



HAL
open science

Innovative AI Integration for Patient Reception and Staff Scheduling

Hossain Kordestani, Abdelghani Chibani, Wagdy Zahran

► **To cite this version:**

Hossain Kordestani, Abdelghani Chibani, Wagdy Zahran. Innovative AI Integration for Patient Reception and Staff Scheduling. 2024. hal-04809555

HAL Id: hal-04809555

<https://hal.science/hal-04809555v1>

Preprint submitted on 28 Nov 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Open licence - etalab

INNOVATIVE AI INTEGRATION FOR PATIENT RECEPTION AND STAFF SCHEDULING

Hossain Kordestani

Department of Research and Innovation
Maidis SAS
Saint-Germain-en-Laye, France
hossain.kordestani@maidis.fr

Abdelghani Chibani

Laboratoire Images, Signaux et Systèmes Intelligents
University Paris-Est Créteil
Vitry-sur-Seine, France
chibani@u-pec.fr

Wagdy Zahran

Department of Research and Innovation
Maidis SAS
Saint-Germain-en-Laye, France
wagdy.zahran@maidis.fr

ABSTRACT

This conceptual paper introduces an integrated AI-powered kiosk system aimed at revolutionizing patient reception in French medical centers. By leveraging cutting-edge technologies such as biometric recognition, natural language processing, and blockchain, the proposed framework addresses the inefficiencies of current patient registration, staff scheduling, and waiting room management. Unlike conventional systems such as RFID tracking and Alexa-based assistants, this modular approach uniquely combines real-time data insights and advanced scheduling optimization to enhance operational efficiency while ensuring compliance with GDPR standards. The novelty of our approach lies in the seamless integration of multiple AI-driven components into a unified, scalable solution for healthcare environments. Expected impacts include significantly improved patient satisfaction and operational efficiency. This paper outlines the theoretical underpinnings of the proposed solution, reviews related work, and presents future steps for prototyping and testing.

Keywords: AI-powered kiosk, patient reception, healthcare management, blockchain, natural language processing, GDPR compliance, AI planning, biometric authentication, patient flow optimization

1 Introduction

Healthcare systems worldwide face increasing pressure to provide efficient, patient-centric services while addressing operational inefficiencies and compliance challenges. In France, recent reports have highlighted significant challenges within the healthcare system, including increased patient wait times and strained hospital capacity. A 2024 report emphasizes issues such as saturated emergency services and bed closures, which contribute to prolonged wait times and inefficiencies in patient management [1]. A report on health status of France population also underscores the need for innovative solutions to improve patient care and administrative workflows [2].

This paper introduces a next-generation AI-powered kiosk system designed to address these critical challenges. By integrating cutting-edge technologies—including biometric recognition, natural language processing (NLP), and blockchain—the proposed framework reimagines patient reception, staff scheduling, and waiting room management in healthcare facilities. Unlike existing solutions, our approach emphasizes modularity, scalability, and strict adherence to GDPR standards, ensuring robust privacy and security for sensitive patient data.

The novelty of this work lies in the seamless integration of multiple AI-driven components into a unified system that optimizes operations and enhances patient satisfaction. We focus on the conceptual design and theoretical underpinnings

of the system, outlining its potential to transform healthcare workflows. This vision is supported by a roadmap for future development, including pilot implementations and usability studies.

In this paper, we aim to bridge the gap between visionary concepts and practical solutions by offering a comprehensive framework that addresses current limitations in patient reception management. Through this work, we invite collaboration and further research to advance AI-driven innovation in healthcare.

2 Related Works

Several studies have explored the integration of advanced computing technologies to improve efficiency and safety in healthcare settings. Bardram (2004) demonstrated the use of context-aware computing in hospitals, showing that medical devices could automatically adapt to the presence of specific clinicians and patients. This adaptive approach significantly reduces the cognitive load on medical staff by automatically presenting relevant information based on the immediate context, such as patient location or clinician proximity [3]. Our system builds upon these ideas by employing biometric recognition to adapt system interactions based on user identity and role.

Orwat et al. (2008) provided a comprehensive literature review on pervasive computing in healthcare, emphasizing the potential of these technologies for enhancing patient monitoring, workflow optimization, and remote care [4]. Pervasive computing technologies are particularly useful in healthcare settings that require ubiquitous data collection and access, such as patient reception areas. Our proposed AI-powered kiosk incorporates these concepts, offering seamless interaction and data flow between patients and healthcare providers.

In the area of Radio Frequency Identification (RFID) in healthcare, Al Nahas & Deogun (2007) described numerous applications where RFID is used for tracking patients and medical assets in hospitals, thereby improving safety and efficiency [5]. While RFID has been effective, particularly in NICU and equipment management, our system takes identification further by using biometric data, which allows for a more secure and integrated approach to patient reception management.

Chen et al. (2009) implemented an RFID-based management system for operation rooms to enhance patient safety and workflow through real-time tracking of medical personnel and assets [6]. The lessons learned from their work demonstrate the value of automated systems in high-risk environments, reinforcing the importance of similar features in our reception management system to ensure that patients are properly routed and attended to.

3 Challenges in Current Patient Reception Management

3.1 Inefficient Patient Registration

Manual processes often cause delays, leading to overcrowding and patient dissatisfaction. Integrating AI-powered digital solutions can minimize errors and streamline workflows, providing a more seamless and efficient patient experience. For example, a typical patient registration process currently takes approximately 10-15 minutes, which contributes to bottlenecks during peak hours.

3.2 Complex Staff Scheduling

Managing doctors' schedules is complex due to dynamic factors like doctor availability, last-minute changes, and resource constraints. Current tools lack the flexibility to adapt to real-time disruptions, resulting in inefficient utilization of resources. AI-based scheduling can dynamically optimize staffing needs in response to real-time changes, ensuring balanced and effective use of resources.

3.3 Waiting Room Management

Suboptimal patient flow management leads to extended waiting times and unnecessary congestion, undermining the overall patient experience. AI solutions can help in intelligently guiding patient movement, reducing bottlenecks and providing a smoother patient journey.

3.4 Data Security and Privacy Concerns

With the increasing digitization of healthcare, ensuring compliance with GDPR and securing patient data against breaches are paramount challenges. GDPR requires strict consent management, data minimization, and auditability, all

of which present challenges for existing healthcare systems. Several high-profile data breaches in recent years have underscored the vulnerability of healthcare data, emphasizing the importance of robust security measures.

3.5 Patient Data Integration

Healthcare data is often scattered across different systems, such as medical records, lab results, and imaging data, leading to fragmentation and inefficiencies in patient care. Integrating this data into a unified system remains a significant challenge for many healthcare facilities.

3.6 Regulatory Compliance Beyond GDPR

In addition to GDPR, healthcare providers must navigate other regulatory frameworks such as French Health Data Hosting (HDS) certification, which requires strict guidelines for data storage and hosting. Compliance with these regulations demands robust mechanisms for data sharing, protection, and consent management, further complicating the adoption of digital systems.

4 Proposed Approach

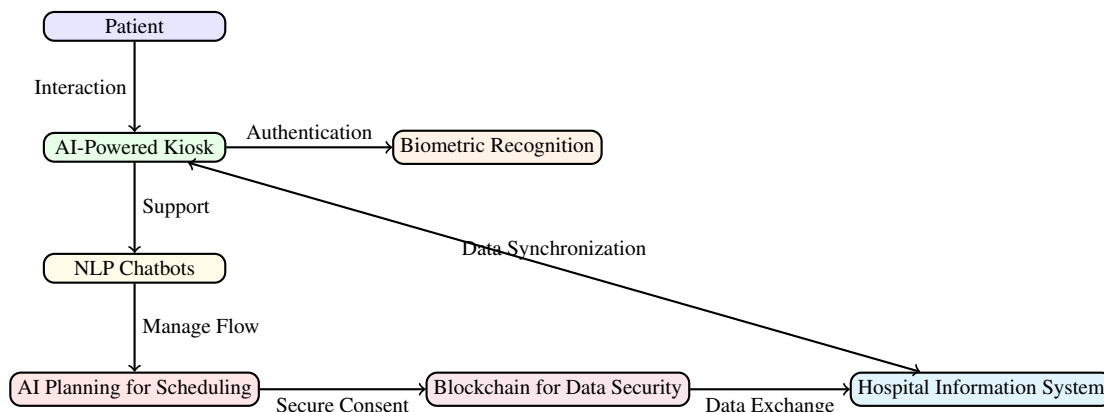


Figure 1: System architecture for the proposed AI-powered kiosk solution in healthcare.

The solution integrates multiple advanced technologies to transform patient reception management into a seamless process. The architecture and the relationships between components is shown in Figure 1:

4.1 Biometric Recognition

Facial recognition technology allows patients to be identified quickly and securely at kiosks. This accelerates the registration process and reduces the dependence on manual identity verification, leading to a more efficient experience.

4.2 NLP-Powered Chatbots

AI-based chatbots provide interactive, multilingual support, assisting patients with registration and answering common queries. This multilingual capability makes the system accessible to diverse patient populations, thereby improving patient satisfaction and overall efficiency.

4.3 AI Planning for Dynamic Scheduling

AI algorithms analyze real-time data to optimize staff allocation, balancing resource utilization and minimizing patient waiting times. This adaptive scheduling approach enables better utilization of staff, equipment, and facilities, especially during high patient volume periods.

4.4 Blockchain for Data Security

Blockchain technology ensures tamper-proof and transparent handling of patient data, building trust while complying with stringent privacy regulations like GDPR. The blockchain framework will also manage patient consent and facilitate secure data sharing among stakeholders, allowing patients to have greater control over their personal information while ensuring data integrity. Additionally, smart contracts can be used to automate patient consent processes, providing transparency and efficiency.

4.5 Waiting Room Optimization

Real-time analytics manage patient flow by dynamically allocating space and reducing wait times through smart queuing systems. This helps to maintain a more organized and less congested waiting area, improving the overall patient experience.

4.6 Integration Strategy

The proposed kiosk system will interface with existing hospital information systems (HIS) to ensure a seamless integration. This integration will facilitate data exchange and interoperability, making the system more effective in automating administrative processes and providing a holistic view of patient interactions.

4.7 Technical Feasibility

To implement the proposed solution, medical centers will require adequate hardware such as biometric sensors and robust network infrastructure. Additionally, software integration with existing electronic health records (EHR) systems will be critical for the smooth functioning of the kiosks.

5 Differentiation from Existing Solutions

Unlike the infrastructure outlined by Bardram (2004) for context-aware computing, which integrates environmental cues into healthcare workflows, our system uniquely focuses on using biometric recognition to enhance the security and personalization of patient interactions [3].

Orwat et al. (2008) reviewed pervasive computing solutions in healthcare, demonstrating their utility for seamless data collection and integration. Our AI-powered kiosk system extends these concepts by providing a fully integrated reception solution that includes dynamic scheduling and blockchain for data security [4].

In comparison to RFID solutions like those presented by Al Nahas & Deogun (2007) and Chen et al. (2009), which primarily improve operational safety by tracking assets and personnel, our approach leverages biometric identification for more secure and user-friendly patient management. While RFID systems are effective for tracking, our AI-powered system provides an added layer of security, privacy, and user adaptability that meets the stringent demands of modern healthcare environments [5, 6].

An overview of the comparison is presented in Table 1.

Feature	Proposed System	RFID Systems [5]	Context-Aware Systems[3]	Sys-
Biometric Authentication	Yes	No	No	
NLP Chatbots	Yes	No	No	
AI-Driven Scheduling	Yes	No	No	
Blockchain Security	Yes	No	No	
Context Adaptation	Yes	Partial	Yes	

Table 1: Feature comparison between the proposed system and existing solutions.

6 Potential Impact on the Healthcare Industry

The proposed AI-powered system can revolutionize patient reception management in the following ways:

Cost Savings: Reduced administrative burden and optimized scheduling lower operational costs. For example, automating patient registration can reduce administrative time by up to 40%, allowing staff to focus on patient care.

Enhanced Patient Experience: Faster registration, reduced waiting times, and multilingual support enhance patient satisfaction. Reducing wait times can increase patient satisfaction, arguably by up to 25%.

Improved Efficiency: Real-time insights enable better resource utilization, ensuring that medical centers operate more efficiently.

Data-Driven Decision Making: AI-powered analytics provide actionable insights for healthcare management, leading to informed decision-making and continuous improvement.

6.1 Stakeholder Perspectives

Patients: Benefit from reduced waiting times, multilingual support, and greater transparency in data management.

Staff: Experience reduced workload, allowing them to focus on critical patient care tasks rather than administrative duties.

Administrators: Gain real-time insights into operational efficiency, enabling better management and planning.

6.2 Long-Term Impact

In the long-term, the proposed system has the potential to influence healthcare management policies, promoting the adoption of more secure and efficient digital systems as standard practice in medical centers.

7 Specific Applications and Scenarios

The proposed system is particularly effective in the following scenarios:

High Patient Volume Periods: Efficiently managing increased patient flow during peak hours without adding strain on staff.

Multilingual Environments: Assisting patients who speak different languages through NLP chatbots, ensuring that language barriers do not impede service.

Emergency Situations: Quickly identifying and prioritizing patients who require urgent care, improving response times and outcomes.

7.1 Detailed Use Cases

The Figure 2, depicts a typical flow of actions in the proposed system. **Before and After Implementation:** Prior to implementing the proposed system, patients typically experience long wait times and inconsistent information. After implementation, the use of biometric recognition and AI-driven scheduling ensures a seamless flow, with reduced waiting times and efficient patient management.

Edge Cases: In scenarios where patients do not have prior appointments or emergencies arise, the system can dynamically adapt by prioritizing these cases, ensuring that critical needs are addressed promptly.

Patient Journey Mapping: The patient journey before and after implementation can be illustrated in a flowchart, depicting the improvements in registration efficiency, waiting time, and patient satisfaction.

8 Limitations and Challenges

While the proposed AI-powered kiosk system offers transformative potential, several challenges and limitations need to be addressed:

- **Accuracy and Reliability:** Ensuring robust and accurate biometric recognition to minimize misidentification risks. Developing natural language processing (NLP) capabilities that are context-aware and sensitive to diverse dialects and accents.
- **Scalability:** The system must scale effectively to handle high patient volumes during peak periods without performance degradation. This requires investment in cloud infrastructure and robust backend systems.

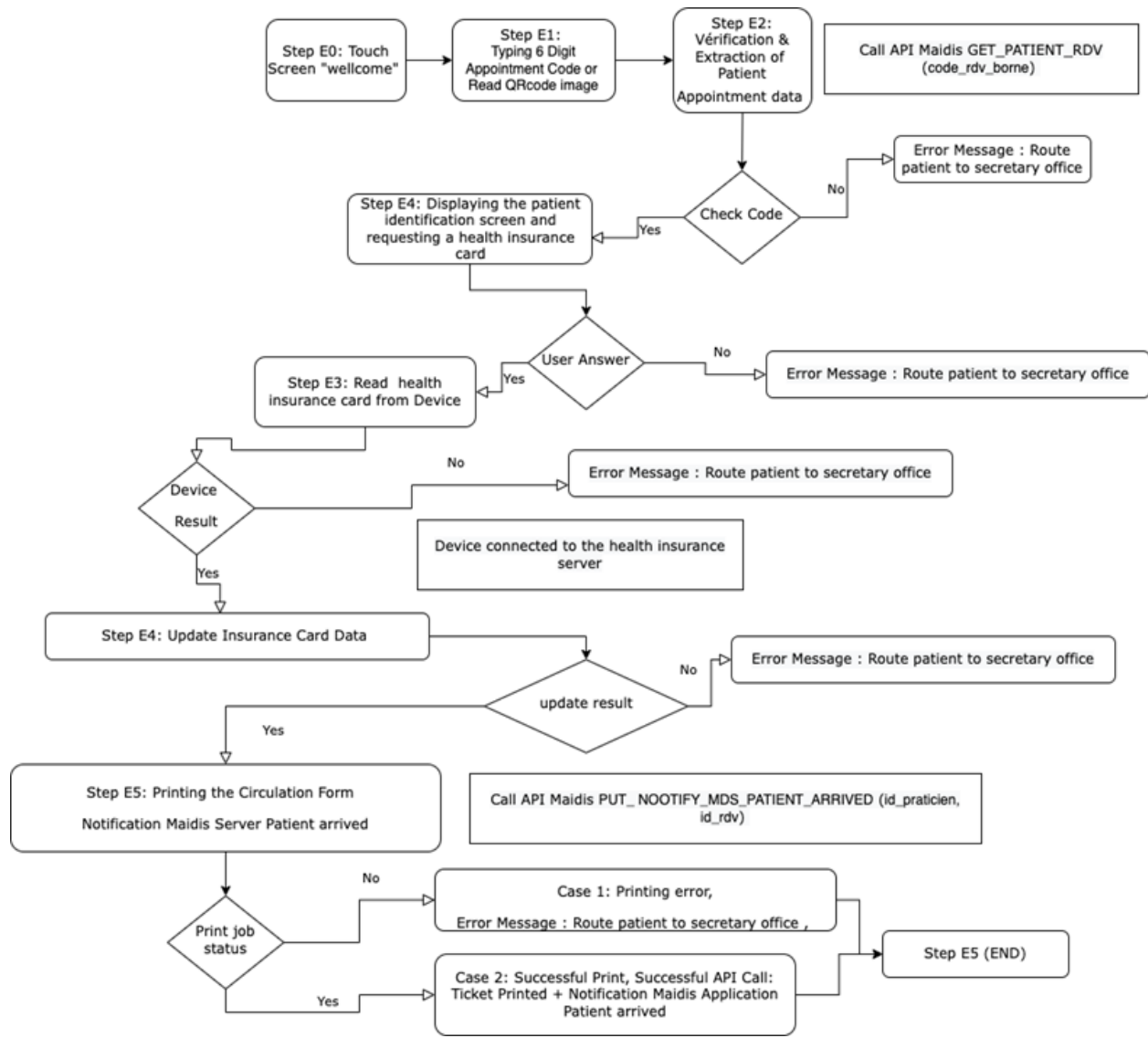


Figure 2: Typical flow in the user interaction

- **Security and Privacy:** Healthcare data is highly sensitive, necessitating rigorous measures to comply with GDPR and other local regulations. Although blockchain offers secure data handling, its integration with legacy systems may pose technical challenges.
- **User Resistance:** Adoption of new technologies can encounter resistance from both patients and healthcare providers. This requires extensive user training and the design of interfaces that are intuitive and accessible.
- **Cost Implications:** Initial costs for implementing biometric sensors, blockchain technology, and AI infrastructure may deter smaller medical centers. Strategies to reduce costs and demonstrate long-term ROI are critical.
- **Algorithmic Bias:** AI systems may unintentionally perpetuate biases in biometric recognition or patient prioritization. Ethical considerations demand rigorous testing and validation to ensure equity in service delivery.

8.1 Mitigation Strategies

- **Technical Solutions:** Regular updates and scalability testing for the system infrastructure. Adoption of explainable AI (XAI) techniques to ensure transparency and fairness in decision-making processes.

- **Stakeholder Engagement:** Workshops and training sessions for staff and patients to build trust and improve system adoption. Collaboration with regulatory bodies to ensure compliance and stakeholder confidence.
- **Cost Management:** Pilot projects to demonstrate cost-effectiveness before scaling. Exploring public-private partnerships to reduce implementation costs.

9 Future Work

To further develop and validate the proposed idea, a series of steps are planned. First, a working prototype of the kiosk system will be created to test functionality. This will be followed by running simulations to evaluate system performance under different scenarios. Subsequently, the system will be deployed in a controlled environment within a medical center for real-world testing, known as a pilot implementation. During this phase, feedback will be gathered from both patients and staff to refine the system and address usability issues. Additionally, a scalability assessment will be conducted to test the system's ability to handle increased loads and larger datasets. Research Methodology

User studies will be conducted to gather qualitative feedback on system usability. Pilot programs will be established by partnering with local medical centers to assess the real-world efficacy of the solution. Collaboration opportunities with technology providers and healthcare institutions will also be explored to facilitate rapid prototyping and testing. A tentative timeline includes six months for prototype development, followed by another six months for simulations, and a year-long pilot program. The effectiveness of the prototypes will be measured by patient satisfaction rates, reduction in waiting times, and improvements in operational efficiency.

10 Conclusion

The integration of AI technologies into patient reception management presents a promising solution to current challenges faced by medical centers in France. By streamlining registration, optimizing staff scheduling, and enhancing data security, the proposed system has the potential to significantly improve operational efficiency and patient satisfaction. Future work will focus on developing prototypes, conducting simulations, and implementing pilot tests to refine the system and demonstrate its efficacy in real-world settings.

The proposed framework offers a transformative approach that, if successfully implemented, can set a new standard for patient reception management in healthcare facilities, ultimately leading to a more efficient, patient-centric experience. We encourage further research and invite collaboration to advance the project. In the long-term, this system could evolve with emerging technologies, such as IoT integration and advancements in AI, offering even more powerful solutions for healthcare management. This vision aligns with the future of AI in healthcare, where intelligent and secure systems work seamlessly to enhance patient outcomes and operational efficiencies.

References

- [1] Le Monde. Crise de l'hôpital: urgences saturées, fermetures de lits, place des cliniques, les dossiers en attente d'un ministre, 2024. Accessed: 2024-11-27.
- [2] L'état de santé de la population en France - Édition 2022, 2022. Accessed: 2024-11-27.
- [3] Jakob E. Bardram. Applications of context-aware computing in hospital work: examples and design principles. In *Proceedings of the 2004 ACM symposium on Applied computing*, pages 1574–1579, Nicosia Cyprus, March 2004. ACM.
- [4] Carsten Orwat, Andreas Graefe, and Timm Faulwasser. Towards pervasive computing in health care – A literature review. *BMC Medical Informatics and Decision Making*, 8(1):26, December 2008.
- [5] Huzaifa Al Nahas and Jitender S. Deogun. Radio Frequency Identification Applications in Smart Hospitals. In *Twentieth IEEE International Symposium on Computer-Based Medical Systems (CBMS'07)*, pages 337–342, Maribor, June 2007. IEEE.
- [6] Po-Jen Chen, Yung-Fu Chen, Sin-Kuo Chai, and Yung-Fa Huang. Implementation of an RFID-based management system for operation room. In *2009 International Conference on Machine Learning and Cybernetics*, pages 2933–2938, Baoding, China, July 2009. IEEE.