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Review Article

Artificial intelligence in healthcare and human resource management: a review of the global divide, Pakistan's landscape and institutional innovations

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ABSTRACT

Artificial intelligence (AI) is reshaping healthcare and organizational management worldwide, yet its benefits remain unevenly distributed between high-income and low- and middle-income countries (LMICs). This review examines the structural drivers of this global AI divide, situates Pakistan's healthcare and digital infrastructure challenges within this context, and presents an institutional case study of four AI-enabled interventions implemented at the Sindh Integrated Emergency and Health Services (SIEHS), an emergency and health services organization under the Health Department, Government of Sindh, Pakistan: an AI-driven recruitment and candidate-job matching system (Talent Match Live), a facial-recognition and geolocation-based field monitoring application, an AI-assisted CCTV training-monitoring system, and an AI-augmented telemedicine triage service embedded within SIEHS's Teletabeeb telehealth department. Each intervention is evaluated against comparable systems documented in the international literature to assess feasibility, evidence of effectiveness, and associated ethical risks. A responsible-adoption framework is proposed to guide organizations in resource-constrained settings toward AI integration that is effective, equitable, and ethically governed. The review concludes that while AI offers meaningful efficiency and access gains for LMIC public-sector organizations such as SIEHS, sustainable adoption requires deliberate attention to data protection, algorithmic bias, workforce consent, and alignment with international ethical guidance.

Keywords: Artificial intelligence, Healthcare, Human resource management, Low- and middle-income countries, Pakistan, Telemedicine, Digital divide

INTRODUCTION

Artificial intelligence (AI) is increasingly embedded not only in clinical decision-making but also in the organizational systems that support healthcare delivery, spanning diagnostic assistance, administrative automation, workforce oversight, and telehealth service delivery. This trajectory is reflected in global investment patterns: the worldwide digital health market was projected to grow substantially between 2019 and 2025, a trend driven in large part by the expanding integration of AI-enabled tools across health systems.[1] This growth, however, has not been evenly distributed. The capacity to develop, adopt, and govern AI technologies remains concentrated in high-income countries, raising the concern that LMICs may be left further behind unless deliberate attention is paid to context-appropriate design, workforce readiness, and governance. This review examines that global AI divide in healthcare, situates it within Pakistan's healthcare and digital infrastructure landscape, and presents an

institutional case study of four AI-enabled interventions implemented by the SIEHS, before proposing a responsible-adoption framework to guide similar public-sector organizations in resource-constrained settings. Figure 1 outlines the structure of the review.

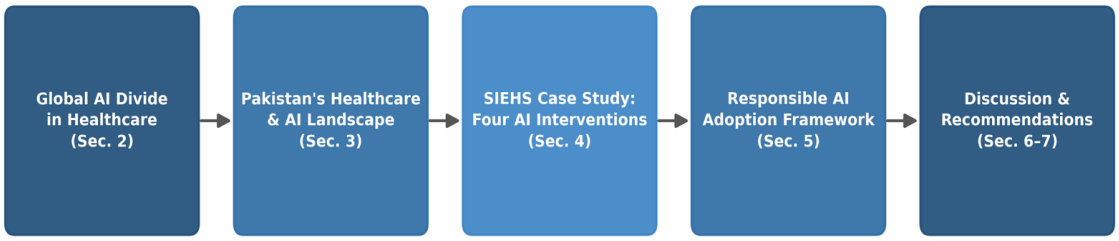


Figure 1: Structure of the review: from the global AI divide in healthcare, through Pakistan's digital-health landscape, to an institutional case study of four AI interventions at SIEHS and a resulting responsible-adoption framework.

METHODS

Study design

This article combines a narrative review with a descriptive institutional case study of artificial intelligence (AI) integration at Sindh Integrated Emergency and Health Services (SIEHS), Sindh, Pakistan. The review covers global disparities in AI readiness, Pakistan's digital-health landscape, and the applications, challenges, and ethical considerations of AI in healthcare delivery and human resource management. A narrative approach was chosen because the topic spans several disciplines and the evidence, particularly from low- and middle-income countries, is still emerging and heterogeneous.

Evidence sources

Evidence was drawn from peer-reviewed studies, reviews, international guidance, policy documents, and institutional reports on AI in healthcare, recruitment, workforce monitoring, digital health, telemedicine, and responsible AI governance, with emphasis on low- and middle-income and Pakistani contexts. Sources were selected purposively for relevance to the review's themes. As no systematic search protocol, quality appraisal, or evidence grading was applied, the findings should be interpreted with this limitation in mind.

Case description and comparative approach

The case study describes four AI-enabled or AI-assisted interventions at SIEHS: (1) AI-driven recruitment and candidate–job matching; (2) facial-recognition and geolocation-based field monitoring; (3) CCTV-based training monitoring; and (4) a proposed AI-assisted enhancement of the Teletabeeb telehealth workflow. Each was examined descriptively in terms of its intended function, comparable applications in the literature, anticipated benefits, and ethical and operational risks. International examples were used to assess feasibility and identify safeguards. No independent technical validation or quantitative performance comparison of the SIEHS systems was undertaken; the case descriptions are therefore illustrative rather than evaluative.

Ethical considerations

Recommendations on human oversight, transparency, accountability, privacy, equity, and responsible implementation draw on the World Health Organization's guidance on the ethics and governance of AI for health. Because this work is a narrative review and descriptive case study involving no collection of new data from human participants, separate research ethics approval was not sought.

THE GLOBAL AI DIVIDE IN HEALTHCARE

The uneven diffusion of AI in healthcare reflects a broader pattern in the global governance of emerging technology. National AI strategies, which set priorities for research funding, data infrastructure, and regulatory frameworks, have been adopted overwhelmingly by high-income economies; a review of national strategy adoption found that more than sixty countries had published such strategies within a five-year window, with over 70% classified as developed economies.[2] This concentration of strategic planning capacity compounds existing disparities in AI readiness. The Oxford Insights Government AI Readiness Index, which scores 181 to 195 governments annually across the pillars of government, technology sector, and data and infrastructure, has repeatedly found that Sub-Saharan African and other low-income regions score well below the global average, particularly on data availability and technological infrastructure.[3]

These gaps carry direct consequences for healthcare. Researchers based in low-income countries face structural barriers to participating in the global AI research ecosystem, including inadequate access to computational infrastructure, fragmented or absent electronic health records, and limited AI-specific training pathways. Left unaddressed, this indifference can widen disparities in labor productivity, digital literacy, governance capacity, and economic development between high-income and low-income settings, and it can leave the design of health AI systems disconnected from the populations most likely to benefit from them.

PAKISTAN'S HEALTHCARE AND AI LANDSCAPE

Pakistan, classified by the World Bank as a lower-middle-income country, exemplifies many of the structural constraints described above.[4] Nationally representative survey data from the 2017-18 Pakistan Demographic and Health Survey found that only 22.9% of urban households had an internet connection, compared with 4.9% of rural households, a divide that has direct implications for the equitable reach of any digital health intervention.[5] Because the effectiveness of telemedicine and other digital health tools depends heavily on internet accessibility, this disparity risks concentrating AI-enabled healthcare benefits in urban centers while leaving rural populations, who often have the greatest unmet healthcare needs, further behind.

Pakistan's health system also faces systemic quality constraints that shape the ceiling for AI-enabled improvement. The Global Burden of Disease Study's Healthcare Access and Quality (HAQ) Index, published in The Lancet Global Health, scored Pakistan among the lower-performing health systems globally in its most recent assessment, reflecting persistent gaps in service delivery, health information systems, and workforce capacity.[6] These same gaps, an absence of robust electronic health record infrastructure, a shortage of trained health informatics personnel, and largely unregulated cybersecurity and data-protection practices, constrain the safe and effective deployment of clinical AI.

The World Health Organization's 2021 guidance on the ethics and governance of AI for health explicitly identifies inclusiveness, equity, and context-appropriate design as prerequisites for AI to benefit resource-constrained health systems rather than exacerbate existing inequities, a caution echoed by Pakistan-specific analyses that describe the country's digital health ecosystem as one of considerable promise but also of governance fragmentation, trainer-capacity bottlenecks, and under-specified data standards.[7,8]

Despite these constraints, Pakistan has seen a growing number of telemedicine and digital health initiatives, including hospital-linked platforms and independent telehealth companies that increasingly incorporate AI for diagnostics, triage, and predictive care. A recent analysis situates this growth using the technology acceptance model, diffusion of innovations theory, and human-centered design, arguing that Pakistan's e-health transformation is best understood as a sociotechnical process shaped as much by institutional constraints, digital literacy, and governance as by the underlying technology itself.[9] This framing is directly relevant to the institutional case study that follows: technically sound AI tools can still fail, or cause harm, if deployed without attention to workforce readiness, data protection, and equitable access.

INSTITUTIONAL CASE STUDY: AI INTEGRATION AT SIEHS

The SIEHS is a provincial emergency and health services organization functioning under the Health Department, Government of Sindh, mandated to deliver emergency response, ambulance, and telehealth services across urban and rural Sindh. Against the backdrop described in sections 2 and 3, SIEHS has implemented four AI-enabled interventions spanning human resource management and telehealth service delivery. Each is described below alongside comparable systems documented in the international literature, in order to assess feasibility and to surface risks that similar deployments have encountered elsewhere.

Table 1: Summary comparison of the four SIEHS AI interventions, their closest documented international analogues, feasibility evidence, principal risks, and recommended safeguards.

Intervention	Domain	Comparable international system	Feasibility evidence	Key risk(s)	Recommended safeguard
Talent match live	HR recruitment	NLP-based resume screening/ job-matching systems	Established category; reduces screening time and improves consistency	Algorithmic bias along gender/name lines[10,11]	Routine bias auditing; transparent scoring; human reviewer in final decision
Facial recognition + geolocation field monitoring	HR field-workforce oversight	Commercial mobile facial recognition with GPS/geo-fencing	Widely deployed at scale internationally; technically well established	Privacy intrusion; consent gaps; function creep[12,13]	Explicit staff consent; narrow purpose limitation; biometric templates, not raw images
AI-enabled CCTV training monitoring	HR training oversight	Deep-learning classroom attention monitoring (YOLOv5-based)	76% average accuracy in pilot evaluation[14]	Behavioral over-profiling; lack of disclosure	Scope limited to attendance/engagement; advance disclosure; limited retention
Teletabeeb AI-augmented triage	Telemedicine	AmarDoctor multilingual voice-interactive triage (Bangladesh/India)	81.1% top-1 diagnostic accuracy; 91.4% specialization-referral accuracy, exceeding physician comparators[15]	Missed or mis-triaged red-flag symptoms	Machine-in-the-loop design; mandatory MO review; red-flag escalation; phased dialect rollout

Talent match live: ai-driven candidate-job matching

SIEHS has deployed Talent Match Live, an in-house AI recruitment tool that automates the screening of incoming candidate CVs against a given job description, filtering applicants, identifying individual strengths and weaknesses relative to role requirements, and generating a fit score. This design mirrors a well-established category of recruitment technology. AI-powered resume screening and job-matching systems typically apply natural language processing and semantic-similarity techniques to align resume content with job descriptions, producing ranked shortlists and, in more advanced implementations, explainable feedback on candidate strengths and gaps; such systems have been reported to meaningfully reduce screening time and improve consistency in candidate evaluation across large applicant pools.

However, the feasibility literature on this technology carries an important caveat. A systematic review of algorithmic decision-making in HR recruitment and development found consistent evidence of discrimination risk, whereby AI screening tools can reproduce or amplify biases present in historical hiring data, particularly along gender and name-based lines.[10] A more recent comprehensive review of bias-mitigation techniques in AI hiring similarly concludes that while technical countermeasures, such as adversarial debiasing, fairness-constrained scoring, and human-in-the-loop review, can reduce discriminatory outcomes, no current system eliminates bias risk entirely, and governance safeguards such as audit trails, candidate appeal mechanisms, and periodic bias testing are essential complements to the technology itself.[11] For an organization deploying a system such as Talent Match Live, this evidence base suggests the tool is feasible and consistent with global practice, provided it is paired with routine bias auditing, transparent scoring criteria communicated to candidates, and a human reviewer retained in the final hiring decision.

Facial recognition and geolocation-based field monitoring

SIEHS has developed an AI-enabled attendance and field verification mechanism combining facial recognition with geolocation controls. The system verifies employee identity and validates presence within an authorized work location or defined geographic radius during attendance. Its purpose is to strengthen attendance integrity, reduce proxy attendance, and improve verification of geographically distributed field staff rather than continuously track employee movement. This class of technology, mobile facial recognition combined with GPS or geo-fencing, has been adopted widely across sectors internationally for attendance verification and field-workforce oversight, and vendors report deployments spanning tens of thousands of employees across multiple countries. The underlying technical feasibility is therefore well established: contactless facial verification linked to device location can reliably confirm that a staff member is present at an authorized location at a given time, addressing common workforce-management problems such as proxy attendance and unverifiable field visits.

The ethical literature on this technology is nonetheless considerably more cautious than the commercial literature. A study of employee attitudes toward facial recognition in workplace surveillance found that many workers experience such monitoring as a meaningful intrusion on autonomy and privacy, with gendered differences in how the technology's presence is perceived and tolerated.[12] A broader review of the ethics, privacy, and regulatory treatment of facial recognition technology highlights recurring concerns around consent, data security, and the potential for legitimate workplace-safety uses to expand into broader, unconsented surveillance, so-called function creep, once the underlying data infrastructure exists.[13] For this intervention, feasibility is not in question, but responsible deployment requires explicit staff consent, clear and narrow purpose limitation (location verification, not continuous behavioral monitoring), defined data-retention limits, and secure storage of biometric templates rather than raw facial images.

AI-enabled CCTV-based training monitoring

SIEHS uses CCTV-linked monitoring to track attendance and attention during staff training sessions. This approach parallels a growing body of applied computer-vision research on classroom and training engagement analysis. A peer-reviewed deep-learning system for real-time classroom attention monitoring, using the YOLOv5 object-detection architecture combined with behavioral and facial-expression classification, demonstrated the ability to automatically track attendance, emotional state, and attention level from video feeds, achieving an average accuracy of 76% across model variants in a pilot evaluation.[14] This body of work confirms that automated, camera-based engagement and attendance monitoring is technically feasible with currently available deep-learning models, and that such systems can supplement, rather than replace, an instructor's own assessment of participant engagement.

As with facial recognition for attendance, the primary risks are not technical feasibility but governance and acceptability. Video-based monitoring of staff during training sessions should be scoped narrowly to attendance and general engagement metrics rather than granular behavioral profiling, should be disclosed to participants in advance, and should store footage and derived analytics only for the period required for training-quality assurance.

Teletabeeb: AI-augmented telemedicine triage

Within Teletabeeb, SIEHS's telemedicine department, the initial patient interaction is currently managed by Health Advisor Information Officers (HAIOs). The HAIO workflow begins with receiving the patient's call, obtaining and verifying demographic information, registering the caller in the telemedicine system, and conducting a structured clinical history based on the patient's presenting complaint or concern. Using

standardized disease-specific algorithms and clinical protocols, the HAIO asks relevant questions, identifies potential red-flag symptoms requiring urgent attention, and prepares a comprehensive, structured disease summary. The patient is then transferred to the next available Medical Officer (MO), who receives the documented history and clinical summary to guide further assessment, diagnosis, and management while maintaining physician oversight of all clinical decisions.

In addition to medical triage, Teletabeeb incorporates mental health screening at the HAIO level. During the initial interaction, callers are screened for common mental health conditions, including anxiety and depression, using standardized assessment tools integrated into the telemedicine workflow. These assessments can be system-generated and embedded within the consultation process, enabling early identification of psychological distress alongside physical health concerns. This integrated model reflects Teletabeeb's commitment to providing both medical and mental health services, ensuring a holistic approach to patient care.

Furthermore, when an ambulance is en route following patient pickup, and the patient's condition is critical, the Command-and-Control Center relays relevant clinical information to the MO stationed at the Tele Tabeeb department. The MO is then connected, via HAIO, to the Emergency Medical Technician (EMT) accompanying the patient in the ambulance. This mechanism also serves as a channel for delivering real-time, on-call critical care advice during the transfer of critically ill patients. The entire process is carried out within the defined protocols of the Medical Priority Dispatch System (MPDS), with ProQA software employed for quality assurance

Currently, SIEHS is introducing an AI-based enhancement to this workflow through the development of an AI agent capable of receiving the initial call in multiple local languages and dialects. The AI system will perform patient registration, collect demographic information, conduct structured history-taking using evidence-based disease algorithms, screen for medical red flags and mental health concerns, generate a standardized clinical summary, and seamlessly hand over the case to the MO. AI-assisted clinical intake and summarization, while preserving physician oversight for diagnosis and treatment, this innovation aims to improve operational efficiency, standardize documentation, reduce workload on frontline staff, expand multilingual accessibility, and strengthen the integration of physical and mental healthcare within the telemedicine service.

This model has a strong and growing evidence base in comparable LMIC settings. AmarDoctor, a multilingual, voice-interactive digital health platform developed for Bengali speakers in Bangladesh and India, provides the closest documented analogue: it combines a voice-interactive AI assistant, supporting standard Bengali and two regional dialects (Sylheti and Chittagonian), with a symptom-checking module and an AI-generated provisional diagnosis and specialist-referral recommendation that is handed to a physician in a structured clinical note. In a validation study against 185 physician-authored clinical vignettes, the system achieved 81.1% top-1 diagnostic accuracy and 91.4% top-1 specialization-recommendation accuracy, both exceeding the average accuracy of the five independent physicians used as comparators, while the system's developers emphasize that it functions as machine-in-the-loop decision support tool rather than an autonomous diagnostic agent.[15] This precedent directly supports the feasibility of an AI agent that ingests multilingual/ multi-dialect patient calls and produces structured summary for physician review, same architecture proposed for Teletabeeb.

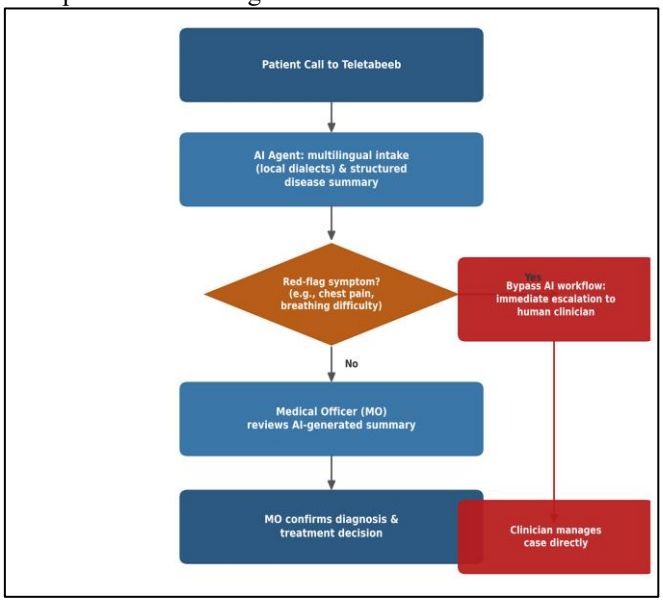


Figure 2: Proposed AI-augmented triage workflow for teletabeeb: the AI agent handles multilingual intake and summarization, red-flag symptoms bypass the AI pathway for immediate clinician escalation, and all other cases proceed to mandatory MO review before any clinical decision.

Within Pakistan specifically, existing telemedicine platforms such as Sehat Kahani and DoctHERS have already demonstrated the viability of remote, technology-mediated triage and consultation at national scale, with published evaluations reporting favorable provider satisfaction and continuity of care through and beyond the COVID-19 pandemic.[16] A recent editorial on integrating AI for patient safety in Pakistan likewise identifies telemedicine-linked AI diagnostics and triage, alongside AI-enabled radiology and predictive analytics, as one of the more immediately actionable opportunities for Pakistani healthcare organizations, while cautioning that successful adoption requires piloting in a single department before scale-up, structured staff training, and local-language support in Urdu, Sindhi, Balochi, and Pashto specifically.[8]

Taken together, this evidence suggests that an AI-based HAIO module for Teletabeeb is both technically feasible and consistent with emerging regional practice, provided that: (i) the AI agent is restricted to intake and summarization rather than diagnosis or triage prioritization, mirroring AmarDoctor's machine-in-the-loop design; (ii) a MO reviews every AI-generated summary before any clinical action is taken; (iii) the system is piloted in one dialect or region before wider rollout; and (iv) mechanisms exist to escalate any call showing red-flag symptoms (e.g., chest pain, breathing difficulty) immediately to a human clinician rather than proceeding through the standard AI-mediated workflow.

TOWARD A RESPONSIBLE AI ADOPTION FRAMEWORK

Drawing on the World Health Organization's six ethical principles for AI in health, which have also been applied to evaluate non-health institutional AI systems, the following framework translates each principle into concrete practice recommendations for 4 interventions described above.[7] While WHO's guidance was written for health applications, its principles of autonomy, well-being, transparency, accountability, equity, and sustainability map naturally onto workplace AI systems more broadly and are used here to unify case study's HR and telehealth interventions under a single governance structure.



Figure 3: The World Health Organization's 6 ethical principles for AI in health, applied as an integrated governance framework unifying SIEHS's HR and telehealth AI interventions.

Table 2: Application of the WHO's six ethical principles for AI in health to the four SIEHS interventions.

Principles	Application to the case study interventions
Protect autonomy	Retain human decision-makers in hiring, require staff consent for biometric monitoring, and preserve physician authority over diagnosis and treatment
Promote well-being, safety, and public interest	Validate each tool's accuracy and safety before scale-up (e.g., vignette-based validation as in AmarDoctor) and define escalation pathways for high-risk cases in telemedicine triage.

Continued.

Principles	Application to the case study interventions
Ensure transparency and explainability	Disclose to candidates how AI scoring works, inform staff when and why they are being monitored, and disclose to patients when they are speaking with an AI agent
Foster responsibility and accountability	Assign named owners for each system's performance and errors; log every AI-assisted decision (hiring score, location flag, triage summary) for audit.
Ensure inclusiveness and equity	Test recruitment scoring for demographic bias; ensure multilingual/dialect coverage in triage so rural and non-Urdu-dominant populations are not excluded.
Promote responsive and sustainable AI	Pilot each system in a single department or region first, monitor for drift or unintended harm, and update models as local data and feedback accumulate.

Operationalizing this framework requires an organization-level AI governance committee, comprising representation from IT, HR, clinical leadership (for Teletabeeb), and data protection, tasked with approving new AI deployments, commissioning periodic bias and accuracy audits, and maintaining a public-facing (or at minimum staff- and patient-facing) statement of how each AI system is used and what safeguards apply.

DISCUSSION

Several cross-cutting challenges emerge from this review, with direct relevance to SIEHS as a provincial public-sector provider. First, Pakistan's underlying digital and health-system infrastructure, characterized by pronounced rural-urban connectivity gaps and a below-average Healthcare Access and Quality score, constrains the reach and reliability of any AI system, however well designed.[5,6] Because SIEHS serves both dense urban centers and remote, poorly connected districts of Sindh, its recruitment tools, monitoring applications, and Teletabeeb triage agent alike depend on stable connectivity and adequately trained staff; deploying them without parallel investment in infrastructure and digital literacy risks widening, rather than narrowing, existing inequities within the province, a concern echoed across recent Pakistan-focused e-health scholarship.[8,9]

Second, each of the four interventions surfaces a distinct governance risk: algorithmic bias in recruitment scoring; privacy and consent concerns in biometric monitoring; and safety-critical failure modes in AI-mediated telemedicine triage, where a missed or mis-triaged red-flag symptom carries direct clinical consequences.[10-13] Cybersecurity and data protection, both identified as areas of concern in Pakistan's current regulatory environment, are relevant across all four systems, given that CVs, biometric identifiers, and patient health information are all forms of sensitive personal data.

Third, the international literature consistently favors machine-in-the-loop over fully autonomous designs in exactly the domains addressed by this case study, human review of AI hiring scores, and physician review of AI-generated triage summaries. This is not merely a risk-mitigation preference; the AmarDoctor validation study demonstrates that AI-physician collaboration can outperform either AI or physicians working alone, suggesting the institution's existing design, where the AI agent hands over to a MO rather than replacing them, is both the safer and the more effective architecture.[15]

Accordingly, this review recommends that SIEHS: (i) commission an independent bias audit of Talent Match Live's scoring model prior to further scale-up; (ii) formalize written consent and data-retention policies for the facial recognition and CCTV monitoring systems, with biometric data stored as non-reversible templates rather than raw images; (iii) pilot the AI-based HAIO module in Teletabeeb within a single district or dialect region of Sindh for an initial period, with defined red-flag escalation protocols, before province-wide rollout, following the phased-pilot approach recommended for AI adoption in Pakistani hospitals (8); and (iv) establish a cross-functional AI governance committee, involving SIEHS's IT, HR, clinical, and data-protection leadership, as described in Section 5, to oversee all four systems on an ongoing basis.

CONCLUSION

The global divide in AI readiness and adoption is mirrored, at a provincial level, in Sindh's uneven digital and healthcare infrastructure. Within this constrained environment, the SIEHS case study reviewed here demonstrates that meaningful AI adoption, spanning recruitment, workforce monitoring, training oversight, and telemedicine triage, is both feasible and consistent with comparable deployments documented internationally, from AI-assisted hiring systems to the AmarDoctor multilingual triage platform in Bangladesh. Feasibility alone, however, is not sufficient. Sustainable and equitable AI adoption in a public-sector LMIC organization such as SIEHS depends on deliberate governance: bias auditing, informed consent, data protection, physician oversight of clinical AI outputs, and phased piloting before scale-up. As a provincial emergency and health services organization integrating AI across multiple administrative and clinical support functions to integrate AI across both its human resource and telehealth functions, SIEHS is well positioned to demonstrate that these safeguards, treated as integral to system design rather than as an afterthought, allow public health institutions in resource-constrained settings to realize AI's efficiency and access benefits without reproducing the inequities that characterize the wider global AI divide.

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