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Developing A Web-Based Patients' Information Management System For Desire Medical Centre

Gumisiriza Justus[1], Hussein Kalinaki[2]
1, 2 Metropolitan International University

Abstract

This study was conducted to develop a web-based patients' information management system (PIMS) for Desire Medical Centre, a private health facility in Uganda. The centre had been operating a largely manual, paper-based patient records management system characterized by inefficiency, data loss, and delays in patient service delivery. Using the System Development Life Cycle (SDLC) methodology specifically the structured waterfall model, the study followed iterative phases of requirements analysis, system design, implementation, testing, and deployment. Primary data were collected from 47 healthcare workers including doctors, nurses, records officers, and administrative staff through interviews and structured questionnaires to determine system requirements. Secondary data were gathered from existing patient records and operational documents. The developed system was built using PHP 8.1, MySQL database, HTML5, CSS3, Bootstrap 5 framework, and JavaScript, hosted on an Apache web server. System testing was conducted using black-box and white-box testing techniques. The evaluation revealed that the system achieved a 97.3% task completion rate in usability testing, significantly reduced average patient registration time from 18 minutes to 4 minutes, and improved records retrieval accuracy to 99.1%. The study concludes that the web-based PIMS effectively addresses Desire Medical Centre's patient information management challenges and recommends full deployment, staff training, and regular system maintenance to sustain operational benefits.

Keywords: Web-Based System, Patients' Information Management System, PIMS, Electronic Health Records, System Development, Uganda, Health Informatics

1.0 Background of the Study

The management of patient information is a cornerstone of effective healthcare delivery. Comprehensive, accurate, and readily accessible patient records enable healthcare providers to make informed clinical decisions, ensure continuity of care, track disease trends, and comply with regulatory requirements(Jac & Kazaara, 2023). Globally, the transition from paper-based to electronic patient information management systems has accelerated significantly over the past two decades, driven by advances in information and communication technology (ICT), growing recognition of the limitations of manual systems, and the need for interoperable health information exchange (WHO, 2021).

In Uganda, the healthcare system comprising public, private-for-profit, and private-not-for-profit facilities — continues to grapple with significant health information management challenges. The Ministry of Health's Health Management Information System (HMIS) provides a national framework for health data collection and reporting, but implementation at the facility level remains uneven, particularly in smaller private healthcare facilities that often lack the technical capacity and financial resources to deploy comprehensive electronic records systems (Ministry of Health

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Uganda, 2021). The result is a fragmented health information landscape characterized by paper records, data duplication, missing files, and delayed information availability(Kazaara & Kazaara, 2023).

Desire Medical Centre is a registered private health facility offering outpatient, inpatient, laboratory, and pharmacy services(Saunders et al., 2015). The centre serves a catchment population of approximately 15,000 people and processes an average of 120 patient visits per day. Its current patient information management approach relies primarily on hand-written registers, manila files, and manual ledgers, creating significant operational inefficiencies including long patient waiting times, difficulty in retrieving historical patient records, frequent record misfiling, and inability to generate real-time statistical reports on patient demographics, diagnoses, and service utilisation(Kazaara & Kazaara, 2025). This study therefore undertook the design and development of a web-based PIMS as a practical solution to these challenges.

2.0 Problem Statement

Desire Medical Centre's manual patient information management system creates multiple operational problems that undermine service delivery quality(Christopher et al., 2022). Patient registration takes an average of 18 minutes due to manual form filling and manual file retrieval, contributing to long queues and patient dissatisfaction(Sarah & Audrey, 2024). Historical patient records are frequently misplaced or incomplete, resulting in clinicians making treatment decisions without access to complete patient histories. The centre is unable to generate automated statistical reports on disease burden, service utilisation, and patient demographics required for health planning and regulatory reporting(Rashid et al., 2023). Data loss due to physical deterioration of paper records, fire, or misplacement poses a significant risk to continuity of care. These challenges were corroborated by a preliminary survey in which 78% of healthcare workers at the centre rated the existing records management system as unsatisfactory or very unsatisfactory. The development of a web-based PIMS is therefore both operationally necessary and potentially transformative for the quality of healthcare delivery at the centre.

3.0 Main Objective

The main objective of this study was to develop a web-based patients' information management system for Desire Medical Centre. Specific objectives were to: (i) analyse the current patient information management system at Desire Medical Centre and identify its limitations; (ii) design a web-based patients' information management system that addresses identified requirements; (iii) implement and test the designed system; and (iv) evaluate the performance and usability of the developed system.

4.0 Literature Review

4.1 Patient Information Management Systems

A Patient Information Management System (PIMS), also referred to as an Electronic Health Records (EHR) system or Hospital Information System (HIS), is a digital system designed to capture, store, manage, and retrieve patient health information. Benson and Grieve (2020) define PIMS as integrated systems that support clinical, administrative,

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and operational functions of healthcare facilities through the digitalisation of patient data. Modern PIMS encompasses modules for patient registration, clinical documentation, appointment scheduling, laboratory management, pharmacy management, billing, and statistical reporting.

The benefits of implementing PIMS in healthcare facilities are well-documented in the literature. Menachemi and Collum (2019) conducted a systematic review of 116 studies on EHR impacts and found consistent evidence of improvements in healthcare quality, patient safety, administrative efficiency, and regulatory compliance. Specifically, EHR implementation was associated with a 55% reduction in medication errors, a 40% improvement in adherence to clinical guidelines, and significant reductions in redundant diagnostic testing. In the African context, Muinga, Magare, Monda, Kamau, English, Fraser, Powell and Paton (2018) documented in a Kenyan hospital study that the implementation of an open-source EHR system reduced patient waiting times by 47% and improved data quality scores by 62%.

The choice of development technology significantly influences the functionality, usability, and sustainability of PIMS solutions. Web-based systems, which are accessed through internet browsers without requiring installation on individual workstations, have gained popularity in healthcare settings due to their platform independence, ease of software updates, and potential for multi-location access (Adebesin, Foster, Kotzé and Van Greunen, 2019). Open-source frameworks such as OpenMRS have been specifically developed for healthcare contexts in low-resource settings and have been successfully implemented across multiple African countries. However, for smaller private facilities like Desire Medical Centre, custom-developed web-based systems may offer more appropriate functionality and better alignment with local workflows than off-the-shelf solutions.

4.2 System Development Methodologies

The System Development Life Cycle (SDLC) provides a structured framework for software system development and encompasses multiple established methodologies including the waterfall model, agile development, rapid application development (RAD), and the spiral model. Pressman and Maxim (2020) describe the waterfall model as a sequential, phase-driven approach in which requirements gathering, system design, implementation, testing, and maintenance occur in a defined order, with each phase producing documented deliverables that inform the subsequent phase. While the waterfall model has been criticised for its inflexibility in responding to changing requirements, it remains appropriate for projects with well-defined, stable requirements and limited scope characteristics that are applicable to the Desire Medical Centre PIMS project.

Sommerville (2019) emphasises the importance of rigorous requirements engineering as the foundation of successful system development, arguing that inadequate requirements analysis is the leading cause of system development failures. System testing, encompassing functional testing, usability testing, performance testing, and security testing, is equally critical to ensuring that developed systems meet user expectations and perform reliably under operational conditions. Pressman and Maxim (2020) recommend black-box testing which evaluates system outputs against

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specified requirements without knowledge of internal code structure and white-box testing which examines code pathways as complementary approaches to comprehensive system quality assurance.

5.0 Methodology

This study adopted the Structured System Analysis and Design Method (SSADM) within the waterfall SDLC framework, proceeding through five sequential phases: (1) Requirements Analysis, (2) System Design, (3) System Implementation, (4) System Testing, and (5) System Evaluation. The research adopted both primary and secondary data collection methods. Primary data on system requirements were gathered through structured interviews with 12 healthcare workers (4 doctors, 5 nurses, and 3 records officers), direct observation of the existing manual records management process, and a structured questionnaire administered to 47 healthcare workers to assess current system pain points and desired system features(Abiodun et al., 2022).

System design artefacts included Use Case Diagrams, Entity-Relationship Diagrams (ERDs), Data Flow Diagrams (DFDs), and interface wireframes developed using draw.io and Figma. The system was implemented using PHP 8.1 as the server-side scripting language, MySQL 8.0 as the relational database management system, HTML5 and CSS3 for front-end structure and styling, Bootstrap 5 for responsive design, and JavaScript for client-side validation and dynamic interface elements. The system was hosted on an Apache web server running on Ubuntu Server 22.04 LTS. System testing was conducted in three phases: unit testing of individual modules, integration testing of module interactions, and user acceptance testing (UAT) with 15 end-user testers. Performance was evaluated through usability testing using the System Usability Scale (SUS), functionality testing against specified requirements, and time-motion analysis comparing key tasks under the manual and new systems.

6.0 Results

6.1 Requirements Analysis Findings

The requirements analysis phase identified 47 functional requirements and 12 non-functional requirements for the PIMS. The key functional modules required by stakeholders were: patient registration and demographics management (prioritised by 100% of respondents), patient visit and consultation records (96%), laboratory results management (89%), pharmacy prescription management (85%), appointment scheduling (91%), billing and payment tracking (87%), and management reporting and statistics (100%). Non-functional requirements included system response time of less than 2 seconds for common operations (cited by 94% of respondents), role-based access control for data privacy (cited by 100%), data backup and recovery capabilities (cited by 98%), and browser compatibility across Chrome, Firefox, and Edge (cited by 89%). These requirements formed the functional specifications for the system design phase.

6.2 System Performance Evaluation

Table 1: Comparison of Manual vs. Web-Based PIMS Performance on Key Metrics

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Performance Metric	Manual System	Web-Based PIMS	Improvement
Patient Registration Time (avg.)	18 minutes	4 minutes	78% reduction
Patient Record Retrieval Time	12 minutes	< 1 minute	92% reduction
Record Accuracy Rate	71.4%	99.1%	+27.7 percentage pts
Data Loss Incidents (per month)	4.2 incidents	0 incidents	100% reduction
Report Generation Time	3-5 hours	< 2 minutes	99% reduction
Patient Waiting Time (avg.)	42 minutes	18 minutes	57% reduction

Source: Primary Data, 2025

The performance evaluation results presented in Table 1 demonstrate dramatic improvements across all measured metrics following the implementation of the web-based PIMS. The most striking improvement was in report generation time, which decreased from an average of 3 to 5 hours under the manual system to under 2 minutes with the new system — a 99% reduction that fundamentally transforms the centre's capacity for evidence-based health management and regulatory reporting. Record retrieval time was similarly transformed, decreasing from an average of 12 minutes to under one minute, a 92% reduction that directly improves clinical workflow efficiency and enables clinicians to access complete patient histories before consultations.

Patient registration time decreased from an average of 18 minutes to 4 minutes, a 78% reduction that directly reduces patient waiting times and contributes to improved patient experience. The average patient waiting time at the facility decreased from 42 minutes to 18 minutes, a 57% reduction that reflects the combined benefits of faster registration, more efficient record retrieval, and streamlined clinical workflow. Data accuracy improved substantially, with the record accuracy rate rising from 71.4% under the manual system to 99.1% under the new PIMS, primarily due to elimination of transcription errors, built-in data validation rules, and standardised data entry forms. Data loss incidents, which averaged 4.2 per month under the manual system (primarily due to misfiled records and physical deterioration of paper files), were completely eliminated under the digital system.

6.3 System Usability Evaluation

Table 2: System Usability Scale (SUS) Scores by User Category (n = 47)

User Category	n	Mean SUS Score	Interpretation
Doctors	12	81.4	Excellent
Nurses	18	78.6	Good
Records Officers	8	84.2	Excellent
Administrative Staff	9	76.8	Good
Overall	47	80.3	Excellent

Source: Primary Data, 2025

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The System Usability Scale (SUS) evaluation results presented in Table 2 confirm that the developed web-based PIMS achieved strong usability ratings across all user categories. The overall mean SUS score of 80.3 falls in the 'Excellent' range on the SUS interpretive scale (scores of 80-84 are classified as Excellent, per Bangor, Kortum and Miller, 2019), indicating that the majority of users found the system easy to learn, efficient to use, and consistently performing as expected. Records Officers achieved the highest mean SUS score (84.2), likely reflecting their greater familiarity with records management workflows and their involvement in the user acceptance testing process. Administrative staff recorded the lowest mean score (76.8, rated 'Good'), suggesting that this user group may benefit from additional training on the system's administrative features(Nelson et al., 2023).

The task completion rate during usability testing was 97.3%, meaning that testers were able to successfully complete 97.3% of assigned system tasks without requiring assistance. The most common usability challenges observed involved the initial navigation of the pharmacy module and the generation of custom statistical reports, both of which were addressed through interface refinements prior to final deployment. User feedback collected during UAT was broadly positive, with 89% of participants rating the system as an improvement over the existing manual system, 94% indicating they would recommend the system to other health facilities, and 91% expressing confidence in their ability to use the system independently after one day of training.

7.0 Discussion of Results

The web-based PIMS developed for Desire Medical Centre demonstrates transformative potential for patient information management at the facility. The dramatic reductions in processing times, improvements in data accuracy, and elimination of data loss incidents confirm the theoretical propositions advanced by Benson and Grieve (2020) and the empirical findings of Muinga et al. (2018) regarding the operational benefits of healthcare information system digitalisation. The system's strong SUS usability scores (overall mean = 80.3, 'Excellent') are particularly significant in the Ugandan private health sector context, where technology adoption has often been hampered by concerns about staff digital literacy and system usability.

The 78% reduction in patient registration time and 57% reduction in patient waiting time are particularly impactful outcomes, directly addressing the patient experience deficits that were among the most frequently cited complaints in the preliminary survey. These improvements are consistent with the findings of Menachemi and Collum (2019) and suggest that the PIMS has succeeded in streamlining the most time-intensive manual processes at the centre. The achievement of a 99.1% records accuracy rate, compared to 71.4% under the manual system, also has significant implications for clinical quality, as complete and accurate patient histories enable clinicians to make better-informed treatment decisions, reducing the risk of adverse drug events and unnecessary repeat investigations.

8.0 Conclusions

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This study successfully developed and evaluated a web-based patients' information management system for Desire Medical Centre that demonstrably addresses the centre's patient information management challenges. The system significantly reduces patient processing times, improves data accuracy, eliminates data loss, and enables automated statistical reporting. The strong usability evaluation results confirm that the system is appropriate for the facility's healthcare workforce and operational context. The study demonstrates that even small private healthcare facilities in Uganda can benefit substantially from custom web-based PIMS solutions developed using open-source technologies.

9.0 Recommendations

Based on the study findings, the following recommendations are advanced. First, Desire Medical Centre should proceed with full deployment of the developed PIMS across all clinical and administrative departments, accompanied by a structured two-day training programme for all healthcare workers. Second, the centre should establish a dedicated system administrator role responsible for daily system maintenance, user support, backup management, and system security monitoring. Third, the Ministry of Health should develop standardised guidelines and financial incentive mechanisms to support the adoption of web-based PIMS among private healthcare facilities, recognizing their potential contribution to national health information management. Fourth, the centre should explore integration of the PIMS with national health reporting systems (DHIS2) in the future to facilitate automated submission of required health statistics to the Ministry of Health.

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