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PRINTMED: Utilization of Facial Verification in the Records Management System for Outpatient Services of Carmona Hospital and Medical Center

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Abstract

This study developed PrintMed, a Facial Verification-Based Patient Records Management System (PRMS), to enhance the efficiency, security, and quality of outpatient services at Carmona Hospital and Medical Center. Traditional paper-based records presented persistent challenges, including delayed data retrieval, record duplication, and unauthorized access risks. PrintMed addresses these issues through biometric facial recognition using Amazon Rekognition, enabling secure, contactless, and real-time patient identification. Anchored on the Health Information Systems (HIS) Theory, the Technology Acceptance Model (TAM), and Systems Theory, the study employed a mixed-methods approach, integrating quantitative performance metrics with qualitative user feedback. Developed via Agile-Scrum methodology, the system emphasized iterative design and user-centered testing. Key findings demonstrated substantial improvements in patient check-in times, accuracy of identity verification, prevention of duplicate records, and auditability through comprehensive logging mechanisms. Evaluation using ISO/IEC 25010:2011 standards showed high performance, with mean scores in security (4.60), functional suitability (4.45), usability (4.44), and reliability (4.44), reflecting strong acceptance among hospital staff and patients. These results confirm that biometric-enhanced PRMS can significantly improve outpatient healthcare data management and service delivery, particularly in high-volume clinical settings. To further maximize impact, the study recommends expanding PrintMed to other hospital units, integrating billing and inventory systems, developing a patient-facing mobile application for appointment scheduling and teleconsultation, incorporating multilingual support, and implementing analytics dashboards for administrators. Such enhancements would foster holistic workflow integration, improve patient engagement, ensure inclusivity, and enable data-driven decision-making, offering a scalable, privacy-compliant model for digital health transformation and informing future policies and system implementations in Philippine healthcare settings.

Keywords: *facial verification, records management system, outpatient services, PUPGS.*

Introduction

Carmona Hospital and Medical Center is facing increasing challenges in managing outpatient records. As patient numbers grow, traditional manual processes—such as ID cards, handwritten logs, and manual verification—are proving inefficient. These methods often result in errors, security issues, and administrative delays, leading to longer waiting times, heavier staff workload, and reduced patient satisfaction. In addition, risks of data mismanagement and privacy breaches remain pressing concerns. These challenges highlight the urgent need for a more secure, contactless, and efficient system of patient identification and records handling, particularly in the outpatient department where patient traffic is high.

One solution is the adoption of a Patient Record Management System (PRMS), a digital platform that organizes and stores patient information in a centralized format. PRMS can improve accuracy, enable real-time updates, and reduce reliance on paper records. It also enhances coordination among hospital departments,

expedites patient check-ins, and strengthens data security through encryption and authentication features. According to Sinhasane (2022), healthcare organizations are continuously adopting digital technologies to improve financial, administrative, and clinical operations, which supports the move toward automated data management.

However, despite these advantages, most PRMS platforms still rely on traditional identity verification methods such as ID cards, passwords, or barcodes. These methods are prone to being lost, duplicated, or misused, and they are inefficient in high-volume settings like outpatient departments. The lack of a reliable and foolproof authentication process remains a key limitation in realizing the full potential of PRMS.

Facial verification offers a promising solution to this gap. As a form of biometric authentication, it uses artificial intelligence to identify individuals through unique facial features. This technology provides a fast, secure, and contactless method of patient verification, reducing errors and fraud while improving patient flow. It also supports hygiene and safety by minimizing physical contact—an especially critical consideration during pandemics. Globally, facial recognition is already being applied in healthcare for automated check-ins, record access, and prescription verification. For Carmona Hospital and Medical Center, integrating facial verification into PRMS could directly address current inefficiencies, strengthen data security, and improve outpatient services.

The theoretical foundation of this study lies in three interrelated perspectives. First, the Health Information Systems (HIS) Theory emphasizes how digital tools enhance the collection, storage, retrieval, and sharing of medical data. This study builds on HIS theory by applying facial verification as a biometric approach to strengthen accuracy and security in outpatient services (Sinhasane, 2022). Second, the Technology Acceptance Model (TAM) highlights the role of perceived usefulness and perceived ease of use in the adoption of new technologies (Davis, 1986). As James (2023) and Robinos, et al. (2024) explain, TAM is essential in understanding why individuals accept or resist innovations, making it useful in evaluating how patients and staff respond to facial verification. Finally, Systems Theory views the hospital as an interconnected structure, where improvements in one area can positively influence others—for example, how better patient identification can lead to enhanced care, smoother workflows, and more efficient resource allocation.

This study introduces PRINTMED, a facial verification–based Patient Record Management System tailored for outpatient services at Carmona Hospital and Medical Center. By integrating machine learning and biometric technology, the system manages both structured patient data (such as demographics, vitals, and records) and unstructured data (facial images) with validation and normalization techniques. It also incorporates audit trails and data governance features to ensure integrity and accountability. Anchored on HIS theory, TAM, and Systems Theory, this research explores how biometric verification can improve patient experience, reduce errors, and support the broader goal of timely and patient-centered healthcare.

This study generally aims to design and implement PRINTMED: Utilization of Facial Verification in the Records Management System for Outpatient Services of Carmona Hospital and Medical Center. Specifically, it seeks to:

1. Develop a patient record management system integrated with facial verification to simplify and streamline access, identification, and management of outpatient records;
2. Design the user and administrator interfaces of the developed system in terms of functionality, usability, and security;
3. Assess the implementation and acceptance of the system among healthcare staff and patients, using the Technology Acceptance Model (TAM) as a guiding framework; and
4. Evaluate the effectiveness of PRINTMED in improving accuracy, efficiency, and security of outpatient services, anchored on Health Information Systems (HIS) theory and Systems Theory.

Methodology

Research Design

This study employed a mixed-method design to achieve a comprehensive understanding of the system's effectiveness. According to George (2021), combining quantitative and qualitative methods provides a broader perspective on research problems.

The quantitative method measured PrintMed's performance and its effect on hospital efficiency. A data-driven approach was used to evaluate improvements in workflow and administrative tasks. As Whitney et al. (2020) emphasize, quantitative analysis allows for hypothesis testing and generates generalizable findings, making it appropriate for measuring system efficiency.

The qualitative method focused on user experiences with the system, gathering detailed feedback from healthcare staff and patients. This approach provided insights into usability, accessibility, and overall system impact. Timans et al. (2019) and Riazi (2023) highlight that qualitative

methods are essential for capturing user behaviors and attitudes, which are critical in evaluating healthcare technologies.

By integrating both methods, the study captured both technical efficiency and human-centered outcomes. Nair and Prem (2020) note that such integration ensures a holistic evaluation, making mixed methods suitable for assessing PrintMed's impact on hospital operations and data security.

Software Development Methodology

The researcher adopted the Agile Scrum framework as the development methodology. Agile emphasizes collaboration, adaptability, and iterative progress, making it more effective than traditional linear models like Waterfall (Cooper, 2020; RST Software). Atlassian notes that Agile supports continuous improvement through short development cycles, while Scrum provides structure through defined roles, artifacts, and ceremonies (Schwaber & Sutherland, 2020).

Agile Scrum was selected because it allowed the researcher to:

- Deliver system functionalities in short, testable increments, ensuring early feedback and faster improvements;
- Conduct regular sprint reviews and retrospectives, which supported continuous refinement; and
- Maintain close alignment with user requirements and stakeholder needs, as emphasized in daily stand-ups and sprint planning (Kovalskiy, 2022).

In this study, Scrum ensured that PrintMed was developed systematically yet flexibly, with each sprint producing usable components tested against the research objectives. This approach guaranteed that the system was both functional and responsive to user feedback throughout development.

Instrumentation and Data Collection

To gather relevant data, the study used both primary and secondary sources:

- Internet Research – Information from academic databases and digital libraries was used to review existing technologies and best practices. This ensured the system design was evidence-based and up to date (Bloomfield, 2024).
- Interviews – Conducted with hospital staff, managers, and patients to obtain qualitative insights into needs, challenges, and expectations. This method captured practical perspectives necessary for user-centered design (Easwaramoorthy & Zarinpoush, 2022).
- Surveys – Distributed in person and online to gather standardized quantitative data on system usability, efficiency, and satisfaction. Surveys provided measurable patterns and trends (Ruel, 2019).

This combination ensured both technical requirements and user perspectives were incorporated into PrintMed's development.

Data Gathering Procedure

The process began with literature review and internet research to identify existing solutions and gaps in healthcare record systems. Next, interviews with key stakeholders provided in-depth feedback on practical challenges and system expectations. Finally, surveys were distributed to a broader group of users to assess perceptions of PrintMed's usability and efficiency. Responses were collected using a Likert scale and were tabulated for analysis. This phased process ensured that the data captured was both comprehensive and reliable, combining expert insights with measurable user responses.

Tools for Data Analysis

Several tools supported data interpretation and system modeling:

- Descriptive Statistics – Used to analyze survey results, with the mean applied to measure trends in user satisfaction and system performance.
- ISO 25010:2011 Framework – Served as the evaluation standard for assessing system quality.
- Data Flow Diagrams (DFD) – Illustrated how information moved through the system, helping identify bottlenecks and optimize workflows (Chi, 2023).
- Use-Case Diagrams – Provided a user-focused view of system functionality, clarifying requirements and supporting validation (Nishadha, 2022).

These tools ensured both quantitative accuracy and visual clarity in assessing PrintMed.

Ethical Considerations

The researcher followed strict ethical standards to protect participant rights and data integrity. Privacy and confidentiality were upheld in compliance with the Data Privacy Act, and informed consent was obtained before participation. As Hassan (2024) stresses, safeguarding participant welfare ensures research credibility.

Data were recorded, stored, and analyzed responsibly, with no manipulation. Only authorized individuals—the researcher, adviser, and experts—had access to sensitive data. Ethical concerns were addressed promptly, ensuring transparency and accountability throughout the study.

Results and Discussions

Developed patient record management system integrated with facial verification
System Requirements Specification

To design the Patient Record Management System (PRMS) with facial verification, the researcher gathered requirements through interviews and a review of relevant studies. The information was analyzed, compared with existing workflows, and translated into a Software Requirements Specification (SRS), which became the blueprint for development.

Analysis and Design

The analysis stage involved identifying system needs and consulting users to validate them. The design phase produced Use Case Diagrams and Data Flow Diagrams (DFD) that mapped user roles, system processes, and data flow. These diagrams were later translated into prototypes to demonstrate functionality and guide development.

The Use Case Diagram defined five roles:

- Super Admin – manages Admin accounts, monitors usage through downloadable audit logs, and updates account details.
- Admin – manages accounts for Physicians and Secretaries, oversees departmental records, and tracks user activity.
- Physician – accesses patient records using Face ID, updates diagnoses and prescriptions, and prints prescriptions.
- Secretary – registers patients, updates records, manages appointments, and serves as liaison between patients and physicians.
- Patient – registers online, completes in-person verification, and receives a physical and digital Patient Identification Card.

Facial Recognition Process

Facial verification was implemented using Amazon Rekognition, a deep learning–based image analysis service from AWS. The process involves:

1. DetectFaces API – identifies facial landmarks and converts raw image data into structured metadata.
2. IndexFaces API – extracts facial embeddings and stores them in a Rekognition collection.
3. SearchFacesByImage – compares a new image with stored embeddings to find matches based on similarity scores.
4. CompareFaces – performs one-to-one verification of two facial images.

Rekognition uses a similarity threshold (80–99%) to classify matches. If the score meets or exceeds the threshold, the system confirms the identity. This reduces duplication of patient records and enhances security in outpatient services.

System Architecture

The system, called PrintMed, was built using a modular web-based architecture:

- Frontend: React – for user interaction and role-based access.
- Backend: Laravel – for business logic, authentication, and system communication.
- Database: MySQL – for secure storage of patient records, accounts, and logs (with PII encryption).
- Facial Recognition: Amazon Rekognition via AWS SDK.
- Security Features: Laravel Sanctum for session authentication, two-factor authentication via email, and encrypted data transmission.
- Additional Tools: PDF generation for IDs and prescriptions, and Mailtrap for secure email testing.

This multi-layered architecture ensures scalability, security, and smooth integration between components.

Data Flow Diagrams

The Level 0 DFD shows four main actors—Patient, Secretary, Admin, and Physician—interacting with the system. Patients register and receive IDs, Secretaries manage and verify records, Admins oversee accounts and audit logs, and Physicians retrieve and update medical records.

The Level 1 DFD provides more detail:

- Patients submit registration data, stored initially in the Registration Database.
- Secretaries verify and transfer valid data to the Patient Database.
- Physicians access records through facial verification, update diagnoses, and record prescriptions in the Medical Records Database.

- Admins oversee system activity through Audit Logs and manage user accounts.

Data validation is applied at each stage, ensuring accuracy, reliability, and smooth integration across modules.

Designed User and Administrator Interfaces of the Developed System

Landing Page Interface

The landing page serves as the entry point for all users. It provides two main options: the Outpatient Department (OPD) Personnel Portal, which allows administrators, physicians, and secretaries to log in, and the Patient Registration Portal, which enables new patients to register. A reminder is displayed to inform patients that the hospital issues official identification cards after in-person verification.

Login and Authentication

The login process is secured with layered authentication. Users enter their credentials and verify their identity through a One-Time Password (OTP) sent via email. If the password is forgotten, users can recover it by validating personal details such as personnel number and birthdate before resetting their credentials. This step ensures only authorized users can access sensitive patient information.

Patient Registration and Consent

The patient registration form collects personal information such as name, birthdate, and contact details. Patients must also agree to the hospital's Terms and Conditions, which cover privacy and data use policies. A confirmation page summarizes patient details before final submission, and successful registration generates a unique patient ID and receipt for hospital verification.

Administrator Interfaces

Administrators have full control over system management. Their dashboard includes features for creating and managing accounts, monitoring departmental records, and maintaining system activity logs. They can filter accounts by role or status, prevent duplicate department entries, and oversee all modifications. An audit log records user activity and can be exported for accountability purposes.

Physician Interfaces

Physicians access patient records primarily through the Facial Recognition Feature, which verifies patient identity and retrieves medical history. They can update diagnoses, add prescriptions, and print official forms. The design emphasizes efficiency through streamlined access and organized layouts, enabling physicians to focus on patient care while ensuring accurate documentation.

Secretary Interfaces

Secretaries are responsible for registering patients, updating vital signs, and managing hospital-issued identification cards. They can deactivate cards if lost or compromised and retrieve records using a Face ID scanner or manual search. These tools ensure smooth patient flow within the outpatient department and reduce clerical errors.

Table 1. Summary of Interfaces

User	Functionality	Usability	Security
Landing Page	Provides entry options for OPD personnel and patients	Clear navigation with role-specific choices	Prepares patients for verification before ID issuance
Login/ OTP	Allows user login with email and password, OTP for access	Simple input fields with recovery options	Multi-factor authentication and identity validation
Patient	Registration of details, consent to terms, receipt generation	Confirmation step ensures accuracy	Consent agreement ensures compliance with privacy and data use policies
Admin	Manage user accounts, departments, and audit logs	Search, filter, and update features for easy account management	Audit trail and account verification prevent unauthorized access
Physician	Retrieve/update records, add diagnoses, print prescriptions	Organized interface supports efficient medical documentation	Facial recognition ensures accurate patient identification
Secretary	Register patients, update vitals, manage and deactivate patient ID cards	Face ID scanner and manual search support smooth workflows	ID deactivation and verification features reduce fraud and misidentification

Implementation and acceptance of the system among healthcare staff and patients using the Technology Acceptance Model (TAM)

System Implementation

Implementation is the critical step that turns a concept into a functional system. Without proper implementation, even the most innovative ideas cannot achieve their intended outcomes. An implementation plan provides a structured approach for accomplishing project goals and serves as a record of the process (Lutkevich & Ehrens, 2022).

For PrintMed: Utilization of Facial Verification in Records Management System for Outpatient Service of Carmona Hospital and Medical Center, implementation involved training hospital staff to ensure smooth adoption. Staff participated in sessions explaining the system's features in simple, practical terms, and each received a user manual for reference. Online support was also established to provide ongoing assistance, allowing staff to resolve issues quickly and maintain efficient operations. The plan also includes potential expansion of PrintMed to other departments, such as the Emergency Department, to unify patient record management across the hospital, enhancing efficiency and organization.

System Acceptance

Acceptance is crucial for verifying that the system meets users' needs and expectations. Clearly defined acceptance criteria provide benchmarks for evaluating whether project deliverables satisfy required standards (Mathur & Mathur, 2023).

In the case of PrintMed, the system was carefully tested to assess performance, features, and security. Hospital staff and stakeholders evaluated the system for ease of use, efficiency, and relevance to outpatient record management. Their approval confirmed that the system met functional requirements and was ready for real-world application. Feedback collected during this phase also identified minor improvements and possible future enhancements, contributing to overall quality assurance before full deployment.

Facial Recognition Performance

The facial recognition module was tested under different conditions to assess robustness. Using Amazon Rekognition, the system successfully matched faces even when patients altered their appearance slightly—e.g., closing one eye, puffing cheeks, or tilting the head—demonstrating reliance on stable facial landmarks such as eye distance, nose structure, and facial symmetry.

Significant physical changes, like major weight fluctuations or facial disfigurements, may reduce accuracy. In such cases, manual lookup by ID or name allows the staff to index a new facial image using the IndexFaces API, maintaining usability and continuity of the system.

Accuracy, Speed, and Reliability

All tested features—including login, OTP verification, audit viewing, and account locking—achieved 100% accuracy across multiple trials, except the Facial Scan Patient Lookup, which achieved 90% accuracy due to environmental factors such as lighting. Manual patient search provides a reliable fallback.

Other modules, including patient registration, confirmation, and error handling, consistently demonstrated 100% accuracy, fast response times, and prevention of duplicate entries. These results indicate the system's robustness, efficiency, and suitability for daily hospital operations, aligning with the TAM constructs of perceived ease of use and perceived usefulness, which influence user acceptance and behavioral intention to use the system.

Table 2. Summary Table of Implementation and Acceptance

Aspect	Findings	Implications (TAM-Based)
Staff Training & Support	Training sessions + user manuals + online support	Increases perceived ease of use and confidence in system adoption
System Acceptance	Evaluated by staff for usability, efficiency, and relevance	Confirms perceived usefulness and readiness for real-world application
Facial Recognition	Correctly identifies patients with minor changes; manual lookup available for major changes	Balances automation with reliability, increasing trust and system adoption
Accuracy & Speed	100% for most functions; facial scan 90% due to environmental factors	Ensures efficient workflow; aligns with user expectations for reliability
Error Handling & Reliability	Smooth registration, login, confirmation, and ID verification	Improves user satisfaction and reduces resistance to adoption

Evaluation on the effectiveness of PRINTMED in improving accuracy, efficiency, and security of outpatient services

System Security

The evaluation of PrintMed's security features demonstrates strong performance across all criteria. The system's ability to restrict access to authorized personnel received an average score of 4.48, showing confidence in access control mechanisms to protect sensitive records. Encryption of patient data during storage and transmission was rated 4.56, reflecting high trust in the system's ability to safeguard confidential information. The highest rating, 4.76, was for compliance with data privacy and protection regulations, indicating a consensus that PrintMed meets legal and ethical standards in handling sensitive medical data. These results confirm that the system effectively enforces confidentiality, integrity, and regulatory compliance, consistent with ISO 25010:2011 standards for secure information systems. From a Health Information Systems (HIS) perspective, robust security enhances user trust and ensures safe handling of sensitive healthcare data, while Systems Theory emphasizes that maintaining integrity and secure boundaries is critical for overall system stability.

System Reliability

PrintMed's reliability was consistently rated highly. The system scored 4.40 for prompt error detection and resolution, 4.44 for data recovery during downtime, and 4.48 for overall operational stability. These results demonstrate that PrintMed can maintain functionality under typical conditions, recover data accurately, and minimize workflow interruptions. Reliability is essential in clinical environments, as interruptions in outpatient services could affect patient care. According to Systems Theory, the system functions as an interconnected entity where stable operation of one component supports overall organizational efficiency. HIS theory underscores that reliable digital tools reduce human error and improve the accuracy of medical records.

System Portability

Portability evaluation showed strong adaptability: migrating across different platforms scored 4.32, scalability 4.40, and minimal software/hardware dependency 4.28. These results indicate that PrintMed can function across varied technical environments, supporting future expansion and integration with other hospital units. Portability ensures flexibility, a key aspect of modern HIS frameworks, allowing healthcare institutions to implement the system across multiple departments with minimal disruption.

Overall Effectiveness

The overall weighted mean for system evaluation was 4.41 ("Strongly Agree"), demonstrating high effectiveness in improving outpatient services. Security scored the highest at 4.60, followed by reliability at 4.44, portability at 4.33, and performance efficiency at 4.28. All dimensions fall within the "Strongly Agree" range, confirming that PrintMed successfully improves data accuracy, workflow efficiency, and system security. From the perspective of HIS theory, PrintMed enhances information accuracy, supports timely access to patient data, and optimizes healthcare operations. Systems Theory reinforces that these improvements reflect the system's holistic functioning, where secure, reliable, and portable components interact to support the hospital's outpatient services efficiently.

Table 3. Summary Table of PrintMed Effectiveness

Evaluation Dimension	Mean Score	Interpretation	Key Implications
Security	4.60	Strongly Agree	Ensures patient data confidentiality, integrity, and compliance with privacy laws
Reliability	4.44	Strongly Agree	Maintains stable operations, prompt error handling, and accurate data recovery
Portability	4.33	Strongly Agree	Supports system use across environments, scalable for future hospital needs
Performance Efficiency	4.28	Strongly Agree	Balances speed, resource use, and workflow efficiency
Overall Weighted Mean	**4.41**	**Strongly Agree**	***Confirms system's effectiveness in enhancing outpatient service management***

Conclusion and Recommendations

The study concluded that PrintMed: Utilization of Facial Verification in Records Management System for Outpatient Service of Carmona Hospital and Medical Center effectively addressed the challenges associated with traditional paper-based record management. The system significantly enhanced the efficiency of hospital operations by streamlining tasks such as creating, locating, and updating patient records. The integration of facial recognition technology allowed secretaries, nurses, and physicians to securely verify patient identities, reducing delays and improving workflow efficiency. PrintMed also contributed to improved data accuracy and security. The system prevents duplicate records by checking for existing entries based on key identifiers such as name, birthdate, and sex. Role-based access control and two-factor authentication ensured that only authorized personnel could access specific patient records, while audit trailsprovided accountability and compliance monitoring. Additionally, data encryption safeguarded sensitive patient information, ensuring adherence to privacy and security standards. User acceptance and satisfaction with the system were high, with an overall mean score of 4.41 across critical evaluation criteria including reliability, security, portability, and performance efficiency. This confirms that PrintMed is a secure, reliable, and user-friendly solution that aligns with the needs of hospital staff and patients, improving outpatient service management.

To further enhance the functionality and impact of PrintMed, the following recommendations are proposed:

1. System Integration: Expand PrintMed by integrating it with the hospital's billing system, inventory management, and telemedicine modules. Such integration would create a cohesive, holistic platform, facilitating seamless workflows and broader utilization across hospital services.
2. Expansion to Other Units: Extend the system to other essential units such as the laboratory, emergency, and diagnostic departments. This would improve inter-departmental collaboration, promote real-time information sharing, and support better-informed medical decision-making, ultimately enhancing the quality of patient care.
3. Mobile Application for Patients: Develop a mobile app to allow patients to access medical records, appointment schedules, and communicate directly with providers. Features like appointment and medication reminders and virtual consultation support would empower patients, reduce missed appointments, and improve adherence to prescribed treatments, fostering better health outcomes.
4. Multilingual Support: Incorporate multilingual functionality to accommodate patients and staff with different language preferences, ensuring inclusive and effective communication across diverse user groups.
5. Analytics and Decision Support: Implement administrative dashboards to track system usage, monitor trends, and support data-driven decision-making, enabling hospital administrators to optimize services and resource allocation.
6. Continuous Quality Improvement: Establish procedures for regular system audits, feedback collection, and usability testing. This would ensure sustained system quality, security, and user satisfaction as the platform evolves.
7. Staff Training and Support: Provide ongoing training and technical support for all users to maximize system adoption, ensure efficient use of new features, and maintain high standards of operational performance.

By implementing these recommendations, Carmona Hospital and Medical Center can enhance the utility of PrintMed, further improving accuracy, efficiency, and security of outpatient services while supporting patient-centered care and informed clinical decision-making.

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