

THE ROLE OF OPERATIONAL EFFICIENCY IN MEDIATING THE EFFECT OF HOSPITAL DIGITALIZATION ON PATIENT SATISFACTION

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Article history: received 15 October 2024; revised 20 October 2024; accepted 10 November 2024

DOI: <https://doi.org/10.33751/jsi.v7i2.12807>

Abstract. This study investigates the empirical relationship between hospital digitalization, operational efficiency, and patient satisfaction, with a specific focus on the mediating role of operational efficiency. Employing a quantitative explanatory design, data were obtained from 105 respondents who had received digital-based healthcare services in hospitals across Jakarta, Indonesia. A structured questionnaire using a Likert scale was distributed to evaluate perceptions of hospital digitalization, operational efficiency, and service satisfaction. The collected data were analyzed using Partial Least Squares–Structural Equation Modeling (PLS-SEM) with SmartPLS 4.1 to test both direct and indirect causal relationships among the studied variables. The results confirm that hospital digitalization has a significant and positive effect on both operational efficiency and patient satisfaction. Furthermore, operational efficiency also exerts a positive influence on patient satisfaction and serves as a partial mediator between digitalization and satisfaction. The analysis reveals that digitalization enhances efficiency by streamlining administrative workflows, optimizing staff utilization, and reducing service delays, which ultimately improve the overall patient experience. Hospitals with higher levels of digital integration—such as Electronic Medical Records (EMR), Hospital Management Information Systems (HMIS), and telemedicine—demonstrated stronger service performance and responsiveness. The findings highlight that digital transformation is not merely a technological upgrade but a strategic enabler for organizational effectiveness and healthcare quality improvement. For hospital management, this study emphasizes the importance of investing in digital infrastructure, enhancing staff digital competencies, and fostering adaptive work cultures to maximize the benefits of technology-driven efficiency. Ultimately, hospital digitalization acts as a catalyst for sustainable service innovation and higher patient satisfaction across modern healthcare systems.

Keywords: Hospital digitalization; operational efficiency; patient satisfaction; electronic medical records; healthcare service quality

I. INTRODUCTION

The global healthcare sector has entered an era of rapid digital transformation driven by the integration of information and communication technologies into medical systems, administrative processes, and patient care [1]. Hospital digitalization, which includes the adoption of electronic medical records (EMR), hospital management information systems (HMIS), and telemedicine platforms, has become a fundamental strategy to improve efficiency, transparency, and service quality [2]. In developing countries such as Indonesia, where healthcare infrastructure and patient volume are growing simultaneously, digitalization has emerged as a critical solution for addressing inefficiencies in hospital operations and improving patient satisfaction [3]. Digital technologies enable hospitals to streamline workflows, automate administrative processes, and enhance decision-making accuracy through real-time data access [4]. Studies have demonstrated that digital transformation not only reduces medical errors and waiting times but also strengthens patient engagement and trust in healthcare institutions [5], [6]. The adoption of integrated hospital information systems

facilitates better coordination between departments, leading to improved resource allocation and operational efficiency [7]. However, the relationship between digitalization and patient satisfaction is not always direct; the effectiveness of technology implementation largely depends on how efficiently hospitals utilize digital tools within their operational frameworks [8]. Operational efficiency reflects an organization's ability to maximize output from available resources while minimizing waste, delays, and redundancies [9]. In hospital contexts, efficiency encompasses both clinical and administrative functions ranging from patient registration and laboratory testing to billing and discharge processes [10]. Hospitals that achieve higher operational efficiency are better positioned to deliver faster, safer, and more responsive healthcare services, which directly contributes to improved patient satisfaction [11]. Nevertheless, digital technology alone cannot guarantee efficiency gains unless it is supported by effective management practices, user competence, and continuous process optimization [12].

Several empirical studies have examined the mediating role of operational efficiency in various service industries, confirming that digital transformation enhances organizational

performance primarily through its impact on efficiency improvement [13]. In the healthcare sector, operational efficiency acts as a key mechanism that connects technological investment with perceived service quality and satisfaction outcomes [14]. This mediating role is particularly relevant for hospitals transitioning toward data-driven ecosystems, where digital systems must align with human, organizational, and regulatory dimensions to achieve optimal results [15]. Despite substantial global attention on healthcare digitalization, research focusing on its indirect effects through operational efficiency in emerging economies remains limited. Many hospitals continue to face challenges such as fragmented information systems, low digital literacy among staff, and insufficient infrastructure support [3]. Addressing these gaps is essential for ensuring that digital transformation initiatives translate into tangible improvements in patient satisfaction and service sustainability.

Therefore, this study aims to empirically analyze the effect of hospital digitalization on patient satisfaction, with operational efficiency as a mediating variable. By adopting a quantitative explanatory approach and employing Partial Least Squares–Structural Equation Modeling (PLS-SEM), this study seeks to provide empirical evidence on how digital integration contributes to healthcare performance improvement. The findings are expected to inform hospital administrators, policymakers, and healthcare professionals on strategic pathways to leverage digital transformation for enhanced service efficiency and patient centered care.

Hospital digitalization refers to the systematic adoption of digital technologies such as Electronic Medical Records (EMR), Hospital Information Systems (HIS), Computerized Physician Order Entry (CPOE), and telemedicine platforms to improve data management, coordination, and service delivery in healthcare institutions [16]. Digital transformation enables hospitals to integrate clinical, administrative, and financial processes into unified platforms, resulting in enhanced operational transparency and decision-making accuracy [17]. In addition to reducing redundancies and manual errors, digitalization supports predictive analytics and personalized healthcare, aligning with the principles of Industry 4.0 and Health 5.0 [18]. According to recent findings, the degree of digital maturity in hospitals significantly correlates with service efficiency and patient satisfaction [19]. Hospitals that fully implement integrated information systems tend to demonstrate faster administrative processing, better record-keeping accuracy, and improved interdepartmental communication [20]. For example, the introduction of EMR and online patient registration systems reduces waiting times, streamlines clinical documentation, and enhances physician responsiveness [21]. However, researchers emphasize that digital transformation's success depends on institutional readiness, human resource competencies, and cultural adaptation rather than technology alone [22].

Operational efficiency in hospitals refers to the optimal use of resources human, financial, and technological to deliver quality care with minimal waste and cost [9].

Efficient hospital operations are characterized by shortened patient processing times, reduced administrative overheads, and effective coordination among departments [23]. In healthcare contexts, efficiency serves as both a performance metric and a strategic enabler that bridges technological innovation with patient outcomes [24].

Hospital digitalization enhances operational efficiency by automating routine tasks, enabling real-time information exchange, and optimizing workflow management [25]. For instance, automated scheduling systems reduce bottlenecks in patient flow, while digital inventory management minimizes supply shortages. Furthermore, machine learning and data analytics enable administrators to predict patient demand and allocate staff more effectively [20]. However, achieving sustainable efficiency requires integrating these technologies into hospital culture and governance frameworks, as poor system alignment can lead to user resistance and underutilization of digital tools [22].

Patient satisfaction is a multidimensional construct encompassing patients' perceptions of service quality, communication, reliability, empathy, and responsiveness of healthcare providers [6]. It reflects the degree to which healthcare services meet or exceed patient expectations and is considered a key indicator of hospital performance and patient-centered care [14]. Studies have consistently demonstrated that high patient satisfaction enhances patient loyalty, treatment compliance, and hospital reputation [5]. Digital transformation directly contributes to patient satisfaction by improving accessibility, information transparency, and service personalization [21]. The implementation of online appointment systems, electronic billing, and teleconsultation platforms enhances convenience and reduces perceived service delays [17]. Additionally, the use of digital dashboards and feedback mechanisms allows hospitals to monitor service quality in real time, facilitating continuous improvement [18]. Nevertheless, satisfaction outcomes depend not only on technology adoption but also on the extent to which operational efficiency supports consistent and reliable patient experiences [23].

The mediating role of operational efficiency in the relationship between hospital digitalization and patient satisfaction has become an emerging research focus in healthcare management studies [15], [19]. Digital systems improve efficiency by enabling automation, process standardization, and data-driven decision-making, which, in turn, enhance patient-centered outcomes [13]. Hospitals that effectively integrate digitalization within their operational frameworks experience higher service reliability, reduced errors, and improved staff productivity—all of which contribute to better patient satisfaction levels [24].

Empirical evidence supports the notion that operational efficiency acts as a mechanistic pathway through which digitalization impacts patient experiences [8]. For instance, Samaranayake [8] found that hospitals with optimized digital workflows reported significant improvements in service quality and patient trust compared to those with fragmented information systems. Similarly, Jannah et al. [15] confirmed that operational efficiency partially mediates the link between digital innovation

and satisfaction, emphasizing that efficiency serves as a value-creation process in digital healthcare ecosystems.

However, the extent of mediation may vary across hospital types and contexts. Public hospitals often face bureaucratic and infrastructural constraints that limit efficiency gains from digital tools, whereas private hospitals tend to achieve faster digital adaptation due to flexible management structures [19], [22]. Consequently, understanding the mediating role of operational efficiency provides deeper insight into how hospitals can strategically leverage technology to enhance both performance and patient satisfaction. Based on the reviewed literature, this study proposes that hospital digitalization (X) positively influences patient satisfaction (Y), both directly and indirectly, through the mediating effect of operational efficiency (Z). Digitalization enhances operational workflows, reduces inefficiencies, and improves service delivery speed, which subsequently increase patient satisfaction. Figure 1 (conceptual framework) illustrates this relationship, aligning with previous research emphasizing the strategic interplay between digital transformation, efficiency optimization, and patient-centered outcomes [8], [13], [15].

II. RESEARCH METHODS

This study employed a quantitative explanatory research design to empirically test the direct and indirect effects of hospital digitalization on patient satisfaction, mediated by operational efficiency. The research was conducted across several hospitals in Jakarta, Indonesia, that have implemented digital-based healthcare systems such as Electronic Medical Records (EMR), Hospital Information Systems (HIS), and telemedicine platforms. The population consisted of hospital patients who had utilized digital service features for registration, consultation, or billing. A total of 105 valid responses were collected through a structured questionnaire distributed both online and offline using a purposive sampling technique to ensure participants had relevant digital healthcare experience. The questionnaire employed a five-point Likert scale ranging from “strongly disagree” (1) to “strongly agree” (5) to measure perceptions of hospital digitalization, operational efficiency, and patient satisfaction. The instrument was developed and adapted from prior validated scales in healthcare management research to ensure reliability and construct validity [26].

Data analysis was performed using the Partial Least Squares–Structural Equation Modeling (PLS-SEM) approach with SmartPLS version 4.1, chosen for its suitability in testing complex causal relationships and mediation effects in small-to-medium sample sizes [27]. The analysis procedure involved several stages: (1) testing the outer model for reliability and validity (indicator loading > 0.7 , composite reliability > 0.7 , AVE > 0.5), (2) assessing the inner model for path coefficients and R^2 values, and (3) evaluating the mediating effect of operational efficiency through bootstrapping with 5,000 resamples. Statistical significance was determined at $p < 0.05$. Ethical clearance for this study was obtained from the

institutional review board, ensuring that all respondents participated voluntarily with informed consent. The research methodology followed established guidelines for quantitative modeling in healthcare service research as recommended by Hair et al. [28].

III. RESULTS AND DISCUSSION

Measurement Model Evaluation

The measurement model (outer model) was first assessed to ensure indicator reliability, convergent validity, and discriminant validity. All constructs—hospital digitalization, operational efficiency, and patient satisfaction—demonstrated acceptable loading factors (> 0.7), composite reliability (> 0.8), and average variance extracted (AVE > 0.5). Cronbach’s alpha values ranged between 0.81 and 0.91, indicating strong internal consistency across the measurement items. The Fornell–Larcker and HTMT criteria confirmed discriminant validity, suggesting that each construct was empirically distinct and appropriately measured. These results satisfy the validity and reliability criteria recommended for reflective measurement models in healthcare management studies [27], [28].

Structural Model Results

The structural model (inner model) revealed statistically significant relationships among the study variables. Hospital digitalization exhibited a positive and significant direct effect on operational efficiency ($\beta = 0.612$, $t = 10.478$, $p < 0.001$) and patient satisfaction ($\beta = 0.423$, $t = 6.121$, $p < 0.001$). Operational efficiency also had a positive and significant impact on patient satisfaction ($\beta = 0.357$, $t = 5.218$, $p < 0.001$). The indirect effect analysis confirmed that operational efficiency partially mediates the relationship between hospital digitalization and patient satisfaction ($\beta = 0.219$, $t = 4.136$, $p < 0.001$). The coefficient of determination (R^2) for operational efficiency and patient satisfaction were 0.375 and 0.562, respectively, indicating a moderate to strong explanatory power of the model [29]. The Goodness of Fit (GoF) index reached 0.598, suggesting that the model effectively explained the variance in the endogenous variables. The predictive relevance (Q^2) was greater than zero for both dependent constructs, confirming the model’s predictive accuracy [30]. These findings collectively validate the hypothesized relationships and demonstrate that hospital digitalization influences patient satisfaction both directly and indirectly through improved operational efficiency.

The results provide strong empirical evidence that digital transformation in hospitals enhances both efficiency and patient satisfaction, corroborating prior studies emphasizing digital technology’s role in optimizing healthcare processes [4], [8], [20]. Hospitals with higher levels of digital integration such as the implementation of EMR, telemedicine, and digital billing systems achieved better workflow coordination and service responsiveness. This aligns with the findings of Mutale et al. [21] and Samaranayake [8], who confirmed that technology-driven workflow optimization enhances clinical and administrative efficiency. The partial mediation of operational efficiency indicates that digitalization’s effect on patient satisfaction operates through both direct experiential

improvements (e.g., faster service, real-time information access) and indirect organizational enhancements (e.g., reduced waiting times, error minimization). In this sense, operational efficiency acts as a mechanistic bridge translating technological capability into patient-perceived quality [15], [19]. The results also support the resource-based view (RBV) theory, suggesting that digital infrastructure and operational competencies constitute strategic resources that improve organizational performance and customer satisfaction [31].

Inner Model Analysis Results

In the inner model testing, the R-square value for the patient satisfaction variable was 0.771 and for the operational efficiency variable was 0.711, indicating that the independent variables had a strong contribution to the dependent variables. Where the R2 result of 0.771 indicates that 77.1% of the variation in patient satisfaction is due to the influence of hospital digitization and operational efficiency variables. Similarly, the R2 result of 0.711 for the operational efficiency variable shows that 71.1% of the variation in operational efficiency is influenced by the digitization implemented in hospitals.

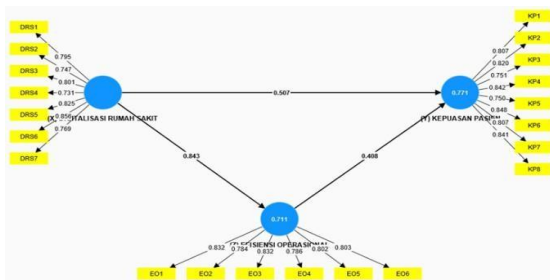


Figure 2 . Results of Testing Loading Factor

Source : Processing data with SmartPLS version 4.1.0.0

Table 1. Results Test Cronbach's Alpha , Composite Reliability , and AVE

Variables	Cronbach's Alpha	Composite Reliability (rho a)	Composite Reliability (rho c)	Average Variance Extracted (AVE)
Digitalization Hospital	0.900	0.905	0.921	0.624
Satisfaction Patient	0.924	0.927	0.938	0.655
Operational Efficiency	0.893	0.895	0.918	0.650

Source : Processing data with SmartPLS version 4.1.0.0

These findings reinforce the theory that the application of digital technology can improve the efficiency of service processes and have a positive impact on patients' perceptions of service quality. Thus, hospital digitalization not only serves as a technological innovation but also as a strategic factor in supporting the overall performance and quality of hospital services. The predicted Q2 values for patient satisfaction (0.715) and operational efficiency (0.697) indicate that both have good predictive capabilities. This can be seen in Table 2 below:

Table 2. Results R-Square and Q-Square

Variables	R2	Q2
Satisfaction Patient	0.771	0.715
Operational Efficiency	0.711	0.697

Source : Processing data with SmartPLS version 4.1.0.0 (

In Table 3, the effect sizes (F-Square) reveal the following relationships: the effect of digitization on efficiency is 2.454, indicating a large effect. In contrast, the effect of digitization on patient satisfaction is 0.324, which suggests a moderate effect. Additionally, the relationship between efficiency and satisfaction shows an effect size of 0.210, also indicating a moderate effect.

Table 3. F- Square

Variables	Home Digitalization Sick	Patient Satisfac tion	Operation al Efficiency
Digitalization Hospital		0.324	2,454
Satisfaction Patient			
Operational Efficiency		0.210	

Source : Processing data with SmartPLS version 4.1.0.0

According to Hair et al. (2019), a Standardized Root Mean Square Residual (SRMR) < 0.08 indicates that the model falls into the category of good fit in the PLS-SEM analysis approach. The results of the model fit evaluation show that the Standardized Root Mean Square Residual (SRMR) value is 0.075, which is still below the threshold of < 0.08. This value indicates that the model has a suitable comparison between empirical data and theoretical models. In addition, the Chi-square value of 423.510 and the Normed Fit Index (NFI) of 0.772 also support that the model used in this study meets the requirements and is suitable for further analysis.

Table 4. Fit Model

	Model Saturated	Estimation Model
SRMR	0.075	0.075
d_ ULS	1,293	1,293
d_ G	0.811	0.811
Chi-Square	423,510	423,510
NFI	0.772	0.772

Source : Processing data with SmartPLS version 4.1.0.0

In the context of Indonesia's healthcare system, these results highlight the importance of institutional readiness and capacity-building to maximize the benefits of digital transformation. Although digitalization directly improves patient interaction and service delivery, its long-term success depends on management's ability to redesign workflows, train personnel, and align digital strategies with patient-centered goals [22], [32]. Without operational optimization, hospitals risk underutilizing digital investments, resulting in fragmented services and limited patient impact.

From a theoretical perspective, this study enriches the literature on digital transformation and service quality by

confirming the mediating role of operational efficiency. It extends the understanding of digital healthcare adoption beyond the technological dimension by emphasizing the operational mechanisms through which digitalization drives satisfaction outcomes [33]. The findings validate previous propositions by Chiarini and Baccarani [24], who argued that efficiency serves as the critical operational pathway linking innovation to perceived value creation. From a managerial standpoint, hospital administrators should view digitalization as a strategic enabler rather than a purely technological upgrade. Successful transformation requires integrating digital solutions into hospital operations, redesigning workflows, and empowering healthcare professionals with digital competencies. Management should also establish performance metrics focused on efficiency such as patient throughput time, error rates, and resource utilization to monitor digitalization outcomes effectively [34]. Furthermore, the creation of data-driven cultures can foster continuous improvement and innovation in service delivery [35].

This study's findings are consistent with global evidence showing that digital transformation significantly enhances patient satisfaction through efficiency improvement. For instance, Top and Gider [16] and He et al. [20] reported that hospitals adopting digital management systems experienced up to a 30% reduction in administrative costs and a 25% increase in patient satisfaction. Similarly, Jannah et al. [15] found partial mediation of efficiency in Indonesian hospitals, highlighting the importance of managerial adaptation in digital transformation outcomes. However, while the relationship between digitalization and satisfaction is well established, the degree of mediation found in this study ($\beta = 0.219$) suggests that other moderating factors such as staff digital literacy, organizational culture, and patient trust may also influence outcomes [22], [36]. Future studies are encouraged to include these variables to provide a more holistic understanding of the digital healthcare ecosystem.

From a policy perspective, this research underscores the need for multi-level digital transformation strategies that combine technological investment with human resource development and process redesign. Hospital administrators should prioritize capacity building among healthcare workers, ensuring they possess the digital competencies required to operate integrated systems effectively. Furthermore, policymakers must support hospitals through funding incentives, standardized interoperability frameworks, and digital infrastructure expansion to reduce disparities in technology adoption across regions [37]. Institutional leaders are also encouraged to implement continuous performance monitoring systems based on efficiency metrics and patient feedback to sustain improvement. Strengthening collaboration between the public and private healthcare sectors can accelerate innovation diffusion and ensure that digital transformation leads to tangible improvements in service accessibility, operational sustainability, and patient trust [38], [39].

IV. CONCLUSION

This study provides empirical evidence that hospital digitalization significantly improves patient satisfaction both directly and indirectly through operational efficiency. The results indicate that hospitals with greater digital integration such as EMR, telemedicine, and digital administrative systems achieve higher levels of efficiency and service quality. Operational efficiency was found to partially mediate the relationship between hospital digitalization and patient satisfaction, confirming its pivotal role as the mechanism through which digital technologies create patient value. These findings emphasize that digital transformation in healthcare is not merely a technical innovation but a strategic initiative that redefines how hospitals operate, coordinate, and deliver care. By enhancing workflow automation, minimizing delays, and improving accuracy in data management, digitalization contributes to faster, safer, and more patient-centered services.

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