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Evaluating Determinants of Electronic Medical Record Implementation Effectiveness in a Regional Indonesian Hospital

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ABSTRACT

Introduction: Electronic Medical Record (EMR) implementation is a key component of digital transformation in healthcare. This study evaluated the perceived effectiveness of EMR implementation in a regional Indonesian hospital by examining three empirically measured determinants, namely efficiency, accuracy, and system quality. The objective was narrowed to provide evidence on how these factors predict perceived EMR effectiveness within a single-site, low-resource setting without extending to unmeasured constructs such as health literacy or health promotion.

Methods: A cross-sectional survey was conducted among 100 healthcare professionals using a structured, validated questionnaire. Data were analyzed using descriptive statistics, chi-square tests with effect sizes, and logistic regression with odds ratios and confidence intervals. Analyses examined how perceptions of efficiency, accuracy, and system quality predicted perceived EMR implementation effectiveness.

Results: Respondents reported high perceptions of efficiency (96%), accuracy (94%), and system quality (95%). All three determinants were significantly associated with perceived EMR effectiveness ($p < 0.001$), with effect sizes indicating strong relationships. Logistic regression showed that system quality had the largest effect size (OR=7.02; 95% CI 2.04–24.10), followed by efficiency (OR=5.83; 95% CI 1.85–18.41) and accuracy (OR=4.26; 95% CI 1.24–14.68). These results indicate that usability and reliability are central predictors of perceived implementation effectiveness in this context.

Conclusion: This single-site study provides empirical evidence on the determinants of perceived EMR implementation effectiveness in a regional Indonesian hospital. System quality emerged as the strongest predictor, emphasizing the need for user-friendly, reliable systems supported by training and governance. Because the study did not directly measure health literacy or health promotion outcomes, such impacts are identified as areas for future research rather than conclusions. The results offer practical guidance for improving EMR adoption and inform ongoing work in technology acceptance frameworks.

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INTRODUCTION

The digital transformation of healthcare systems has accelerated globally, with Electronic Medical Records (EMRs) becoming a core component of modern health information systems. EMRs enhance efficiency, data accuracy, and continuity of care, particularly in well-resourced settings (1,2). However, adoption remains uneven in regional and low-resource hospitals due to infrastructure gaps, workforce limitations, and challenges in system readiness. The COVID-19 pandemic further underscored the importance of digital tools for maintaining service continuity and improving clinical documentation (3). In this context, EMRs are primarily understood as operational and clinical systems, and broader concepts such as health literacy or health promotion—while relevant at the policy level—are not the empirical focus of this study.

In regional and low-resource settings, barriers to EMR implementation tend to be more pronounced. Limited IT infrastructure, workforce digital competency, and financial constraints frequently delay or weaken system deployment (4,5). Additional constraints such as connectivity problems, limited hardware availability, and poor system interoperability have been documented in Indonesian hospitals and other low- and middle-income countries. (6,7). While such barriers may indirectly influence a hospital's broader functions, including communication and patient engagement, they primarily shape the operational and technical feasibility of EMR adoption. Accordingly, the present study focuses on measured determinants of EMR implementation, rather than broader constructs such as health promotion or empowerment.

Indonesia has prioritized national EMR adoption through the Ministry of Health Regulation No. 24 of 2022, which mandates the transition to digital medical records across healthcare facilities (8). Despite this directive, many regional hospitals continue to face readiness gaps, including infrastructure limitations, inconsistent implementation timelines, and challenges related to change management (9-11) National platforms such as SATUSEHAT aim to standardize interoperability and support digital integration (10) (11) However, successful EMR adoption depends heavily on user acceptance, system quality, and organizational preparedness, factors consistently highlighted in Southeast Asian and broader LMIC studies. (12,13). current study therefore examines these determinants within a regional hospital context.

Persistent EMR implementation barriers in LMICs—including Indonesia—span technical, human resource, organizational, and policy-related domains (16-19). Limited digital literacy, insufficient training, and high staff turnover hinder system adoption, while organizational resistance and inconsistent leadership further reduce implementation success (13,17). Policy fragmentation and variable institutional readiness compound these challenges. Although such issues may have indirect implications for patient communication or educational activities, the present study focuses specifically on operational determinants of EMR effectiveness, not on broader health promotion outcomes (18).

Evidence from LMICs indicates that EMR implementation effectiveness is strongly influenced by three core dimensions: efficiency, accuracy, and system quality (17-21). Efficient systems improve workflow processes; accurate data support clinical decision-making and patient safety; and high system quality, including usability, responsiveness, and reliability, promotes user satisfaction and sustained adoption. (13,15,20). These dimensions form the empirical basis of the present study. While broader concepts such as patient education or behavioural change are often discussed in digital health literature, they were not measured in this research and therefore are not treated as study outcomes (11).

International evidence, including findings from Tanzania, Ethiopia, and Kenya, shows that infrastructure readiness, leadership engagement, and cultural fit are critical determinants of EMR adoption. (21). In LMIC settings more broadly, sustained IT support, workforce readiness, and digital literacy influence whether systems are effectively integrated into routine practice (22,23). Global digital health research also highlights the importance of interoperability and data governance for system scalability and reliability (11,23).

Despite growing national efforts toward digitalization, Southeast Asia still has limited empirical studies examining EMR implementation determinants in regional or resource-constrained hospitals (24-26). Research gaps relate to system readiness, user acceptance, interoperability, and data governance. Broader outcomes such as behaviour change or health literacy remain understudied and require separate methodological approaches. These gaps highlight the need for context-specific research focusing on measurable dimensions of EMR implementation, such as efficiency, accuracy, and system quality.

Within this context, the present study investigates the perceived effectiveness of EMR implementation at RSUD Nene Mallomo, a regional Class C hospital in South Sulawesi, Indonesia. By examining three empirically measurable determinants, namely efficiency, accuracy, and system quality, the study fills a gap in evidence on EMR implementation in underrepresented regional hospital settings. The study's contribution lies in providing context-specific insights into factors influencing perceived EMR effectiveness, aligned with Indonesia's national digital health policies. Broader concepts such as health literacy or health promotion are treated as contextual background and not as study outcomes, given that they were not measured empirically.

METHODOLOGY

Study Design

This study employed a quantitative cross-sectional design to examine determinants of perceived Electronic Medical Record (EMR) implementation effectiveness at RSUD Nene Mallomo, a regional Class C hospital in South Sulawesi, Indonesia. The design was selected for its suitability in capturing user perceptions at a single point in time and is commonly used in EMR adoption studies in low- and middle-income countries (27-29). The focus of this study is limited to measurable constructs, namely efficiency, accuracy, and system quality, and does not assess unmeasured outcomes such as health literacy or health promotion. Advanced designs such as longitudinal or quasi-experimental methods are acknowledged as potential approaches for future research.

Research Setting

The study was conducted at RSUD Nene Mallomo, a government-owned Class C regional hospital in Sidenreng Rappang Regency, South Sulawesi. The hospital operates within common constraints found in regional Indonesian healthcare facilities, including limited infrastructure, varied digital readiness, and heterogeneous user experience. These characteristics make it an appropriate setting for examining determinants of perceived EMR implementation effectiveness. References to broader outcomes such as health promotion or empowerment are treated as contextual background and were not assessed empirically.

Population and Sampling

The target population consisted of healthcare professionals actively using the EMR system, including physicians, nurses, pharmacists, and administrative personnel. Purposive sampling was applied to include only those with at least three months of EMR use to ensure adequate familiarity with the system. Of the 138 eligible staff, 112 were invited, and 100 completed the survey (response rate: 89.3%). The sample size met minimum recommendations for logistic regression and is comparable to similar EMR studies in Southeast Asia (27). This study examines perceived EMR effectiveness only and does not measure broader constructs such as health education or interprofessional collaboration.

Instrumentation

Questionnaire Design

A structured questionnaire was developed to measure four constructs, namely perceived efficiency, accuracy, system quality, and overall EMR implementation effectiveness. Items were rated on a 5-point Likert scale. The instrument focused exclusively on operational and technical dimensions; items related to health promotion or literacy were removed to maintain alignment with measured constructs. Pilot testing with 15 staff assessed clarity and relevance. Reliability analysis yielded a Cronbach's alpha of 0.86. A summary of items, factor loadings (>0.60), and subscale reliabilities is provided in an appendix to enhance transparency and replicability.

Reference to Existing Instruments

Reference to Existing Instruments the questionnaire was adapted from validated frameworks, including the Technology Acceptance Model (TAM), SERVQUAL, the National Usability-Focused Health Information System Scale (NuHISS), and the CAFP EHR Readiness Assessment (27,31,32).These instruments informed the operationalization of efficiency, accuracy, and system quality. References to health media or disease intervention strategies were not included, as these constructs were beyond the empirical scope of this study.

Validity and Reliability Procedures

Content validity was assessed through expert review by three academics specializing in health information systems. Exploratory factor analysis (EFA) was conducted to confirm construct structure, yielding factor loadings >0.60 for all retained items. Cronbach's alpha values for subscales ranged from 0.81 to 0.88. Sensitivity to health literacy or health promotion was not evaluated, as these constructs were not included in the measurement model.

Data Collection Procedures

Data were collected from December 2024 to January 2025 using both online (Google Forms) and paper-based questionnaires to accommodate varied staff schedules. Participants received written informed consent explaining study objectives, confidentiality protocols, and voluntary participation. The dual-mode approach minimized nonresponse bias and improved coverage; however, references to community empowerment or health promotion were removed as they were not examined empirically.

Data Analysis

Descriptive Statistics

Descriptive statistics were used to summarize participant demographics and the distribution of key variables. Analyses focused solely on operational perceptions of efficiency, accuracy, system quality, and overall EMR effectiveness. No analyses regarding health promotion or behaviour change were conducted.

Inferential Statistics

Chi-square tests ($\alpha = 0.05$) were used to assess associations between determinants and perceived EMR implementation effectiveness, with effect sizes reported using Cramer's V. Logistic regression was performed to identify predictors, reporting odds ratios, 95% confidence intervals, pseudoR^2 values, Hosmer–Lemeshow goodness-of-fit, and checks for multicollinearity. The analysis focused strictly on EMR operational outcomes, without extending to educational or promotional functions.

Advanced Analytical Approaches in Literature

While logistic regression was appropriate for the study's binary outcome, literature also highlights the value of structural equation modeling (SEM) and quasi-experimental approaches for examining EMR implementation processes(29,33). These advanced methods could strengthen future studies by enabling analysis of causal pathways and multi-dimensional system interactions. Their mention here is limited to informing future research, as the present study did not assess outcomes such as behaviour change or health promotion.

Ethical Considerations

Ethical clearance was obtained from the Ethics Committee of ITKeS Muhammadiyah Sidrap. Participants were informed of their right, including voluntary participation and withdrawal without consequences. Data were anonymized and stored securely. References to health literacy or empowerment initiatives were removed, as these outcomes were not measured.(11).

RESULTS

Characteristics of Respondents

The study engaged 100 healthcare professionals at RSUD Nene Mallomo, encompassing doctors, nurses, pharmacists, and administrative staff. Table 1 summarizes the demographic characteristics. Most respondents were female (83.0%), and the largest age group was 31–40 years (42.0%). Most participants held a bachelor's degree or professional equivalent (66.0%). These demographic distributions align with staffing patterns commonly reported in regional hospitals (21,29). They provide contextual information for understanding variation in user perceptions of EMR efficiency, accuracy, and system quality. References to broader constructs such as health literacy or staff empowerment have been removed, as these were not measured in the study.(30,31).

Table 1. Characteristics of Respondents at RSUD Nene Mallomo

No	Variable	Category	Frequency (n, %)
1	Age	20–30 years	22 (22.0%)
		31–40 years	42 (42.0%)
		41–50 years	26 (26.0%)
		51–60 years	10 (10.0%)
2	Gender	Male	17 (17.0%)
		Female	83 (83.0%)
3	Education	Senior High School	1 (1.0%)
		Diploma III	25 (25.0%)
		Bachelor/Nurse/Midwife	66 (66.0%)
		Master Degree	8 (8.0%)

The demographic profile suggests that age, educational background, and professional role may influence perceptions of EMR implementation. Prior literature indicates that older staff may face greater challenges in adapting to digital systems, while educational attainment often correlates with higher digital confidence (21). These observations provide contextual interpretation only; the study did not directly measure digital literacy, training needs, or empowerment-related constructs.

Distribution of EMR-Related Variables

Respondents reported overwhelmingly positive perceptions of EMR Efficiency (96.0%), accuracy (94.0%), and system quality (95.0%) were all rated highly. Perceived overall EMR effectiveness was also high (91.0%) (Table 2). These distributions indicate a pronounced positive skew, suggesting a potential ceiling effect that may limit variability in responses, a limitation addressed in the discussion(25,32).

Table 2. Distribution of EMR Variables

No	Variable	Category	Frequency (n, %)
1	Efficiency	Effective	96 (96.0%)
		Ineffective	4 (4.0%)
2	Accuracy	Effective	94 (94.0%)
		Ineffective	6 (6.0%)
3	Quality	Effective	95 (95.0%)
		Ineffective	5 (5.0%)
4	Effectiveness	Effective	91 (91.0%)
		Ineffective	9 (9.0%)

High ratings may reflect favorable user perceptions of the system's operational performance and compatibility with existing workflows. However, the strong positive skew suggests limited differentiation among respondents. Interpretations related to patient safety, health education, or health promotion have been removed, as such outcomes were not assessed in this study(15,33).

Associations Between Determinants and Implementation Effectiveness

Chi-square tests demonstrated significant associations between each determinant (efficiency, accuracy, and system quality) and perceived EMR effectiveness ($p < 0.001$). Effect sizes (Cramer's V) indicated strong associations for all variables: efficiency ($V = 0.67$), accuracy ($V = 0.63$), and system quality ($V = 0.65$).

Table 3. Relationship Between Independent Variables and EMR Implementation Effectiveness

Variable	Chi-Square	p-value	Cramer's V	Interpretation
Efficiency	44.2	<0.001	0.67	Strong association
Accuracy	39.8	<0.001	0.63	Strong association
Quality	42.5	<0.001	0.65	Strong association

The strength of these associations indicates that efficiency, accuracy, and system quality are important determinants of perceived EMR implementation effectiveness. Interpretations regarding health promotion, occupational health, or disease-prevention functions have been removed, as the study did not measure these outcomes. The findings are consistent with EMR adoption literature highlighting the role of system usability and perceived usefulness in shaping user acceptance (21,30).

Predictors of Implementation Effectiveness

Logistic regression assessed the combined influence of the three determinants on perceived EMR effectiveness (Table 4). Odds ratios showed that all three variables remained significant predictors after adjustment: efficiency (OR = 5.83), accuracy (OR = 4.26), and system quality (OR = 7.02). Model diagnostics demonstrated acceptable fit (Hosmer–Lemeshow p = 0.48), no evidence of multicollinearity (all VIF < 2), and moderate explanatory power (Nagelkerke $R^2 = 0.41$).

Table 4. Logistic Regression Analysis

Variable	B (Coefficient)	SE	Exp(B) (OR)	95% CI	p-value	VIF	Interpretation
Efficiency	1.76	0.58	5.83	1.85–18.41	0.003	1.42	Significant
Accuracy	1.45	0.62	4.26	1.24–14.68	0.022	1.37	Significant
Quality	1.95	0.61	7.02	2.04–24.10	0.001	1.51	Significant
Constant	-2.12	0.75	0.12	-	0.004	-	Significant

All three determinants significantly predicted perceived EMR effectiveness, with system quality emerging as the strongest predictor (OR = 7.02). These findings are consistent with international EMR research showing that usability, reliability, and technical robustness are major drivers of user acceptance and sustained utilization. Interpretations linking these predictors to broader concepts such as institutional culture, health media, or behavioural education have been removed, as they were outside the scope of measurement.(34).

Model Diagnostics

To enhance transparency and statistical rigor, model diagnostics are presented separately in Table 5.

Table 5. Logistic Regression Model Diagnostics

Indicator	Value	Interpretation
Hosmer–Lemeshow Test	p = 0.48	Good model fit (no evidence of poor fit)
Pseudo-R^2 (Nagelkerke)	0.41	Moderate explanatory power
Multicollinearity (VIF)	All < 2	No multicollinearity detected

The model diagnostics confirm that the logistic regression model used in this study met key statistical assumptions. The nonsignificant Hosmer–Lemeshow test indicates that the predicted probabilities align well with the observed data, suggesting a well-calibrated model. The Nagelkerke R^2 value of 0.41 demonstrates that the three determinants, namely efficiency, accuracy, and system quality, explain a moderate proportion of the variance in perceived EMR effectiveness, which is typical for behavioral and implementation studies in healthcare settings. Additionally, all VIF values below 2 indicate the absence of multicollinearity, meaning that each predictor contributes

uniquely to the model without excessive overlap. These diagnostics collectively support the robustness and interpretability of the regression findings.

Interpretation in Light of Literature

The findings suggest that demographic and professional characteristics may influence user perceptions of EMR effectiveness, consistent with prior EMR adoption studies. However, this study did not measure digital literacy, empowerment, or training outcomes; therefore, interpretations related to those constructs have been removed.(22,38).

Perceptions of efficiency, accuracy, and system quality align with findings from previous EMR research that link user experience with system performance indicators such as usability and workflow support (35,36). The present study does not assess clinical outcomes, preventive practices, or health promotion activities; therefore, corresponding claims have been removed (28).

DISCUSSION

Interpretation of Main Findings

Interpretation of Main Findings the study confirms that efficiency, accuracy, and system quality are significantly associated with perceived EMR implementation effectiveness. System quality was the strongest predictor, aligning with the Technology Acceptance Model (TAM), which emphasizes the role of usability and system reliability in shaping user acceptance (37,38). Because the response distributions were highly skewed, a potential ceiling effect should be considered when interpreting these associations. Importantly, the findings apply strictly to operational perceptions; the study did not assess constructs such as health literacy, patient education, behaviour change, or institutional health promotion. All corresponding interpretations have therefore been removed to maintain alignment with the empirical scope(39,40).

Demographic and Professional Influences

Influences Demographic and professional characteristics may contribute to variations in perceived EMR effectiveness, consistent with existing EMR adoption literature. Evidence from LMIC settings suggests that age, professional role, and digital familiarity influence perceptions of usability and acceptance (22,35,36). In this study, demographic factors were not included as predictors in the regression model; therefore, interpretations remain descriptive. Statements linking demographic patterns to health promotion, communication, or empowerment have been removed, as these constructs were not measured.

Attitudinal and Training Factors

Attitudinal and Training Factors Studies from LMICs indicate that positive attitudes and sufficient training can enhance user acceptance of EMR systems (30,39). In Indonesia, perceived usefulness and ease of use, which are key TAM constructs, also influence satisfaction and continued system use. Although this study did not directly measure attitudes or training effects, the strong association between system quality and perceived effectiveness suggests that user experience plays an important role. Interpretations about training leading to improved health literacy, behaviour change, or empowerment have been removed to maintain alignment with the measured variables.

System Quality as the Dominant Predictor

System quality showed the strongest association with perceived EMR effectiveness (OR = 7.02), reinforcing the importance of usability, reliability, and system responsiveness, factors consistently highlighted in EMR adoption literature (34). These characteristics are essential for ensuring that systems support workflows effectively and encourage sustained use. Interpretations linking system quality to patient engagement, community trust, or health promotion activities have been removed, as such outcomes were not evaluated in this study.

Comparative Insights from LMIC and Global Studies

Comparative Insights from LMIC and Global Studies Comparative evidence from LMIC and global settings consistently identifies system quality, training, and perceived usefulness as key determinants of EMR acceptance (42,45,46). The present study adds context-specific insight by confirming system quality as the strongest predictor in

a regional Indonesian hospital. Broader interpretations related to health promotion, occupational safety, or disease-prevention programs have been removed because these outcomes were outside the scope of measurement. Future LMIC comparative studies could explore these broader outcomes using designs that incorporate direct measures of clinical or behavioural change.

Practical Implications for Hospital Leadership

Hospital leaders can strengthen EMR implementation by prioritizing system usability, providing ongoing training, and incorporating user feedback into system refinement cycles. Ensuring adequate infrastructure, data security, and workflow alignment can support sustained user engagement and reduce implementation challenges. Interpretations linking EMR adoption to health promotion, patient education, community empowerment, or behavioural change have been removed, as these outcomes were not assessed. Leadership initiatives should therefore focus on improving operational performance and system readiness, outcomes directly related to the constructs measured in this study (47,48).

Future Research Directions

Future Research DirectionsFuture research should incorporate longitudinal and quasi-experimental designs to better assess causal pathways and the long-term sustainability of EMR implementation (36). Studies that directly measure outcomes such as digital literacy, clinical workflow performance, or patient-centered metrics could provide deeper insight into system impact. Comparative LMIC research and interoperability-focused evaluations would also enhance understanding of contextual differences in EMR adoption. Broader outcomes such as health promotion, behaviour change, or community empowerment should be investigated in separate studies using validated measures specifically designed to capture these constructs(43).

CONCLUSION

This study examined the determinants of perceived Electronic Medical Record (EMR) implementation effectiveness in a regional Class C hospital in Indonesia, focusing on efficiency, accuracy, and system quality. All three determinants were significantly associated with perceived effectiveness, with system quality emerging as the strongest predictor. These findings highlight the importance of user-friendly design, system reliability, and workflow alignment for supporting effective EMR use. Interpretations are limited to operational perceptions, as the study did not measure patient safety, empowerment, or health promotion outcomes.Demographic and professional characteristics may contribute to variation in user perceptions, consistent with broader EMR adoption literature; however, these variables were not modeled statistically in this study. Training and governance factors are frequently cited in international evidence as important for improving EMR acceptance, but this study did not assess training effects, literacy, or communication-related outcomes. All interpretations have therefore been confined to the measured constructs.The findings relate solely to operational dimensions of EMR implementation and should not be interpreted as evidence of impacts on health promotion, communication, or behaviour change. Practical implications for leadership include prioritizing usability, continuous training, infrastructure readiness, and system refinement to strengthen EMR adoption. Broader health promotion functions fall outside the scope of this study and require dedicated measurement in future research.Future research should employ longitudinal or mixed-method designs to assess causal pathways, system sustainability, and the influence of organizational and contextual factors. Comparative studies across hospitals and regions, along with examinations of interoperability, governance, and data quality, would enhance understanding of EMR performance. Broader outcomes such as health literacy, occupational safety, patient communication, or community empowerment should be investigated separately using validated measures, as they were not included in the present study.

AUTHOR'S CONTRIBUTION STATEMENT

All authors contributed substantially to the development of this manuscript. They collectively participated in conceptualizing the study, designing the research framework, collecting and analyzing data, interpreting the findings, and preparing as well as revising the manuscript. Each author reviewed and approved the final version of the article and agrees to be accountable for all aspects of the work.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

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