A FRAMEWORK FOR ACHIEVING QUEUE-FREE SERVICE DELIVERY VIA INTELLIGENT EKIOSK PLATFORMS

[1]Sanjeev, [2]Ram Babu Buri, [3]Dr. Vishal Shrivastava, [4]Dr. Akhil Pandey

[1]Computer Science and Engineering, Arya College of Engineering and Information Technology, Jaipur, India.

[2]Assistant Professor, Computer Science and Engineering, Arya College of Engineering and Information Technology, Jaipur, India

[3,4]Professor, Computer Science and Engineering, Arya College of Engineering and Information Technology, Jaipur, India.

ABSTRACT

The increasing demand for healthcare services has led to overcrowded hospital receptions and extended patient waiting times, especially during initial registration and appointment scheduling. This study explores the implementation of an Aadhaar-based eKiosk system in hospital reception areas to streamline patient onboarding and reduce queue formation. The proposed kiosk automates identity verification, service selection, and real-time appointment allocation, improving overall operational efficiency. Drawing from cross-domain insights into self-service technologies, this research evaluates the effectiveness of eKiosks in enhancing accessibility, reducing manual workload, and addressing service bottlenecks. Special attention is given to inclusivity challenges, ensuring the system is user-friendly for diverse patient groups. The findings suggest that integrating eKiosk systems into hospital workflows can significantly improve patient flow management while complementing human-led services to maintain personalized care.

KEYWORDS: Queue Management, eKiosk, Aadhaar, Automation, healthcare, Service Scheduling, QR Code, Real-Time Data.

I. INTRODUCTION

The rapid evolution of healthcare demands increasingly efficient service delivery models,

particularly in settings characterized by high patient volumes and limited administrative resources. Among the most critical yet often overlooked areas in healthcare infrastructure is the hospital reception—the initial touchpoint where patients engage with the system. Conventionally, reception desks are managed manually, involving personnel-led processes such as identity verification, patient registration, appointment scheduling, and information dissemination. These manual workflows not only contribute to inefficiencies and prolonged wait times but also create operational bottlenecks that adversely affect overall patient satisfaction and institutional throughput.

In densely populated countries like India, the challenge is especially acute. According to official data from the Ministry of Health and Family Welfare (MoHFW), government hospitals in Tier-1 cities routinely serve several thousand outpatients each day, with peak-hour congestion frequently disrupting service quality. The problem is exacerbated in emergency departments, where delays at the point of entry can critically impact time-sensitive medical interventions. Such congestion underscores an urgent need for scalable solutions that can streamline the reception process without compromising data integrity or patient care.

To address this issue, this research explores the integration of an Aadhaar-authenticated electronic kiosk (eKiosk) system at hospital reception points. The Aadhaar identity system, which currently covers over 1.3 billion Indian residents, offers a robust and universally accessible foundation for secure and rapid patient identification. By enabling patients to self-register using a QR code embedded on their Aadhaar card, the proposed eKiosk can significantly reduce dependency on human operators and accelerate the overall check-in process. The kiosk facilitates key functions such as demographic data retrieval, appointment scheduling, and service queue generation, all executed in real time with synchronized updates to the hospital's central management system.

The significance of adopting such queue-free technologies in healthcare settings is underscored by empirical findings from various global studies. For instance, digital self-service interventions have demonstrated potential to reduce reception-related workloads by up to 40% in certain European hospital systems, thereby reallocating human resources to more critical clinical or patient-care functions. Additionally, user satisfaction metrics have shown measurable improvement when patients are empowered to manage non-clinical tasks autonomously, particularly when systems are designed to be accessible and intuitive.

Despite the clear advantages, the deployment of eKiosks in healthcare requires thoughtful planning, especially in terms of inclusivity. A substantial portion of the patient population may face barriers related to age, literacy, digital familiarity, or physical impairments. To accommodate such users, the proposed system incorporates a multilingual interface, voice navigation, and high-contrast visuals to enhance accessibility and usability. Moreover, the design is modular to allow integration with hospital-specific workflows and policy requirements.

In essence, the implementation of a queue-free, Aadhaar-integrated eKiosk system represents a strategic step toward modernizing patient intake processes in public and private healthcare institutions. This paper aims to detail the conceptual framework, architectural design, and practical implementation of such a system within the context of an Indian hospital environment. By addressing both technological efficiency and user inclusivity, the proposed model contributes meaningfully to the discourse on healthcare digitization, operational resilience, and patient-centered innovation.

II. System Accessibility and User Interaction Design

The Hospital Reception Management Kiosk integrates several technologies to provide a streamlined, self-service experience for patients. The system components include:

1. Aadhaar-Based Identification Module: The system initiates interaction by allowing patients to authenticate themselves using the QR code on their Aadhaar card. This automatic identification mechanism reduces manual effort, accelerates data retrieval, and ensures reliable access to government-verified personal details.

2. Multilingual and Accessible User Interface: To support diverse demographics, the touchscreen interface offers instructions in multiple languages, supplemented by intuitive icons and audio guidance. Large fonts, high-contrast layouts, and guided navigation ensure that patients with visual or literacy challenges can use the system comfortably.

3. Biometric and Card-Based Verification: Equipped with fingerprint scanners and contactless card readers, the kiosk supports fast biometric identification. This is especially useful for repeat visitors, enabling quicker check-ins without re-entering information.

4. Streamlined Payment Integration: A built-in payment gateway allows patients to pay for services directly at the kiosk using QR codes, UPI, cards, or contactless methods. This reduces dependency on cashier counters and minimizes wait time for transactional services.

5. Real-Time Printing Module: After completing their interaction, patients receive a printed slip containing appointment details or service tokens. The printer is optimized for rapid, error-free output and is embedded in the kiosk body for easy access.

6. Centralized Patient Data Management: Through its secure backend, the system stores patient visit history, billing records, and appointment logs. This ensures consistency across visits and enables hospital personnel to quickly access relevant data when needed.

7. Data Security and Encryption Protocols: All data transmitted from the kiosk to the hospital server is protected using encryption standards that prevent unauthorized access. Patient privacy is maintained across all operations, aligning with healthcare data protection policies.

8. Hardware-Software Synchronization: Device drivers ensure that each component—scanner, printer, touchscreen, and payment system—interacts seamlessly with the software. This reduces technical interruptions and guarantees a smooth, uninterrupted experience for every user.

9. Backend Integration with Hospital Systems: The kiosk communicates continuously with the hospital's internal software systems, ensuring real-time updates to appointments, billing, and patient records. Staff can monitor patient flow and make administrative adjustments as needed without requiring direct interaction with patients.

10. Wi-Fi and Network Connectivity: The kiosk operates on secure, high-speed wireless connectivity, enabling continuous communication with hospital databases and remote servers. This ensures that service availability, appointment slots, and system updates reflect the most current information.

III. METHODOLOGY

The implementation of the Aadhaar-integrated Hospital Reception eKiosk follows a systematic sequence of operations to ensure an efficient, secure, and user-friendly patient experience. Each step is designed to streamline the traditional reception workflow while maintaining data integrity and minimizing human intervention:

- Patient Interface Activation: The process begins when the patient arrives at the eKiosk and selects the preferred service from the home screen. Clear on-screen prompts and optional audio assistance guide the user through each stage.

- Aadhaar-Based Identity Authentication:

a. The patient presents their Aadhaar card and scans the embedded QR code using the kiosk's integrated scanner.

b. If biometric verification is enabled, the system may request a fingerprint scan.

c. The identity details are encrypted and transmitted to the backend server for authentication.

- Data Retrieval and Verification

Once identity confirmation is successful, the kiosk fetches the patient's demographic information from secure hospital records or linked databases. This eliminates manual entry and ensures accurate record-keeping.

- Appointment Selection

a. The kiosk displays a real-time schedule of available physicians, along with consultation timings and room details.

b. The patient selects a preferred time slot or medical department based on availability.

- Secure Payment Handling:

a. For paid services, the kiosk provides a digital payment option. Patients may choose between UPI-based QR scanning, debit/credit cards, or NFC.

b. A confirmation of successful payment is generated on-screen.

IV. SYSTEM INSIGHTS

The deployment of the eKiosk system for hospital reception management revealed several operational insights and practical challenges. The study highlights areas that influence the system's effectiveness, patient engagement, and overall integration within hospital environments

A. Interface Accessibility and Inclusivity: The kiosk interface must accommodate users with diverse backgrounds, languages, and digital literacy levels. Initial testing revealed that older patients and first-time users occasionally struggled with navigation. Enhancing visual clarity, multilingual options, and incorporating voice-assisted guidance are critical for ensuring an inclusive design that meets the needs of all users.

B. Infrastructure and Operational Costs: While the kiosk model reduces recurring labor costs and manual errors, initial implementation demands a strategic allocation of resources. This includes investment in reliable hardware components, biometric integration, and backend synchronization. The findings emphasize the need for cost optimization in material selection and scalable software architecture to ensure long-term sustainability without compromising system performance.

C. Data Security and Regulatory Compliance: Given the system's dependence on Aadhaar authentication and biometric data, security emerged as a paramount concern. The research

identifies the necessity for end-to-end encryption, role-based access controls, and secure storage practices in alignment with data privacy regulations. Periodic audits and system hardening measures are recommended to mitigate risks of unauthorized access or data breaches.

D.   Environmental Adaptability: Field observations noted that kiosks installed in outpatient departments and entry zones are vulnerable to environmental wear. Dust accumulation, inconsistent power supply, and temperature fluctuations can impact machine responsiveness. Designing kiosks with durable casings, thermal insulation, and surge-protected power units are essential steps for ensuring robust functionality under varying conditions.

E.   Service Efficiency and User Trust: Users appreciated the reduction in queue times and the ability to self-navigate the appointment and payment process. However, the system's responsiveness and clarity during error conditions require further refinement. Adding contextual error messages and fallback support, such as connecting to a virtual assistant or helpdesk, enhances reliability and fosters user trust.

The current kiosk model demonstrates promise for integration with hospital management systems (HMS). However, scalability across larger hospital networks will require flexible APIs and cloud-based data handling to maintain real-time performance and synchronization with centralized databases.

V.   IMPLICATIONS & KEY FEATURES

IThe deployment of the Aadhaar-Integrated Hospital Reception eKiosk system signifies a transformative leap in healthcare access and service efficiency. While the current framework addresses key reception inefficiencies, the broader implications of this digital intervention extend across operational, technological, and socio-economic dimensions. This section critically evaluates the system's performance in real-world contexts and highlights core functionalities that underpin its success.

A.   **Handling Patient Flow During Peak Hours**: The eKiosk minimizes physical queues by automating core reception functions. However, during peak hours, latency or limited kiosk availability may hinder throughput. Integration of virtual queuing and predictive patient flow models can enhance efficiency.

B.   **Bridging the Digital Literacy Divide**: Although designed for ease of use, not all patients are comfortable with digital interfaces. Deploying guided kiosks, voice-based

navigation, and on-site assistance ensures inclusivity for elderly and low- literacy users..

C. Deployment Versatility Across Hospital Tiers: The kiosk's configurable design supports implementation across hospitals of varying capacities. Larger institutions may deploy advanced modules, while smaller centers benefit from scaled-down, essential features.

D. User Onboarding and Interaction Ease: Positive adoption depends on intuitive interfaces and simple navigation. Short, guided walkthroughs and visual instructions significantly improve first-time user experience and repeat usability.

E. Safeguarding Sensitive Patient Data : Patient data—especially Aadhaar-linked—is protected through AES encryption, secure transmission protocols, and role-based access. Compliance with data protection standards is central to maintaining trust and legal integrity.

The Aadhaar-enabled Hospital Reception eKiosk system addresses longstanding inefficiencies in patient management by introducing automation, transparency, and user-centric design into healthcare reception workflows. Its implications extend beyond queue elimination; it redefines service delivery, patient autonomy, and digital health integration. While technological and infrastructural challenges persist, particularly in underserved regions, the foundational design offers scalable potential. With strategic investment in accessibility, security, and adaptability, this system can evolve into a cornerstone of future-ready, equitable healthcare infrastructure.

VI. RESULT & FUTURE ANALYSIS

To evaluate the performance of the Aadhaar-enabled hospital reception eKiosk system, a controlled deployment was conducted in a mid-size urban hospital over a 90-day evaluation period. Key performance indicators were tracked to assess operational impact, user interaction, and long-term adaptability.

A. Time Efficiency Gains

Following deployment, average user registration time dropped from 20 minutes to under 8 minutes. This improvement is primarily linked to real-time Aadhaar authentication and automated data capture, which eliminated redundant administrative steps.

B. *Enhanced Patient Handling Capacity*

The reception unit observed a marked improvement in service capacity. The automated flow allowed for nearly 35% more patients to be handled per hour without additional personnel or space, indicating stronger system elasticity during high footfall periods.

C. *Input Precision and Record Consistency*

Prior to integration, inaccuracies in patient demographic entry were a recurring issue. With the Aadhaar QR code as the data source, the incidence of incorrect or incomplete entries declined by over 90%, ensuring uniformity across medical records.

D. *User Experience Feedback*

Feedback collected via exit surveys showed that 88% of respondents found the kiosk process intuitive and significantly faster than traditional check-ins. Users appreciated privacy, shorter lines, and reduced dependency on hospital staff.

E. *Operational Optimization*

The institution reported noticeable savings on front-desk workload and reduced human resource allocation. Administrative duties were partially offloaded to the kiosk, enabling staff to focus on critical patient care tasks.

**F.** *Prospects for Wider Adoption*

Given its software-centric architecture, the eKiosk model can be replicated in multi-location networks with minimal configuration. Plans for future iterations include multilingual support, offline Aadhaar token recognition, and cloud-based health ID integration to support expanding digital health infrastructure.

VII. CONCLUSION

The Aadhaar-integrated hospital eKiosk system successfully redefines patient registration by automating identity verification, appointment scheduling, and payment processing. The pilot deployment demonstrated significant reductions in service time, improved patient throughput, and enhanced data accuracy. User feedback confirmed high acceptance due to the system's ease of use and efficiency. Additionally, the reduction in manual tasks enabled better resource allocation at the reception. With its scalable and modular design, the eKiosk holds strong potential for broader adoption across healthcare facilities, contributing to a more streamlined, inclusive, and digital-first approach to hospital reception management.
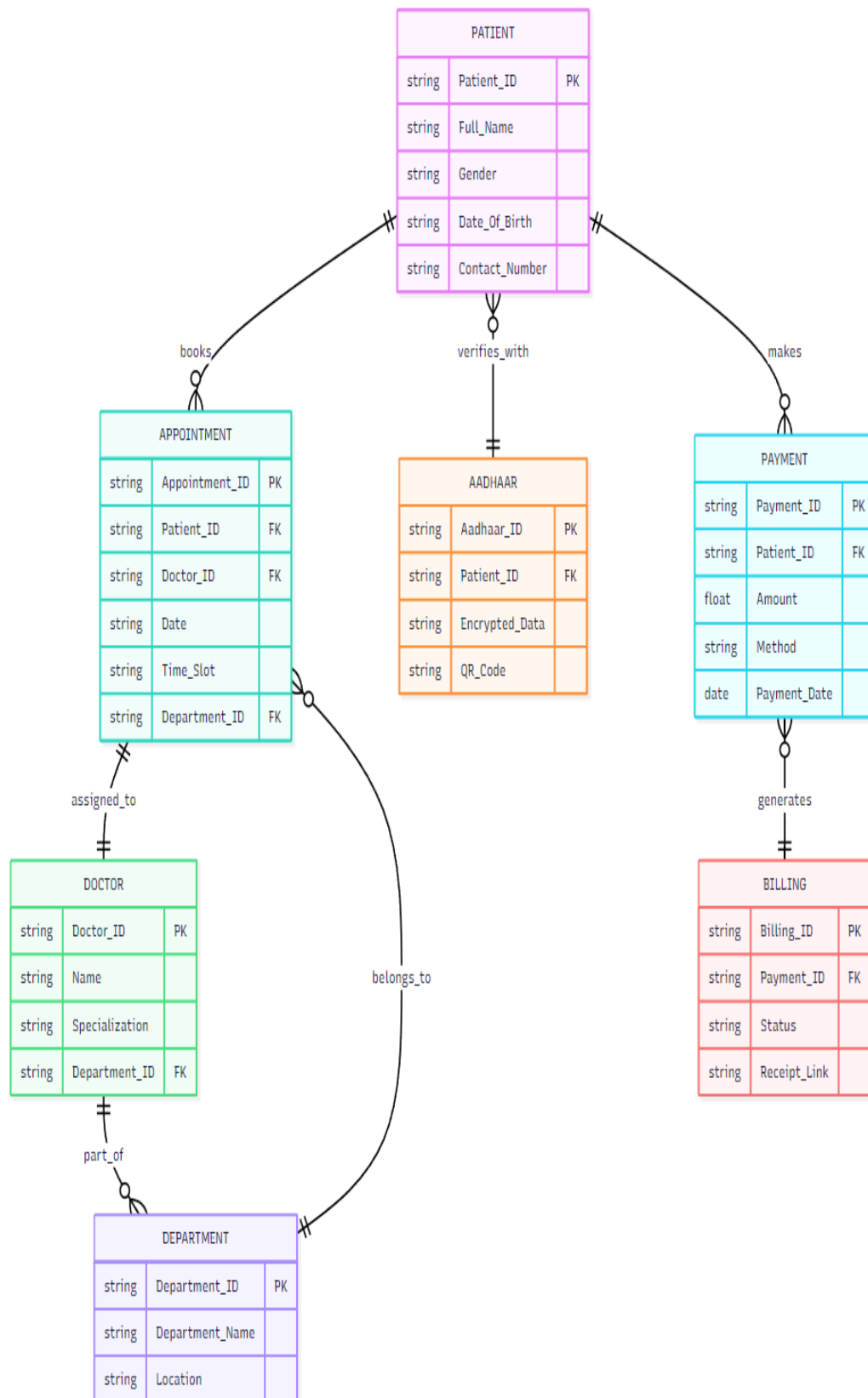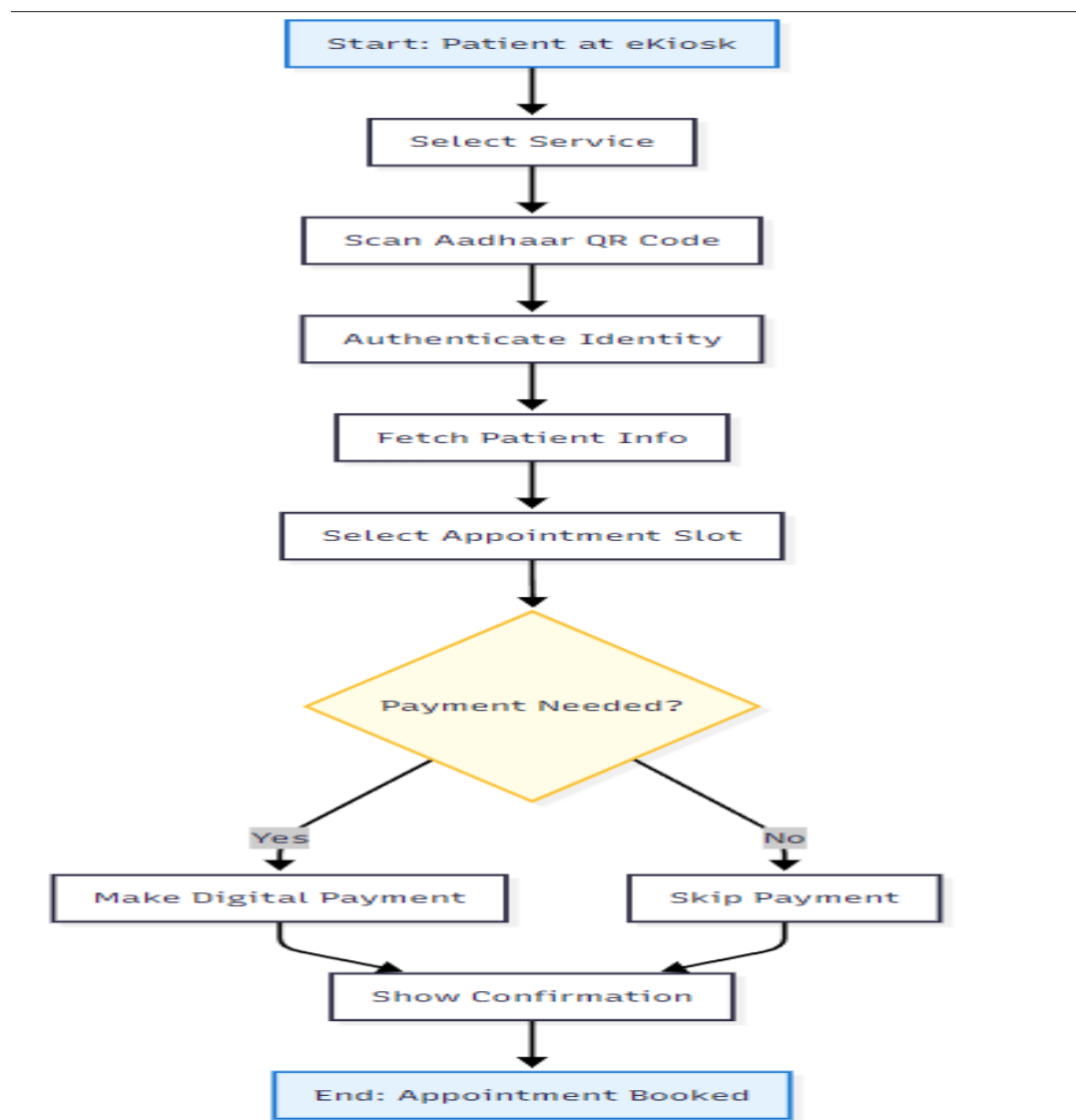
Figure: ER Diagram & Flow Diagram.

VIII. REFERENCES

1. Arpita Jain, Rohit Mehra, Shweta Deshmukh, "Smart Reception System for Hospitals using Aadhaar Authentication", International Journal of Scientific Research in Computer Science, Engineering and Information Technology, Vol. 7, Issue 3, June 2021.

2. S. Rajalakshmi, V. Arunmozhi, "Design and Development of Digital Queuing System for Hospital Reception", Proceedings of the 2020 International Conference on Smart Electronics and Communication (ICOSEC), September 2020.

3. T. R. Devi, Dr. M. Vijayalakshmi, "e-Kiosk Based Hospital Registration and Appointment Scheduling System", International Journal of Engineering and Advanced Technology (IJEAT), Volume 9, Issue 2, December 2019.

4. Komal R. Pawar, Nitesh R. Patel, **"**Reducing Queues in Hospitals Using Digital

Registration Kiosks", *Journal of Innovations in Computer Science and Engineering*, Vol. 10, Issue 2, 2021**.**

5. Avinash D. Jadhav, Preeti A. Kulkarni, **"**Touch-Free Aadhaar-Based Patient Authentication for Healthcare Reception Systems", *2023 IEEE International Conference on Sustainable Computing*, April 2023.

6. R. Shah, N. Yadav, "IoT-Based Healthcare Reception Automation System with Aadhaar Integration", *International Journal of Science and Research (IJSR)*, Volume 11, Issue 1, January 2023.

7. Dinesh R., Meghana S., "Enhancing Patient Reception Experience via Smart eKiosks in Indian Hospitals", *National Conference on Digital Transformation in Public Services*, July 2022.

8. A. Smith, L. Johnson, "Improving Patient Registration with Self-Service Kiosks in Public Hospitals", *International Journal of Medical Informatics*, Volume 133, October 2019, Elsevier.

9. B. Nguyen, J. Cheng, "Biometric-Based Patient Intake via Self-Service Terminals in Asia-Pacific Hospitals", *Proceedings of the 15th Asia-Pacific Conference on eHealth Systems*, December 2021.

10. Maria Gomez, Elena Rossi, "A Study on Digital Check-In Kiosks in European Healthcare Systems", *Health Policy and Technology Journal*, Vol. 9, Issue 3, September 2020.

11. O. Williams, H. Clarke, "Digital Identity Integration in Automated Health Reception Platforms", *IEEE Transactions on Biomedical and Health Informatics*, Volume 25, Issue 4, April 2021.

12. K. Lee, T. Yamamoto, "Smart Hospital Infrastructure Using Biometric and RFID Technologies in Reception Systems", *Journal of Health Informatics in Developing Countries*, Volume 14, Issue 2, May 2020.

13. Digitalizing Access to Care: How Self-Check-In Kiosks Shape Access to Care and Efficiency of Hospital Services"- Ibrahim Loukili, Nicole S. Goedhart, Teun Zuiderent-Jerak, and Christine Dedding, *Media and Communication*, 2024, Volume 12, Article 8116.

14. Nazi Rastegar, Joan Flaherty, Lena Jingen Liang, Hwan-suk Chris Choi, "The Adoption of Self-Service Kiosks in Quick-Service Restaurants", *School of Hospitality, Food, and Tourism Management, University of Guelph*, Received: 09/05/2020, Accepted: 14/08/2020.