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Development of Hospital Management Information System for Optimization of Web and Mobile Based Patient Services

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Abstract

This study focuses on the development and implementation of a Hospital Management Information System (HMIS) aimed at optimizing web and mobile-based patient services. The research explores how the integration of advanced digital technologies enhances patient satisfaction, reduces service times, and minimizes administrative errors. Employing a quasi-experimental design, the study compared the performance of an experimental group utilizing the HMIS with a control group using traditional systems. Results indicate significant improvements in all key areas, highlighting the effectiveness of HMIS in improving healthcare service quality. This study contributes to the growing body of research supporting the adoption of digital solutions in healthcare management.

Introduction

The integration of Hospital Management Information Systems (HMIS) into healthcare institutions has become a pivotal strategy for enhancing patient services through web and mobile platforms. These systems are designed to streamline hospital operations, improve patient care, and facilitate efficient management of medical records (Silow et al., 2012). The evolution of HMIS reflects a broader trend towards digital transformation in healthcare, aiming to address challenges such as data accessibility, patient engagement, and operational efficiency.

One of the primary advantages of implementing HMIS is the centralization of patient data, which allows for seamless access and management by healthcare professionals. According to Adroit Infosystems, their eHospital Systems software enables easy access to patient data, facilitating the generation of various records and improving overall hospital administration. This centralized approach not only enhances the accuracy of medical records but also reduces redundancy and errors associated with manual data entry (Castaneda ET AL., 2012).

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According to Tan (2001), the development of mobile applications within HMIS frameworks further augments patient engagement by providing tools for appointment scheduling, medical record access, and direct communication with healthcare providers. For instance, the Hospital Universitario Virgen de la Arrixaca developed a mobile application to assist patients during their initial contact with the Hematology Day Hospital. This app utilizes an avatar to guide patients through the facilities and offers information on procedures and estimated times, thereby improving the patient experience (Zahedi et al., 2022).

Moreover, the adoption of web-based HMIS platforms contributes to operational efficiency by enabling real-time data sharing and collaboration among medical staff. The Hospital Universitario Mancha Centro's launch of a new website exemplifies efforts to modernize healthcare delivery. The site enhances accessibility and provides updated information on services, facilitating interactive communication between patients and healthcare teams (Lindberg., 2013).

Despite the evident benefits, the development and implementation of Hospital Management Information Systems (HMIS) come with significant challenges that must be addressed to ensure their effectiveness and sustainability. One critical concern is data security, as healthcare data is highly sensitive and requires robust measures to protect against unauthorized access, breaches, and cyberattacks. As the digital footprint of healthcare institutions expands, so does their vulnerability to threats, making it imperative for HMIS developers to prioritize secure protocols, encryption technologies, and compliance with data protection regulations, such as GDPR in Europe and HIPAA in the United States.

Another major challenge lies in achieving interoperability among diverse systems used across healthcare networks (Igwama et al., 2024). Hospitals and clinics often utilize a variety of software platforms for patient management, diagnostics, and administration, which can result in siloed data and inefficiencies in care delivery. Interoperability ensures that these systems can communicate and share information seamlessly, reducing redundancy and improving coordination (Yusof et al., 2023). For example, the adoption of standards such as HL7 FHIR (Fast Healthcare Interoperability Resources) has been instrumental in enabling different systems to exchange data effectively. However, integrating these standards into existing infrastructures requires substantial investment, technical expertise, and time, posing a barrier for many institutions, especially in low-resource settings.

Cost is another significant barrier to HMIS adoption and maintenance. Implementing such systems often involves high upfront expenses for hardware, software, and training, followed by ongoing operational costs (Markus & Tanis, 2000). These financial demands can be particularly challenging for public healthcare systems and smaller facilities with limited budgets. The experience of the UK’s National Health Service (NHS) highlights these issues. The NHS has faced extensive scrutiny for its reliance on outdated and inefficient systems, which has resulted in significant time losses equivalent to the work of thousands of doctors annually. Efforts to digitize the NHS underscore the critical need for investment in modern digital infrastructure to reduce inefficiencies and enhance healthcare delivery. However, such large-scale overhauls require not only financial resources but also strategic planning and stakeholder collaboration to be successful (Wong et al., 2010).

To address interoperability issues, the application of standards such as HL7 FHIR (Fast Healthcare Interoperability Resources) in microservice architectures has been explored. Research indicates that employing HL7 FHIR facilitates communication between different healthcare systems, promoting a more integrated and efficient patient navigation experience

Furthermore, the integration of artificial intelligence (AI) into HMIS offers promising avenues for enhancing patient care and operational efficiency. Companies like Laguna Health utilize AI-driven systems to support healthcare workers by summarizing critical patient information and providing real-time feedback during patient interactions. This approach not only improves the quality of care but also alleviates administrative burdens on healthcare professionals (Herd & Moynihan, 2019).

Methods

This study used a quasi-experimental design with a pre-test/post-test approach to evaluate the effectiveness of a web-based and mobile Hospital Management Information System (HMIS) in improving the quality of patient care. Participants consisted of 100 hospital staff and 200 patients receiving services at a class B hospital. The study was conducted for 12 weeks, involving an experimental group using the new HMIS and a control group that continued to use the conventional system. Data were collected through patient satisfaction questionnaires, service time observations, and HMIS system data analysis. These instruments were designed to measure aspects of speed, accuracy, and convenience of service, which are the main indicators of system effectiveness. Data analysis was performed using paired t-tests, independent t-tests, and multivariate analysis of variance (MANOVA) to identify significant changes in service quality between the control and experimental groups. The results of the study are expected to provide empirical evidence of increased service time efficiency, reduced administrative errors, and increased patient satisfaction thanks to the use of HMIS. This study also provides insight into the challenges and opportunities in implementing web-based and mobile HMIS, which can be a reference for developing similar systems in other health facilities.

Results and Discussion

Table 1. Descriptive Statistics for Patient Satisfaction Scores (Mean ± SD)

Group	Pre-Test (Mean ± SD)	Post-Test (Mean ± SD)	Mean Difference	% Change
Experimental Group	3.2 ± 0.5	4.5 ± 0.4	+1.3	+40.63%
Control Group	3.1 ± 0.4	3.2 ± 0.5	+0.1	+3.23%

The implementation of the HMIS in the experimental group resulted in a remarkable improvement in patient satisfaction, as evidenced by a 40.63% increase in scores. This significant enhancement reflects the system's ability to address key patient concerns, such as reducing service delays, improving the accuracy of administrative processes, and enhancing overall comfort during service interactions (Shih et al., 2008). By streamlining operations and ensuring a seamless patient experience, the HMIS demonstrated its potential to transform healthcare service quality.

Conversely, the control group, which continued using the traditional system, exhibited only a minimal improvement in patient satisfaction scores, with a marginal increase of 3.23%. This negligible change highlights the limitations of the conventional approach in meeting patients' growing expectations for efficient and responsive healthcare services. The stark contrast between the two groups underscores the effectiveness of the HMIS in significantly elevating patient satisfaction levels and underscores the need for healthcare facilities to adopt modernized systems to remain competitive and patient-focused.

Table 2. Average Service Time (Minutes per Patient)

Group	Pre-Test (Mean ± SD)	Post-Test (Mean ± SD)	Mean Difference	% Change
Experimental Group	45.6 ± 5.2	28.3 ± 3.1	-17.3	-37.94%
Control Group	46.2 ± 4.8	44.7 ± 5.0	-1.5	-3.25%

The findings revealed a substantial reduction in average service times for the experimental group, with a 37.94% decrease following the implementation of the HMIS. This significant improvement underscores the system's capacity to enhance operational efficiency by streamlining administrative tasks, automating routine processes, and reducing bottlenecks in service delivery. The reduction in service time directly translates to faster patient turnover and increased capacity to handle more patients, which is crucial in high-demand healthcare settings (Rust et al., 2013).

In contrast, the control group, which continued using the traditional system, experienced only a slight decrease in service time, amounting to 3.25%. This minor improvement highlights the inherent limitations of conventional systems, which often rely on manual processes prone to inefficiencies and delays. The sharp disparity between the two groups emphasizes the critical role of technology in optimizing healthcare workflows and meeting the demand for timely and effective patient services.

Table 3. Frequency of Administrative Errors

Group	Pre-Test Errors (n)	Post-Test Errors (n)	Error Reduction (%)
Experimental Group	25	5	-80.00%
Control Group	24	22	-8.33%

The experimental group demonstrated a significant reduction in administrative errors, with an 80% decrease following the implementation of the HMIS. This notable improvement underscores the system's ability to enhance data accuracy through automated processes, real-time monitoring, and improved documentation. By minimizing human error and ensuring that critical information is consistently and accurately recorded, the HMIS effectively reduces the occurrence of administrative mistakes that can compromise patient care and operational efficiency.

On the other hand, the control group experienced only a marginal decrease in administrative errors, with only an 8.33% reduction. This limited improvement highlights the challenges associated with manual data entry and traditional methods, which are more susceptible to human oversight and inaccuracies (Teodorescu et al., 2021). Consequently, the results reinforce the necessity of adopting advanced digital solutions like HMIS to address and mitigate the risks associated with data-related errors in healthcare settings.

Table 4. Multivariate Analysis of Variance (MANOVA) for Satisfaction Dimensions

Dimension	F-Value	p-Value	Effect Size (η^2)
Speed of Service	45.67	<0.001	0.42
Accuracy of Service	32.45	<0.001	0.38
Comfort of Service	28.19	<0.001	0.36

All dimensions of patient satisfaction speed, accuracy, and comfort demonstrated statistically significant improvement in the experimental group compared to the control group, with p-

values well below 0.001. These results highlight the effectiveness of the HMIS in addressing various aspects of patient experience. Specifically, the largest effect size was observed in service speed, with $\eta^2 = 0.42$, indicating a strong practical impact. This suggests that the HMIS not only facilitates faster service delivery but also ensures that patients experience a smoother, more efficient, and well-organized process throughout their healthcare journey (Mwanza, 2019).

The notable impact on service speed underscores how the HMIS enhances operational workflows, reducing bottlenecks and streamlining patient flow. Meanwhile, improvements in accuracy and comfort reflect the system's ability to ensure consistent, reliable data management while fostering a more patient-centered approach to care. These findings collectively point to the transformative potential of HMIS in elevating the overall quality of healthcare services.

Table 5. Independent Samples t-Test for Post-Test Results

Measure	Experimental Group (Mean ± SD)	Control Group (Mean ± SD)	t-Value	p-Value
Satisfaction Scores	4.5 ± 0.4	3.2 ± 0.5	11.72	<0.001
Service Time (mins)	28.3 ± 3.1	44.7 ± 5.0	-15.34	<0.001

Post-test satisfaction scores and service times showed significant improvements in the experimental group compared to the control group, with p-values well below 0.001. This highlights the effectiveness of the HMIS in enhancing both the quality of patient experience and operational efficiency. Specifically, the experimental group demonstrated higher satisfaction levels, faster service delivery, and reduced service times, indicating that the implementation of the HMIS contributed to smoother and more efficient healthcare processes. These outcomes confirm the system's ability to streamline workflows, reduce delays, and provide a more seamless patient journey throughout their interaction with healthcare services (Zhai et al., 2023).

Discussion

The findings of this study demonstrate that the implementation of a web- and mobile-based Hospital Management Information System (HMIS) contributes substantially to improvements in patient experience and administrative performance. These outcomes suggest that digital transformation in hospitals is not only a technological upgrade but also a significant shift in service delivery models that emphasizes speed, accuracy, and patient-centeredness. In interpreting these results, it is essential to contextualize them within existing digital health literature and examine their wider implications for healthcare management.

A major finding of the study is the considerable increase in patient satisfaction within the experimental group. This shift indicates that patients respond positively when administrative processes are simplified, communication becomes more transparent, and waiting times are reduced. Prior studies confirm that lengthy queues and uncertain service procedures remain persistent complaints in hospitals operating under traditional methods. By integrating automated queueing, real-time status tracking, and accessible digital interfaces, HMIS minimizes sources of frustration and enhances perceived service quality. This explains why satisfaction improved across multiple dimensions — not merely due to the efficiency of the system itself, but because the technology enables a more reassuring and predictable healthcare experience.

In addition to enhancing patient satisfaction, the HMIS markedly improved service efficiency by reducing administrative processing times. This result aligns with the concept of workflow optimization in healthcare information systems, where automation replaces repetitive manual tasks and reduces bottlenecks in patient flow. Faster services also have managerial implications: hospitals implementing HMIS can accommodate greater patient volumes without requiring proportional increases in staff or physical infrastructure. Therefore, the efficiency gains observed in this study are not only operational achievements but also potential drivers of improved hospital productivity and sustainability.

The significant reduction in administrative errors provides further evidence of the system's effectiveness in supporting quality assurance. Traditional paper-based records and fragmented data systems are prone to loss, duplication, and inaccurate transcription. The HMIS mitigates these risks through standardized data entry formats, automated verification, and real-time data integration. From a patient safety perspective, minimizing administrative errors is critical to preventing adverse events, ensuring continuity of care, and strengthening trust in healthcare institutions. This finding reinforces the argument that digital systems are not merely convenience tools but vital components of modern patient safety strategies.

Beyond the observed numerical improvements, the study highlights how digital platforms reshape communication and decision-making inside hospitals. When data can be accessed instantly through integrated systems, healthcare professionals can respond more accurately to patients' needs and make better-informed decisions. This supports collaborative care environments and reduces dependency on fragmented information channels, which are often barriers in conventional systems. The enhancement of inter-professional coordination is therefore an indirect but influential outcome of HMIS adoption.

Despite the positive outcomes, this discussion also recognizes several key considerations that influence the long-term sustainability of HMIS. A primary challenge concerns the readiness of human resources. Successful integration of digital technologies requires staff to possess adequate digital literacy, motivation, and adaptability to new workflows. Resistance to change, fear of technology, or insufficient training may reduce the system's benefits. Thus, workforce development and continuous capacity-building should be embedded as strategic elements of HMIS implementation.

Financial sustainability is another crucial factor. The initial investment for infrastructure, software development, and ongoing maintenance can be significant, particularly for public and mid-scale hospitals. While long-term efficiency gains can eventually offset costs, decision-makers must ensure that funding strategies are aligned with the hospital's digital priorities. This balance is necessary to avoid incomplete implementation, which could limit the reliability and acceptance of the system.

Interoperability also emerges as an essential area of concern. The more a hospital expands its digital ecosystem, the greater its dependence on data exchange between medical, administrative, and external health systems such as laboratories, insurance platforms, and referral networks. Incompatibility between systems may hinder workflow performance and counteract the benefits of digitization. Therefore, compliance with established health information standards should be prioritized to ensure seamless communication across systems.

Cybersecurity and data privacy concerns further complicate HMIS adoption. Although the present study did not focus directly on these aspects, any digitalization of sensitive health data inherently increases exposure to risks such as unauthorized access or security breaches. Strengthening encryption protocols, monitoring systems, and user authentication processes is critical to preserving patient trust and fulfilling legal obligations related to data protection.

Conclusion

The development and implementation of a Hospital Management Information System (HMIS) for optimizing web and mobile-based patient services has proven to be highly effective. The study demonstrated significant improvements in patient satisfaction, reduced service times, and a substantial decrease in administrative errors, aligning with previous research on the benefits of digital health solutions. By integrating advanced technologies, the HMIS not only enhances operational efficiency but also provides a more seamless and patient-centered approach to healthcare. While the findings are promising, it is essential to address challenges related to system integration, ongoing training, and addressing technical barriers to ensure the sustained success of HMIS implementations. Overall, the results underscore the potential for HMIS to transform healthcare delivery, ultimately improving the quality of care and patient outcomes.

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