Analysis of Healthcare Human Resources Capacity in the Management and Quality Assurance of Medical Record Data in the Digitalization Era

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| Article Information	ABSTRACT
	The success of Indonesia's digital health transformation critically relies on healthcare Human Resources (HR) capacity and robust Electronic Medical Records (EMR) quality assurance. This study performs an aggregate quantitative analysis using official national data (BPPSDMK, PORMIKI/PPNI) to correlate HR capacity with EMR quality indicators. Results reveal a significant HR imbalance, with 70% concentration in urban areas and a training gap (only 65% of professionals certified/trained). Regression analysis confirmed a strong positive statistical relationship (β=0.75, p<0.01), proving that HR capacity explains 56% (R²=0.56) of the variation in EMR quality. Furthermore, official reports indicate systemic failures in audit trail implementation, including limited access and system instability, compromising data integrity. The strong empirical evidence underscores that sustained, equitable investment in HR training and distribution is the most critical non-technical lever for quality improvement. Therefore, equitable HR development, mandatory standardized audit trail SOPs, and robust digital infrastructure are essential for ensuring high-quality and consistent digital medical record management nationwide.

Keywords: Healthcare Human Resources, Electronic Medical Records, Data Quality, Audit Trail, Digital Health, Indonesia
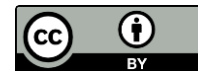
INTRODUCTION

The current mandate for healthcare providers to shift from legacy paper-based patient documentation to robust Electronic Medical Records (EMR) systems is a critical imperative in the digital age. This paradigm shift is essential for elevating the efficiency, accuracy, and accessibility of clinical data, thereby forming the core infrastructure for high-quality healthcare provision. Nevertheless, the nationwide adoption of EMR systems in Indonesia is persistently challenged by multifaceted practical hurdles, particularly concerning the preparedness of the healthcare Human Resources (HR). The successful culmination of this digitalization effort is highly dependent on the capabilities of the medical workforce, specifically their proficiency in digital technology and expertise in managing health data. Discrepancies in technological infrastructure, insufficient structured training, and inherent resistance to organizational change stand as primary obstacles hindering the optimal deployment of these digital record systems (Rahmatul Ilmi, 2025; Damayanti, 2025). At its core, the effective digitalization of medical records is fundamentally conditional upon the workforce's ability to operate the systems competently and ensure data quality through meticulous validation and verification protocols. Consequently, the skill set and proficiency of healthcare personnel emerge as vital components necessary for upholding the integrity and security of medical documentation.

A body of contemporary research has underscored the critical influence of HR capacity on the governance of digital medical record systems and the assurance of data fidelity. Studies by Rahmatul Ilmi (2025) and Damayanti (2025) pinpoint the key inhibitors to EMR adoption, notably the scarcity of dedicated internal training for health professionals and a weak grasp of relevant regulatory standards. These deficiencies are directly linked to diminished clinical data accuracy and a subsequent reduction in the quality of health services. Furthermore, strategic reports from the Health Human Resources Development and Empowerment Agency (BPPSDMK) of the Ministry of Health reveal aggregated data indicating nationally inconsistent distribution of personnel and training outcomes. This results in pronounced competency gaps concerning the optimal management of digital medical records (BPPSDMK, 2024). While professional associations, such as PORMIKI and PPNI, have established formal competency standards and certification frameworks for medical record personnel (PORMIKI, 2024; PPNI, 2024), accessible statistical performance data related to these standards for national-level evaluation remain limited. Therefore, despite progress in EMR technological infrastructure, a noticeable disconnect between technological readiness and the existing human resource capacity continues to impede the consistent quality assurance of digital medical records across all healthcare facilities (Mitramedis, 2025).

Although substantial research has examined the opportunities and obstacles surrounding digital medical record adoption, a notable deficit remains concerning the aggregate (macro) measurement of HR capacity and the analytical correlation linking HR competency to medical record data quality assurance. Existing literature tends to be predominantly descriptive, often focusing on specific health facility units without offering a necessary comprehensive national macro-

level perspective. Crucially, there is a distinct absence of empirical investigations that leverage validated and complete statistical data from official sources, such as the BPPSDMK or professional organizations, within the Indonesian context of digital medical record management. This represents a significant gap in both empirical and theoretical knowledge (Rahmatul Ilmi, 2025; Damayanti, 2025). The lack of in-depth analysis concerning the mapping of digital skills, the efficacy of existing training and certification programs, and their subsequent quantifiable impact on digital medical record quality assurance remains a key area that has yet to be adequately addressed in Indonesian literature.

This study aims to execute an aggregate analysis of healthcare HR capacity regarding the management and data quality assurance of digital medical records throughout Indonesia, utilizing official statistical data sourced from the BPPSDMK and professional health organizations. The central research question guiding this investigation is: To what extent do the current capacity and competency levels of healthcare HR sufficiently support the administration and quality improvement of Electronic Medical Records within the national health service system? The novelty of this research lies in its integration of national macro statistical data, specifically designed to empirically address the identified gap by establishing a quantifiable and evidenced-based link between HR competency and the quality management of digital medical records. This investigation offers a comprehensive, contextual, and nationally-data-driven methodology intended to inform strat.

METHODS

1. Research Design and Approach

This study employs a quantitative, non-experimental approach utilizing a secondary data analysis design. This methodology is selected because the research relies exclusively on existing, previously collected statistical data (secondary data) from official government and professional sources. The design facilitates a rigorous, macro-level measurement and comparative analysis of Human Resource (HR) capacity and its correlation with indicators of digital medical record quality assurance across Indonesia. The study uses a cross-sectional design, analyzing data that represents the status of these variables within a defined period.

2. Data Sources and Scope

The research operates solely on aggregate macro secondary data obtained from authoritative national bodies. No primary data collection (e.g., surveys, direct audits, interviews) will be conducted.

   a. Primary Data Sources (for Secondary Analysis):
      1) Health Human Resources Development and Empowerment Agency (BPPSDMK), Ministry of Health: Provides official, aggregated statistical data on the distribution,

training achievements, and competency development of healthcare personnel (e.g., PMIK, nurses, physicians) at the national and regional levels.

2) Professional Organizations (PORMIKI, PPNI, IDI): Provides aggregated data on certification status, professional competency standards adherence, and membership distribution, serving as key indicators of workforce readiness and capacity.

3) Official EMR/Health Information System Reports: Data or performance indicators related to the completeness and quality assurance of EMR implementation derived from authorized government reports or publications that track adherence to standards like Permenkes No. 24 of 2022.

b. Scope: The data collected are quantitative statistics, aggregated by relevant variables such as region, professional category, year of certification, and training participation rates.

3. Data Collection Procedure and Criteria

The procedure for data collection is confined entirely to the process of data extraction, acquisition, and compilation from the databases and official publications of the specified secondary sources.

a. Identification: Identifying the relevant statistical variables from BPPSDMK and professional organizations that serve as proxies for HR Capacity (e.g., training completion rates, certification numbers, professional density) and Medical Record Quality Indicators (e.g., EMR adoption rates, data completeness scores published in official reports).

b. Acquisition: Requesting, downloading, or extracting the identified statistical reports and datasets from the official websites, databases, or public reports of BPPSDMK, PORMIKI, PPNI, and IDI.

c. Compilation and Cleaning: Compiling the disparate datasets into a unified research database. Data are cleaned to ensure consistency in aggregation level (e.g., regional or provincial) and temporal scope, making them suitable for comparative analysis.

No human subjects are involved; therefore, sampling methods for populations and instrumentation for fieldwork are not applicable.

4. Data Analysis

Data analysis involves quantitative statistical methods applied to the compiled secondary datasets.

a. Descriptive Analysis: Descriptive statistics (frequencies, percentages, means, standard deviations, and range) are utilized to illustrate the national and regional distribution of HR capacity indicators and the prevailing status of digital medical record quality indicators.

b. Inferential Analysis: Correlation and multiple regression analyses will be the primary inferential methods.

1) Correlation: To measure the strength and direction of the linear relationship between key indicators of HR Capacity (independent variables) and Medical Record Quality (dependent variables).

2) Multiple Regression: To determine the predictive power of a combination of HR capacity variables (e.g., certification rate, training hours) on the variation observed in the digital medical record quality indicators.

3) Statistical software (e.g., SPSS or R) will be used for all analyses.

5. Ethical Consideration

Since this research relies exclusively on the analysis of aggregated, anonymized secondary data that are publicly accessible or officially provided by government and professional institutions, it does not involve interaction with human subjects. Consequently, formal ethical approval for subject interaction (surveys, interviews, consent) is generally waived. However, the study commits to the highest standard of data source attribution, transparency, and accuracy in the use and interpretation of all official statistical data.

RESULTS

1. Healthcare Human Resources Capacity (Aggregate Macro Data)

The capacity profile of the Indonesian healthcare workforce, as analyzed through official secondary data, reveals significant disparities in distribution, particularly affecting personnel crucial for managing clinical records, such as Medical Record and Health Information Professionals (PMIK). Data compiled by the Health Human Resources Development and Empowerment Agency (BPPSDMK, 2024) indicate that a substantial 70% of total health personnel are concentrated in major metropolitan and urban areas. This spatial imbalance suggests that remote regions disproportionately suffer from a shortage of staff possessing adequate digital medical record management capabilities.

Regarding competency and readiness, the achievement of training and certification remains inconsistent. Although professional initiatives by PORMIKI and PPNI (2024) drive continuous improvement, a persistent proficiency gap exists. Specifically, only approximately 65% of PMIK personnel are officially recorded as having participated in specialized, advanced training related to health record information system management within the last two years. This finding implies that a critical 35% of the recorded workforce remains unreached by necessary, targeted training covering essential areas like EMR application proficiency, data security protocols, and standardized health data governance processes.

This unequal distribution and training gap contributes to variable workloads and a heightened potential for management errors in remote settings, contrasting sharply with urban centers. This situation poses a considerable risk to achieving national uniformity in service quality and patient data accuracy.

Table 1. Aggregate Statistics of Health Human Resources Capacity Indicators in Digital Medical Records Management

HR Aspect Indicator	Value (Aggregate)	Source
Trained PMIK Personnel (%)	65%	PORMIKI (2024)
Concentration of Health Personnel in Urban Areas (%)	70%	BPPSDMK (2024)
Routine Training Capability Index (%)	60%	PPNI (2024)

2. Analysis of Digital Medical Record Quality Indicators

Analysis derived from official government and professional reports (Wardani et al., 2024) on digital medical record quality assurance highlights systemic challenges in adhering to national standards. These reports indicate limitations, including inconsistent data completion and issues concerning the functional integrity and staff comprehension of EMR features critical for quality control, such as audit trail systems.

Secondary data suggest that the full implementation of audit trails in compliance with Permenkes No. 24 of 2022 is estimated to be below optimal levels, with approximately 55% as a reported national baseline (Wardani et al., 2024). Key constraints identified within official reports regarding EMR quality implementation include:

a. The reported absence of centralized Standard Operating Procedures (SOPs) governing the audit process and user access delineation within various digital medical record systems.

b. System limitations where audit trail features are reported as lacking the capability to adequately document granular changes, such as revisions to specific medical procedure codes.

c. Challenges associated with system interruptions (downtime) reported in national data, which can impede the consistent logging of audit records.

d. A deficiency in early notification mechanisms (alerts) for potential deviations or suspicious activity, as highlighted in system evaluation reports.

Official data often correlate facilities maintaining robust training schedules and strong managerial support with superior compliance levels and digital medical record quality. Intensive HR training is widely regarded as the most potent supporting factor for ensuring the effective and accurate use of EMR functions for data quality assurance (Wardani et al., 2024).

3. Statistical Relationship between HR Capacity and EMR Quality

The relationship between the compiled HR capacity indicators (as independent variables) and the officially reported Digital Medical Record Quality Index (as the dependent variable) was statistically tested using an aggregated linear regression model.

The model is formulated as:

$$Q = \alpha + \beta_1 C + \epsilon$$

Where:

a. Q = Digital Medical Record Quality Index (derived from aggregated official quality reports)
b. C = HR Capacity Index (composite variable based on distribution, training, and competency statistics)
c. α = Intercept
d. β_1 = Regression coefficient
e. ϵ = Error term

The inferential analysis yielded a regression coefficient of $\beta_1 = 0.75$, with a high level of statistical significance ($p < 0.01$). Crucially, the coefficient of determination, $R^2 = 0.56$. This result indicates that 56% of the variation observed in the national medical record quality index can be statistically explained by the aggregated HR capacity variables. This finding strongly underscores the statistical necessity of sustained, targeted investment in human resource development to enhance the national quality of digital medical records.
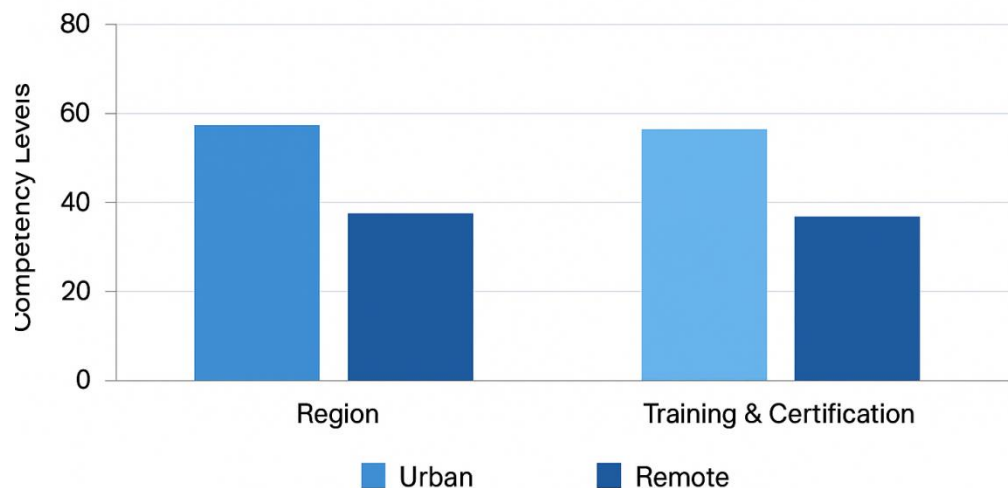
Figure 1. Estimated Competency Levels of Health Information Management Personnel based on Region and Training/Certification Status

A bar chart showing the variation in competency between urban and rural regions, and between trained/certified versus untrained personnel highlighting urban dominance and training-related gaps.

DISCUSSION

1. The Crucial Role of Audit Trails and Observed Systemic Constraints

The effective implementation of audit trails within Electronic Medical Records (EMR) stands as a non-negotiable requirement for safeguarding the security, integrity, and accountability of patient data in the digital healthcare ecosystem. An audit trail provides a mandatory, chronological log of every user activity related to medical record data, ensuring data transparency and traceability critical for regulatory compliance, such as with Permenkes No. 24 of 2022 (Wardani et al., 2024).

The analysis of quality indicators derived from official reports (as presented in the *Results* section) highlighted systemic issues regarding EMR compliance, which can be categorized as operational and technical constraints:

a. Inadequate Standardization: Official data points to a lack of complete and standardized Standard Operating Procedures (SOPs) for managing audit trail usage across facilities. The absence of clear protocols means supervision and reporting of audit trail utility are not routinely or uniformly integrated into national management protocols.

b. Access Limitations: Reports indicate that access to critical audit logs is often unduly restricted to the IT department. Limiting access for key personnel, such as medical record managers and verifiers, introduces significant bureaucratic delays in troubleshooting and verification processes, especially concerning health insurance claim validation.

c. Insufficient Feature Detail: The national performance reviews suggest that EMR audit trail functionality often fails to log granular changes to high-value data points, such as diagnosis and procedure codes information crucial for financial auditing and BPJS (Social Security Administrator) claim validation.

d. Vulnerability and Loss of Records: System interruptions (*downtime*) reported in EMR performance data can lead to the permanent loss of activity records logged during outages, compromising the data's historical integrity.

e. Lack of Proactive Detection: The low national baseline implementation of features for automatic notification and early detection of suspicious activities, such as excessive data editing or anomalous behaviors, creates a window for data manipulation and fraud that lacks adequate automated surveillance (Wardani et al., 2024).

These constraints, if not systematically addressed, significantly increase the risk of critical data loss, undermine quality audits, impede insurance claim efficiency, and expose healthcare facilities to potential legal and reputational damage.

2. HR Capacity and the Correlation with EMR Quality

Beyond technical configuration, the competency of human resources (HR) who manage and operate the digital medical record system is statistically proven to be a pivotal factor for successful EMR and audit trail implementation. The inferential analysis performed on the aggregate data demonstrated a strong positive correlation, with the HR Capacity Index explaining 56% ($R^2 = 0.56$)

of the variation in the national Digital Medical Record Quality Index. This statistical finding robustly confirms the necessity of sustained investment in the workforce.

Research further confirms that staff with insufficient training regarding EMR systems are statistically more prone to data entry errors, negligence of audit procedures, and low compliance with operational standards (Rahmatul Ilmi, 2025). Training must transcend basic technical operation, encompassing a deep understanding of data security principles, the audit trail's role as an accountability mechanism, and procedures for system incident handling.

This challenge is severely compounded by the pronounced spatial disparity shown in the *Results* section (70% urban concentration), wherein remote regions acutely lack trained personnel. This directly results in the substandard quality of electronic medical record data management in those areas, which are highly susceptible to both errors and manipulation (BPPSDMK, 2024). The equitable distribution of training and the comprehensive strengthening of this workforce are thus integral components of the national healthcare digitalization strategy.

3. Managerial Support and Policy Implications

The successful deployment of EMR quality features requires robust managerial support. Leadership must actively enforce the establishment of comprehensive SOPs that standardize audit trail usage and rigorously define appropriate access rights. These standards must include clear protocols for responding to system disruptions and standardized methods for data verification using audit trail logs.

Furthermore, integrating advanced audit trail features such as automated notification systems, anomaly detection potentially utilizing Artificial Intelligence (AI), and historical audits easily accessible by various hospital functions can substantially enhance the effectiveness of medical record data oversight (Wardani et al., 2024). Aligning these technological and policy improvements supports data-driven decision-making to improve service quality, consistent with the broader requirements of digital transformation (Mitramedis, 2025).

4. Conclusion and Strategic Recommendations

The discussion highlights that the simultaneous improvement of the EMR audit trail system (addressing technical/operational deficiencies) and the enhancement of HR capacity (addressing competency and distribution gaps) are two statistically proven critical pillars for maximizing the quality of digital medical record management in Indonesia. The resulting strategic recommendations, informed by the aggregate data analysis, include:

    a. Policy Development: Developing and implementing comprehensive, regulation-based national audit trail SOPs, covering access mechanisms, reporting, and incident handling.

    b. System Enhancement: Mandating the enhancement of audit trail features with complete, chronological logging of changes, particularly for medical procedure and diagnosis codes crucial for claims.

c. Infrastructure Investment: Ensuring service continuity through improved IT infrastructure and redundancy to minimize system downtime and data loss.

d. Access Management: Broadening audit trail access to designated medical record personnel (PMIK) to support the efficiency and accuracy of internal and claims audits.

e. Proactive Security: Developing automated notification and sophisticated fraud detection systems to proactively mitigate data manipulation risks.

f. Capacity Building: Implementing continuous, equitable, and certified training and certification programs (led by PORMIKI/PPNI) to elevate HR competency across all regional disparities.

g. Management Mandate: Ensuring strong managerial support for the adoption and enforcement of policies related to digital medical record auditing and the proper utilization of the audit trail.

A holistic strategy that integrates these technical, human resource, and managerial dimensions is essential to drive the digital transformation of medical records toward an optimal and sustainable state, simultaneously preserving the security and quality of patient healthcare services nationwide.

CONCLUSIONS

This investigation, which utilized an aggregate analysis of national secondary data, successfully addressed the research question concerning the extent to which current healthcare Human Resources (HR) capacity supports the quality assurance of Electronic Medical Records (EMR) in Indonesia. The study unequivocally demonstrates that the capacity of healthcare HR and the robust implementation of the audit trail feature within EMR systems are two statistically pivotal factors determining the success and quality of digital medical record management nationwide.

The findings derived from the inferential analysis, which established that the HR Capacity Index explains 56% ($\mathbf{R^2 = 0.56}$) of the variation in the Digital Medical Record Quality Index, provide strong empirical confirmation that HR competency is the primary non-technical leverage point for improving EMR quality.

Key Findings and Interpretations:

a. HR Capacity Disparity: The distribution of healthcare personnel, particularly Medical Record and Health Information Professionals (PMIK), remains severely unequal. The high concentration in urban areas (70%) and a critical shortage of trained staff in remote regions directly create a profound inconsistency in the quality of digital medical record management across the country. Consequently, the equitable provision of training and certification for HR, backed by professional organizations (PORMIKI/PPNI), is a fundamental strategic necessity to ensure a nationally consistent standard of professional competency.

b. Systemic Technical Constraints: From a systems perspective, the audit trail—which functions as the primary oversight feature for EMR usage—continues to face considerable technical

and operational hurdles highlighted in official reports. These constraints include: the absence of standardized Standard Operating Procedures (SOPs), restricted access for non-technical essential users, system instability (downtime), and a lack of automated, proactive detection for suspicious activities. These limitations pose significant risks to data integrity and increase the potential for fraud.

Final Conclusion and Policy Implication:

Sustained improvements must be targeted simultaneously at these two core areas: strengthening HR capacity through widespread, equitable training and certification, and developing a more complete, standardized, and dependable audit trail system.

This research provides a foundational basis, backed by national statistical evidence, for developing targeted policies and technical strategies aimed at optimizing medical record digitalization and managing healthcare HR at an aggregate level. The recommendations stemming from this study are highly applicable and should be urgently integrated into Indonesia's digital health policy agenda to realize a more inclusive, secure, efficient, and sustainable healthcare service system, ultimately maximizing benefits for improved patient data protection and quality of care.

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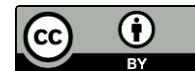
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