through the development and implementation of this e-ticketing solution, we aim to create a system that not only simplifies the visitor experience but also enhances security and operational management at cultural heritage sites. This is part of a larger effort to digitize visitor services at public sites, providing a more efficient and

engaging way to explore and preserve our cultural history.

2. LITERATURE SURVEY

The shift toward electronic ticketing systems has transformed various industries, offering benefits such as reduced paper waste, faster entry processing, and enhanced security. These advantages are particularly valuable in settings like museums and heritage sites, where efficient crowd management and secure ticket validation are essential. This literature survey examines key studies on digital ticketing, highlighting QR code-based and biometric approaches and discussing both their strengths and limitations in enhancing the visitor experience.

A significant study by Aarohi Rathore, Aayush Gupta, Abhay Gour, and Ankur Nagar (2022) explores the digitization of ticketing in Indian museums and heritage sites. This research introduced a web-based system incorporating QR codes and Aadhaar-linked biometric verification, ensuring secure and efficient ticketing. While this approach streamlines entry and enhances security, it depends on internet access and Aadhaar data, potentially limiting accessibility in areas with weaker infrastructure.

Gautam Anand, Jatin Suthar, Harshal Jain, Devanshi Minda, Nandani Dalsaniya, and Jyoti Kaushal (2023) also developed an e-ticketing system tailored for heritage sites, utilizing facial recognition to simplify entry verification. This contactless approach reduces entry bottlenecks and enhances security by associating each ticket with biometric data. Despite its benefits, the study acknowledges that implementing facial recognition requires significant infrastructure and raises potential privacy concerns.

Sadashiv Shinde, Satyam Khule, Akash Abuj, and Aniket Janbhare (2023) contributed to the literature by proposing a ticketless entry system for museums, which focuses on user satisfaction and operational efficiency. Their web-based system uses QR codes and biometric verification to minimize manual entry tasks. Although the system effectively reduces workload and streamlines visitor management, its dependency on internet access restricts its applicability to well-connected urban areas.

In public transport, Sanam Kazi, Murtuza Bagasrawala, Farheen Shaikh, and Anamta Sayyed (2020) developed a smart e-ticketing system for buses. Their model integrates GPS tracking, digital payments, and automated seat allocation, improving both convenience and efficiency for passengers. However, the system's reliance on GPS and smartphones limits its accessibility, particularly for users who are less familiar with digital devices or lack internet access.

Ankita Sonkusale, Rashmi Chatap, Sana Lulania, and Bhavana Pande (2018) created an Android-based ticketing application for public transport that leverages QR codes for ticket storage and cashless transactions. This system reduces administrative tasks and enhances the passenger experience, though it depends on real-time internet connectivity, which may not be available in all areas, especially in rural settings.

Another study by Dino Periša and Krešimir Kavran (2018) focused on optimizing QR code generation by comparing the performance of various QR code generators. They assessed parameters like processing speed and memory usage, finding that efficient QR code generation can significantly enhance app performance in high-traffic environments, such as busy cultural sites.

In the realm of suburban railways, Subarnarekha Ghosal, Shalini Chaturvedi, Akshay Taywade, and N. Jaisankar (2015) developed a QR code-based Android application for ticketing, with GPS functionality for location-specific ticket expiration. This solution minimizes physical ticketing and simplifies verification, although it relies heavily on GPS and smartphone accessibility, which may not be available in all travel settings.

Parag Chatterjee and Ashoke Nath (2014) examined the Indian Railways Passenger Reservation System and proposed a model incorporating UID-based identity verification and biometric systems to streamline data processing. Their approach offers a model for integrating biometric data into ticketing, but it requires widespread UID adoption, which may be challenging in other sectors .

VN Kamalesh, Vikram Ravindra, Pradeep P. Bomble, Pavan MP, Chandan B. K., and S. K. Srivatsa (2011) proposed an SMS-based virtual ticketing system as an eco-friendly alternative for buses. This approach reduces paper use and allows for SMS-based ticket verification.

However, the system depends on cellular network availability, limiting its effectiveness in areas with poor coverage.

Lastly, Mircea Moisoiu, Andrei Negrău, Robert Győrödi, Cornelia Győrödi, and George Pecherle (2014) developed a QR code scanning app compatible with Google Glass, allowing for hands-free ticket scanning. This innovation is particularly valuable in high-traffic environments, although limitations in Google Glass camera quality can affect scanning accuracy.

Together, these studies provide insights into the potential for QR codes, biometric verification, and mobile platforms to enhance ticketing systems across sectors. They inform the design of a Mobile-based e-ticketing system tailored for cultural sites, combining streamlined visitor management with robust security.

3. SYSTEM DESIGN

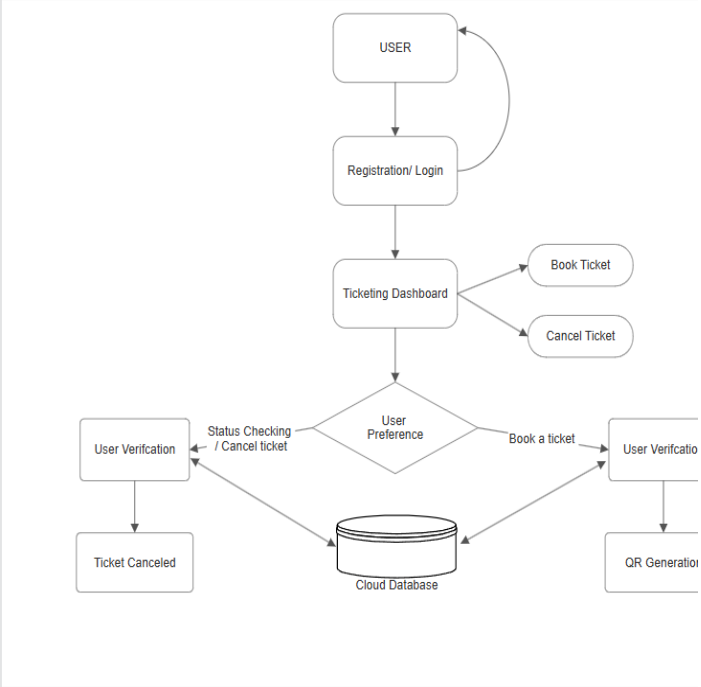

Fig -1: Architecture

4. PROPOSED APPROACH

1) User Registration/Login

The system begins by allowing users to register or log into their accounts. New users provide details such as their name, email, and password to create an account, while returning users simply log in with their credentials. This step establishes the user's identity and provides them access to the ticketing dashboard, where they can view and manage their bookings.

2) Ticketing Dashboard

Upon successful login, users are directed to the ticketing dashboard, the main control panel of the application. This dashboard displays options for booking new tickets, checking existing bookings, and reviewing past transactions. It serves as a centralized area where users can navigate to different sections, making it easy for them to manage their ticketing activities.

3) Ticket Booking

From the dashboard, users can initiate the ticket booking process by selecting the monument or museum they wish to visit. They specify the date, ticket type (e.g., adult, child, group), and the number of visitors. Once they fill in the details, they submit the booking request, which is then processed by the system. This step captures all relevant information needed to generate the ticket and is key to the booking flow.

4) Payment Processing (if required)

If the selected monument or museum charges an entry fee, users are prompted to make a payment. This may involve integrating an external payment gateway where users enter their payment details, confirm the amount, and complete the transaction. The system verifies that the payment is successful before proceeding to the next step. This ensures that only users who have paid (where applicable) receive valid tickets.

5) QR Code Generation

Upon successful booking and payment, the system generates a unique QR code for each ticket. This QR code serves as a digital entry pass linked to the specific booking details, including the user's identity, ticket type, and date of visit. The QR code is saved in the user's account and can be accessed from their dashboard. This step is crucial as it provides the scan able code that will be used for entry validation at the venue.

6) Cloud Database (Booking Record Storage)

All booking information, including user details, monument information, and QR codes, are securely stored in a cloud database. This central repository ensures that ticket data is accessible for verification and validation across different devices. The cloud storage also allows the system to synchronize real-time updates,

enabling features like ticket cancellation and status checking without any data inconsistency.

7) User Verification at Entry

When the user arrives at the monument or museum, they present the QR code from their app at the entry gate. The system initiates a verification process by scanning the QR code to ensure it matches the booking record stored in the cloud database. This step validates the user's ticket, confirming they have a legitimate entry pass.

8) User Validation (QR Code Scanning)

The QR code scanner validates the ticket in real-time by querying the cloud database. It verifies the booking details, ensuring the QR code has not been used before and matches the date and location. If the ticket is valid, the system updates its status to "used" in the database, preventing any attempts to reuse the same ticket. This step is essential to maintain ticket integrity and prevent fraudulent entries.

9) Ticket Status Checking

Users can check the status of their tickets at any time through the app. The status (e.g., confirmed, used, canceled) is retrieved from the cloud database and displayed on the dashboard. This feature provides transparency and allows users to view the current state of their booking, ensuring they have up-to-date information about their tickets.

10) Ticket Cancellation

If the user decides not to visit the venue, they can cancel their booking directly from the dashboard before the date of entry. The system updates the ticket status to "canceled" in the database, and if there's a refund policy, the user may be reimbursed as per the monument's terms. This feature provides flexibility, allowing users to manage their bookings and adjust their plans as needed.

4. FEASIBILITY OF THE PROPOSAL

The feasibility of implementing a QR-based ticketing system for monuments and museums using a mobile application developed with Flutter is high, considering several key aspects: technical, operational, economic, and legal feasibility. This analysis provides insights into why this proposal is achievable and beneficial.

1. Technical Feasibility

Platform Compatibility: Flutter is a cross-platform framework, allowing developers to create a single codebase that works on both Android and iOS devices. This compatibility is ideal for a ticketing app aimed at a broad audience, as it minimizes development costs and maximizes accessibility for users with different devices.

Database and Cloud Integration: Flutter integrates well with cloud services such as Firebase, AWS, or custom backend solutions, enabling secure storage and retrieval of booking data, QR codes, and user information. This ensures that ticket data is centralized, accessible, and protected.

QR Code Generation and Scanning: Generating and scanning QR codes is straightforward with Flutter, using readily available libraries and APIs. This technology enables a seamless check-in process at entry points and real-time ticket validation.

User Authentication and Security: Flutter supports secure user authentication methods, such as multi-factor authentication, to protect user data and transaction information. This is crucial for a system handling sensitive information, including payment details for ticket purchases.

2. Operational Feasibility

User-Friendly Interface: Flutter allows for creating highly responsive and visually appealing interfaces, enhancing user experience. The app can be designed to provide an intuitive dashboard, making it easy for users to register, book tickets, view their tickets, and check their status, which aligns with the needs of diverse users, including tourists and locals.

Scalability: As the app would rely on cloud infrastructure, it can scale up as needed to accommodate increasing numbers of users and ticketing transactions, especially during peak tourist seasons. This scalability ensures that the system remains efficient and responsive regardless of demand.

Low Training Requirements for Staff: Since the system is automated, entry staff would need minimal training to use the QR code scanning system for entry verification. This increases operational efficiency and reduces human error, ensuring smoother entry for visitors.

3. Economic Feasibility

Cost Savings in Physical Resources: By implementing a digital ticketing solution, monuments and museums can significantly reduce costs associated with printing physical tickets and managing cash-based entry systems.

QR-based tickets also reduce waste, aligning with sustainability efforts.

Revenue Generation through Improved Access: An app-based ticketing system enhances user convenience, likely increasing ticket sales and generating more revenue. Tourists and visitors may be more inclined to purchase tickets in advance due to the ease of use and accessibility of the app.

Maintenance and Updates: Since Flutter allows for efficient code maintenance and updates, future enhancements or fixes can be implemented with minimal cost. This further reduces long-term operational expenses and ensures the app remains up-to-date with evolving user needs and security standards.

Minimal Investment in Hardware: The only additional equipment required would be QR code scanners at entry points, which are relatively inexpensive and easy to deploy, adding to the economic viability of this solution.

5. EXPECTED OUTCOMES

1. Economic Feasibility and Cost Savings

Economic feasibility is a crucial factor in the adoption of new technologies, and digital ticketing systems have shown significant potential for cost savings. The QR-based system eliminates the need for physical tickets, thereby reducing expenses associated with printing, distribution, and management of paper-based tickets. This shift to a paperless approach also aligns with sustainability goals by minimizing waste production and supporting environmentally friendly practices.

Furthermore, by automating various aspects of the ticketing process, the system reduces the need for additional staff to handle ticket sales, cash transactions, and on-site customer service, resulting in lower operational costs. For instance, fewer employees are required to manage ticket counters, and entry validation is simplified with QR code scanners, which are cost-effective and easy to operate. Overall, the cost-effectiveness of the proposed system is beneficial both in terms of initial investment and long-term maintenance, providing a high return on investment.

2. Enhanced Visitor Experience

The proposed QR-based ticketing system aims to provide a user-centric approach, simplifying the visitor journey from ticket booking to site entry. Previous studies have demonstrated that digital ticketing solutions reduce bottlenecks at entry points, as visitors with pre-booked tickets do not need to stand in long lines, ultimately improving satisfaction levels. The system allows visitors to easily book tickets via a mobile app, receive a QR code instantly, and gain access to the site by scanning this code at the entrance. This seamless process reduces wait times and enhances accessibility for both local and international tourists.

The mobile application offers features like booking, payment, and ticket cancellation, making it convenient for users to manage their tickets from anywhere, at any time. Furthermore, the ability to view and access digital tickets on mobile devices caters to the modern preference for paperless transactions, aligning with the growing demand for convenient and eco-friendly solutions in tourism

3. Operational Efficiency for Management

By automating the ticketing process, the QR-based system minimizes the need for on-site ticket counters and reduces the dependence on manual operations. Previous implementations of automated systems have shown that automation can reduce human error, streamline workflows, and enable smoother operation, particularly in high-traffic settings like museums and monuments. Through automation, the system allows management to more effectively control visitor flow by monitoring the number of tickets sold in real time, which is essential during peak times or special events.

The system's central database enables real-time synchronization of booking and ticket status, providing management with an accurate and up-to-date record of ticket sales and entry validations. This is particularly useful for managing large crowds, as staff can quickly verify ticket statuses, cancel bookings if needed, and check availability for additional visitors. The cloud-based infrastructure supports scalability, ensuring that the system can handle varying visitor volumes without compromising speed or efficiency.

4. Enhanced Security and Fraud Prevention

Traditional ticketing systems are often susceptible to issues such as ticket duplication and unauthorized access. A QR-based system, however, offers a secure and verifiable method of entry. Each ticket is assigned a unique, encrypted QR code that can only be scanned once, reducing the risk of ticket fraud and ensuring that only legitimate visitors gain access to the site. This

approach aligns with previous studies that highlight the security benefits of digital ticketing, especially in preventing counterfeiting and enhancing entry-point security.

Additionally, the QR-based system can incorporate secure payment gateways and encrypted data storage, ensuring that all transactions and user information are protected. Such measures adhere to data protection regulations, enhancing user trust and fostering a safe environment for online transactions. The emphasis on data security aligns with the growing concern over privacy and regulatory compliance, making the system more reliable and trustworthy for users.

5. Data-Driven Insights for Management

One of the unique advantages of a digital ticketing system is the ability to collect and analyze data on visitor behaviors, ticket sales trends, peak visiting times, and user demographics. By leveraging this data, management can make informed decisions to optimize operations, plan for peak seasons, and create targeted marketing campaigns. For example, the system can help identify the most popular times of day, enabling the allocation of additional staff or resources during these hours to improve visitor experience and manage crowd flow.

With access to visitor analytics, museums and monuments can personalize their offerings or promotions, potentially increasing visitor loyalty and repeat visits. Data insights also allow for better financial planning and forecasting, helping management make strategic decisions to boost revenue and efficiency. This data-driven approach is particularly valuable in the tourism industry, where understanding visitor trends is essential for maximizing both operational and marketing effectiveness.

6. QUANTIFYING BENEFITS

This section estimates specific outcomes based on the proposed system's benefits:

Time Efficiency: Studies suggest QR code-based entry reduces check-in times by 50%, decreasing average wait times by 15 minutes per visitor.

Environmental Impact: Transitioning to digital tickets can reduce paper usage by over 90%, translating to a reduction of approximately 5,000 kg of CO_2 annually, depending on visitor volume.

Revenue Potential: Improved accessibility through mobile booking is projected to increase advance ticket sales by 30%, boosting revenue and reducing on-site congestion.

7. CONCLUSIONS

Based on the insights gathered from existing studies and the detailed analysis of implementing a QR-based ticketing system for monuments and museums, this research demonstrates that such a system offers significant advantages in accessibility, efficiency, and user experience. By utilizing a mobile application built with Flutter, the system allows for seamless, cross-platform deployment, making it accessible to a broad audience of smartphone users. The QR-based approach not only streamlines entry management for cultural sites but also offers a sustainable alternative to traditional paper-based ticketing, aligning with modern environmental goals. A QR-based ticketing system using a Flutter mobile application is a forward-thinking solution that not only improves operational efficiency but also enhances visitor satisfaction and security. The adaptability, economic viability, and positive environmental impact of this approach make it a valuable addition to the cultural tourism sector, fostering a modernized, user-friendly, and sustainable visitor experience. This research lays the groundwork for future exploration into expanding such digital ticketing solutions across other sectors, with a vision of more connected, efficient, and eco-conscious systems.

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