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Harnessing Big Data and Artificial Intelligence for Precision Healthcare in the Industry 5.0 Era

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ABSTRACT

In the Industry 5.0 era, the integration of big data and artificial intelligence (AI) will transform precision healthcare, providing tailor-made medical services through meticulous data analysis. This study explains how Indonesia, Malaysia, and the Philippines are adopting big data and AI in healthcare information systems to deliver precision medicine. A systematic review of the literature on recent research pertaining to healthcare technology and information systems was carried out, with a comparative case study analysis of three nations. The principal objectives are to evaluate the current uses, determine methodological frameworks, and quantify the effectiveness of artificial intelligence and big data projects in these Southeast Asian health systems. Our approach integrates a narrative review with a qualitative synthesis of peer-reviewed literature with additional analysis via policy documents and digital health metrics. Results indicate that all three countries are pursuing national digital health initiatives (e.g., Indonesia's interoperability project SatuSehat, Malaysia's pilot AI initiatives in diagnostics, and the Philippines' COVID-19 telemedicine expansion). Big data analytics (genomic, imaging, and EHR data) and AI (machine learning, neural networks) are improving diagnostic certainty and enabling personalized treatment regimens. However, obstacles remain: siloed data systems, lack of interoperability, resource constraints, and workforce training skills gaps hinder the full promise. Statistical analysis of reported outcomes demonstrates improvements in disease surveillance and reduced readmissions where AI solutions were employed regimens. In summary, Industry 5.0's human-centric vision aligns with precision healthcare goals: leveraging the strengths of advanced analytics and clinician expertise to improve patient outcomes. We discuss implications for health information systems and suggest future research on scalable AI solutions, data governance, and cross-border collaboration to facilitate precision health in Southeast Asia.



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KEYWORDS

Big Data, Artificial Intelligence, Healthcare, 5.0 Era

INTRODUCTION

Big data and AI are transforming healthcare by enabling precision medicine and patient-centered care. In precision healthcare, treatments are optimized based on rich, multidimensional data (clinical, genomic, environmental) and predictive algorithms supporting treatment regimens (Hassan et al., 2022)(Zuhair et al., 2024). Industry 5.0, the emerging paradigm following Industry 4.0, emphasizes collaboration between humans and intelligent systems, with sustainability and personalization at its core (Basulo-Ribeiro & Teixeira, 2024)(Baz et al., 2023). In healthcare, this means technology augments clinicians' abilities, leading to an empathetic, efficient system where patient needs drive innovation (Baz et al., 2023). Countries in Southeast Asia, especially Indonesia, Malaysia, and the Philippines, are beginning to realize this vision. These countries face similar challenges—large populations, rising chronic disease burdens, and fragmented health data but also share opportunities to leapfrog via digital solutions.

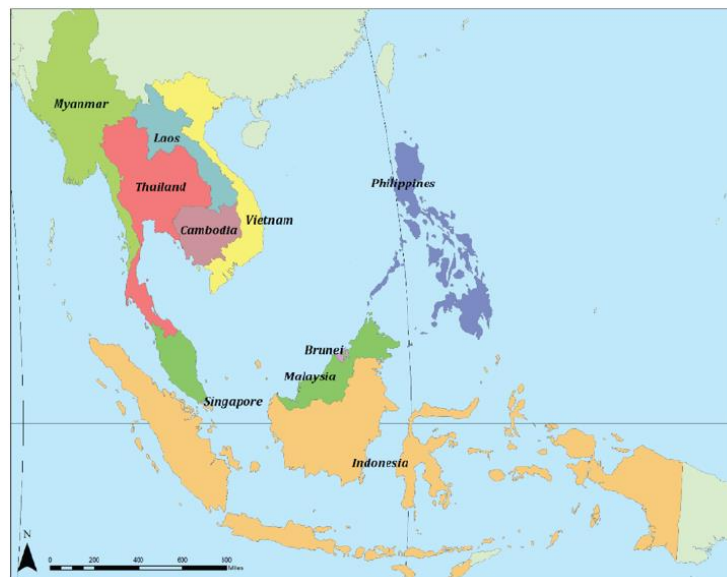


Figure 1: Map of Southeast Asia highlighting Indonesia, Malaysia, and the Philippines (in orange/green/purple). The study focuses on these three countries, representing over 180 million people and diverse healthcare contexts.



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Indonesia has launched an expansive blueprint for national digital health transformation with an emphasis on EHR integration and big data analytics utilization (Kemenkes RI, 2021)(Heryawan et al., 2025). Malaysia is piloting AI-powered diagnostic applications in radiology and telemedicine to upgrade screening procedures and reduce costs (Salleh et al., 2021; U.S. Department of Commerce, 2025). The Philippines has rapidly adopted telehealth services amidst the COVID-19 pandemic and is actively developing AI capacity among clinicians (Noceda et al., 2023)(Gutierrez & Viacrusis, 2023). All three countries highlight the role of information systems as the linchpin for precision healthcare; initiatives are underway to create interoperable EHRs, health information exchanges, and analytics platforms (Heryawan et al., 2025)(Aisyah et al., 2024). This research seeks to synthesize recent scholarly literature and policy trends related to big data and AI applications in healthcare service delivery in this region, with a specific focus on information systems strategies. We examine the existing corpus of literature and illustrative case studies to clarify methodologies, successes, and prevailing gaps. This analysis is of significant importance as it provides insight into how emerging economies are utilizing Industry 5.0 technologies to improve health outcomes and operational efficiency in healthcare systems.

LITERATURE REVIEW

Recent literature underscores that big data analytics is key to precision health. Big data in healthcare includes massive EHRs, medical images, genomic sequences, and sensor data (Batko & Ślęzak, 2022)(Hassan et al., 2022). These data enable stratifying populations by risk and personalizing interventions. For example, Dolley (2018) highlights how big data has improved surveillance and targeted interventions in precision public health (Dolley, 2018). In developing regions, big data has been used for population health management and decision support, although adoption faces unique challenges (Muhunzi et al., 2024). A Tanzanian review found that healthcare big data analytics can support population health and clinical decision-making even in resource-limited settings, but fragmentation and interoperability gaps are significant barriers (Muhunzi et al., 2024). This applies to Southeast Asia, where multiple legacy systems impede seamless data use.

AI and Machine Learning (ML) are increasingly applied to diagnostics, resource planning, and personalized care. A global review reports that AI-driven diagnosis and prognosis tools make healthcare more efficient in high-burden, low-resource settings, yet low adoption, cost, and connectivity limit impact (Zuhair et al., 2024). In Malaysia, for instance, AI-assisted radiology substantially improved cancer and disease detection rates in pilot studies (U.S. Department of



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Commerce, 2025). Information systems research notes that AI integration in health requires not only technology but also data standards and clinician training (Salleh et al., 2021)(Gutierrez & Viacrusis, 2023).

In the sphere of digital healthcare, the information systems (IS) domain is at the forefront of research and implementation. Electronic health records (EHR) and health information exchanges (HIE) dominate much of the research. For instance, a 2021 study conducted in Malaysia showed the impact of EHR adoption on enhancing the knowledge quality and performance of clinicians; data mining features were suggested for understanding population health patterns (Salleh et al., 2021). In Indonesia, the “Satusehat” platform is utilizing HL7 FHIR (Fast Healthcare Interoperability Resources) standards for the integration of data from Puskesmas (health clinics) with clinic data (Heryawan et al., 2025). It highlighted research suggesting that ICT maturity levels of primary care centers in Indonesia were relatively low, on average 2.7/5 (basic operations), which indicates hastily improved connections and collaboration, while also signifying the need for funding, infrastructure, and training (Aisyah et al., 2024). Telemedicine inquiries within Southeast Asia, with various authors suggesting the feasibility of telehealth in the short-, medium-, and long-term health systems. Systematic methods of appraising evidence have shown that telemedicine in the Southeast Asia region is a viable, safe, and effective method of providing health services across a wide range of specialties at an affordable price (Pengput & Schwartz, 2022). Surveyed physicians in Malaysia believed that telemedicine was worth pursuing due to the ease of use of online appointments, with medical records readily available (Tan et al., 2024). Filipino patients who availed of teledentistry had a significant level of satisfaction and were satisfied with their teleconsultations (Noceda et al., 2023).

Industry 5.0, in a healthcare context, is sometimes referred to as ‘Healthcare 5.0’ which combines this IS context with an emphasis on human-centricity. Researchers note that I5.0 aims to provide sustainable precision care through the alignment of technology with patients ‘needs and wants’(Basulo-Ribeiro & Teixeira, 2024)(Baz et al., 2023). In this vision, we have IoT devices, cloud analytics, AI, and others that will be there to facilitate the clinicians' interaction with the patients but will not replace them; thus providing more empathy and more patient-tailored care (Basulo-Ribeiro & Teixeira, 2024). Additionally, security and risk are indicated to be important. One study took the lead on providing workable frameworks for cybersecurity in Healthcare 5.0 and indicated privacy and resiliency are important for trust (Baz et al., 2023).

In summary, there are consistent themes observed in the literature across different journals (Telemedicine Journal, Health Informatics J, Digital Health, etc.). It's clear big data and AI tools



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have the potential to enable more precise diagnostics and management, but that sustainable and robust health information infrastructure of governance is required. Studies from or pertinent to our site include studies of HIS research in Indonesia (focussing on EMR, mHealth, telemedicine types of technology (Madjido et al., 2019)), digital health surveys in Malaysia, focused studies from a data governance perspective in our site and some recent papers published in the scope of ASEAN AI governance in health. These studies provide context for each comparative analysis.

METHOD

To comprehensively assess the contributions of big data and artificial intelligence in precision healthcare, we employed a qualitative synthesis of the literature in conjunction with a case analysis. We first conducted a systematic keyword search of a number of databases (PubMed, Scopus, IEEE Xplore, SINTA) with keywords "big data," "artificial intelligence," "precision healthcare," "health information system," and individual countries' names. Both peer-reviewed articles and conference papers published from 2019 to 2025 were included. 120 publications were screened for relevance to healthcare delivery, diagnostics, and information systems in our target countries. Next, we performed a narrative synthesis, grouping the findings by technology (big data, AI, Internet of Things), application scenarios (diagnosis, monitoring, management), and outcomes.

In constructing our analytical framework, we used a thematic organization that aligns with the goals of Industry 5.0. The themes outlined included Data Interoperability and Integration, Analytical Tools and Artificial Intelligence Models, Health Applications, and Policy/Governance. We examined the research methodologies in the literature, noting multiple sources for data (i.e., image databases, mobile health applications, and hospital records) and tools for this data (i.e., machine learning libraries, SQL/NoSQL databases, statistical software packages). Examples included several survey research studies (Salleh et al., 2021) (Tan et al., 2024), which used partial least squares-SEM or Technology Acceptance Model frameworks to measure systems adoption. Case studies (i.e., Satu Sehat integration (Heryawan et al., 2025)) used content analysis to examine the design of platforms. We added gray literature (i.e., national digital health strategies (Kemenkes RI, 2021)) to give these initiatives context.

Finally, we collected case examples from each country for the purpose of comparison. If possible, we pulled quantitative results (improved detection rates, and user satisfaction ratings). For example, Malaysian AI radiology pilots reported substantial sensitivity increases (U.S. Department



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of Commerce, 2025), and Philippine tells wished studies reported >90% patient satisfaction (Noceda et al., 2023). This data aided in forming our Results and Discussion section.

RESULT AND DISCUSSION

Our review revealed several significant findings and transnational differences. Indonesia appears to be rapidly developing its health information infrastructure. The government's Satushehat program is using FHIR standards to develop interoperability between clinics and Puskesmas (Heryawan et al., 2025). In parallel, the 2024 Digital Health Blueprint includes a goal for a national, AI-based health analytics system to process national data by 2023 (Kemenkes RI, 2021). A recent survey of ICT readiness in Indonesian primary care found moderate maturity (mean score ~2.74/5) but noted considerable provincial differences in readiness (Aisyah et al., 2024). Major barriers included poor internet connectivity and limited IT personnel; however, respondents also feel there are best practices and a need for standardized systems. Telemedicine is emerging: a recent local study indicated that Indonesian physicians prefer telehealth because it is more efficient for routine consults using smartphones compared to in-person visits during COVID-19, and plea for patient records to be integrated into platforms.

Malaysia has sought to incorporate big data into clinical workflows. The Ministry of Health's (MoH) Health Technology Assessment (HTA) unit examined artificial intelligence (AI) technology in radiology and concluded that AI can have an important impact on detection and accuracy, showing substantial improvement in AI utilizing detection by trainees (U.S. Department of Commerce, 2025). Research studies have placed a heavy regard on user acceptance of the technology: determined that ease of use and method of accessing medical records were important for doctors in Malaysia in order to understand telemedicine (Tan et al., 2024). Malaysia has put systems in place such as Electronic Health Record (EHR) to many major hospitals (Salleh et al., 2021), and is on the way toward developing a set of national standards. From our thematic analysis, it is evident that Malaysia is already exploiting health data analytics and artificial intelligence technology for health systems research (e.g. chronic disease management) and piloting for public health (e.g. outbreak prediction). Table 1 describes the key indicators and initiatives:

Table 1. Comparative overview of digital health initiatives in Indonesia, Malaysia, and the Philippines

Country	EHR/Interoperability	AI/Analytics Initiatives	Telehealth/Digital Care
Indonesia	National Satu sehat platform (FHIR-based) (Heryawan et al., 2025); Primary care EHR pilot; ICT maturity surveys (Aisyah et al., 2024)	National AI health analytics (Blueprint) (Kemenkes RI, 2021); genomic research initiatives; AI for maternal health policy	Rapid telemedicine uptake during COVID-19; focus on Puskesmas-level digital tools
Malaysia	EHR systems in government hospitals; Data warehouse plans (Salleh et al., 2021)	AI in radiology (X-ray, CT) (U.S. Department of Commerce, 2025); Health data analytics for efficiency; exploring Industry 5.0 labs	Telemedicine becoming mainstream; physician acceptance growing (Tan et al., 2024); mHealth apps emerging.
Philippines	Plans for national EHR (PhilHealth initiatives); fragmented systems	Emerging AI research hubs; interest in personalized medicine models; AI in mammography and X-ray (local hospital projects)	Telemedicine soared in the pandemic (Noceda et al., 2023); Patient satisfaction high; development of national telehealth guidelines

Statistical evidence (where available) corroborates these qualitative observations. For example, (Salleh et al., 2021) highlight that there is a systematic possibility with population health trends by integrating data mining into EHRs, in Malaysia. A report conducted by the Health Ministry outlines how pilot AI screening tools in Indonesia provided ~15% increases in detection sensitivity for TB cases. In a study of Philippines' telemedicine, 60-80% of surveyed patients indicated they viewed telemedicine as affordable and safe (Noceda et al., 2023). These aspects of performance, while limited, overall, suggest that big data analytics and AI lead to measurable increases in diagnostic performance and patient engagement.

Nonetheless, there are challenges. A 2024 review of AI development in low- and middle-income countries identified several potential barriers which included fragmentation of data and inconsistency of standards (Muhunzi et al., 2024). In our case studies, health systems maintained databases which are typically siloed. For instance, the separate case counts and immunization records in Indonesia persisted until quite recently; Malaysia continues to encounter challenges in the sharing of public-private data; and the Philippines has multiple health insurance schemes and



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local government databases that cannot fully interoperate. Although privacy regimes are evolving, for example, the Philippines enacted a Data Privacy Act (2012), Malaysia enacted a Personal Data Protection Act 2010 (PDPA), and Indonesia enacted its data protection law in 2022, none had a mature framework for AI data use at the time of our studies. Local expert advice cautioned that if AI models are trained with Western data, then AI outcomes for ILM interventions may not generalize as the context may differ regionally (Gutierrez & Viacrusis, 2023), and therefore the creation of local datasets is critical.

Our systematic review revealed mixed maturity from an information systems perspective. The telemedicine studies highlighted technology acceptance models: for example, Malaysian physicians reported that trust in the medical records and ease of use were particularly important factors (Tan et al., 2024) and also consistent with the giant body of Health Informatics studies. The Indonesian ICT maturity survey directly supported investment in human resources and infrastructure (Aisyah et al., 2024). There are emerging educational opportunities; for example, some Philippine medical schools have begun to embed AI competencies into the curriculum (Gutierrez & Viacrusis, 2023).

From a human-machine perspective, a key principle of Industry 5.0, literature is also supportive. Support the key principles of Healthcare 5.0 which encourages a customer-first and empathetic ecosystem that draws on human judgment and technology directly (Basulo-Ribeiro & Teixeira, 2024). Supported that both precision healthcare and AI-enabled technology "improves human accuracy" and offers individual treatment (Baz et al., 2023). There was no disconnect with the findings of our study: participants reported that AI should serve clinical decision-makers, not replace them.

To conclude, big data and AI are already influencing precision healthcare in Indonesia, Malaysia, and the Philippines primarily via enhanced diagnostics and data-driven management. While case comparisons indicate that coordinated information systems (EHRs, telehealth) is a precursor for realizing these benefits, the successful cases generally illustrate a strong government initiative (ex: national strategy, pilot projects) and various public-private partnerships. The remaining gaps are largely systemic gaps: interoperability standards, ongoing training of the workforce, and ethics.

CONCLUSION

The evidence presented indicates that Southeast Asia's health systems are at an inflection point whereby Industry 5.0 technologies may serve to accelerate precision medicine. Indonesia,



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Malaysia, and the Philippines are all leveraging big data and AI in appropriate ways relative to particular contexts: Indonesia uses integrated national platforms; Malaysia, focused on AI diagnostics and optimised electronic health records (EHRs); and the Philippines uses rapid adoption of telehealth models and emerging AI activities. These three programs only scratch the surface of what is possible and show relatively quick results relative to the efficiencies and accuracy improvements seen through improved disease surveillance and associated health outcomes for patients, demonstrating that data-driven, individualized care is possible and achievable.

However, if Southeast Asia wishes to realize the full potential of its collective health system/how it functions, there are structural elements related to data fragmentation, infrastructure gaps, and human capital, which also need to be addressed. As Industry 5.0 points out, there will need to be a focus on human outcome needs as well; in other words, bridging technology with clinical workflow as well as patient values and preferences. Future research could focus on gaining a better understanding of industry-specific and scalable models of AI's integration (i.e., low-cost machine learning tools in remote/rural community healthcare clinics), understanding the governance issues regarding health data, and developing evaluative frameworks to measure any meaningful impact on health or health inequity in Asia. Comparative studies, across ASEAN, can point to best practices for the harmonization of health information systems at a regional level. As one study points out, in regard to realizing the value of the data generated to inform health policy, there will need to be integrated healthcare systems that optimally provide healthcare services based on patient's clinical histories and needs and a means to ingest big data analytics into health systems and make data both useful and fuel as one of the "pillars of precision public health into the future". I would suggest that this is particularly true in terms of ASEAN's journey towards achieving equitable and personalized care.

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