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THEMES AND DEBATES

The Evolution of Digital Health in Indonesia within the Era of Satellite Internet Connectivity

La evolución de la salud digital en Indonesia en la era de la conectividad a Internet por satélite

Ferry Fadzlul Rahman. Departement of Public Health, Universitas Muhammadiyah Kalimantan Timur, Indonesia. Email: ffr607@umkt.ac.id, https://orcid.org/0000-0002-6628-315X
Sayekti Harits Suryawan. Departement of Informatics, Universitas Muhammadiyah Kalimantan Timur, Indonesia. Email: Shs500@umkt.ac.id, https://orcid.org/0000-0001-8628-8823
Muhammad Najeri Al Syahrin. Government Science Department, Universitas Lambung Mangkurat, Indonesia. Email: Najeri.syahrin@ulm.ac.id, https://orcid.org/0000-0002-3164-0647

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Abstract

Background. As global interconnectivity continues to advance through sophisticated information technologies, the future of digital health in Indonesia holds significant potential. The evolution of digital health, particularly in the era of satellite-based internet connectivity, presents important opportunities but also reveals substantial research gaps. Existing studies highlight persistent infrastructure challenges—such as unreliable electricity and limited internet access, especially in rural and remote areas—that hinder the effective implementation of digital health solutions. **Objective.** There is a critical need to understand how satellite internet can address these challenges by enabling the integration and wider adoption of digital health applications across diverse geographic regions. **Results.** Concerns regarding the digital divide and its impact on healthcare equity emphasize the importance of research exploring whether satellite internet can bridge access gaps and provide more equitable delivery of digital health services. This commentary suggests that improved access to healthcare in remote areas, increased efficiency of service delivery, greater patient empowerment, and enhanced use of health data are key potential benefits of satellite-enabled connectivity. **Conclusion.** Further research is needed to evaluate its impact on healthcare access, conduct longitudinal studies on the adoption and sustained use of digital health technologies, integrate advanced digital tools, develop supportive policy and regulatory frameworks, address socio-cultural barriers, and perform comprehensive economic evaluations.

Keyword: Digital Health, Satellite Internet, Connectivity, Indonesia

Resumen

Antecedentes.A medida que la interconectividad global continúa avanzando gracias a las sofisticadas tecnologías de la información, el futuro de la salud digital en Indonesia presenta un potencial significativo. La evolución de la salud digital, en particular en la era de la conectividad a internet por satélite, representa importantes oportunidades, pero también se revelan importantes lagunas en la investigación. Estudios existentes destacan la persistencia de desafíos de infraestructura, como la falta de fiabilidad del suministro eléctrico y el acceso limitado a internet, especialmente en zonas rurales y remotas, lo que dificulta la implementación efectiva de soluciones digitales para la salud. **Objetivo.** Es fundamental comprender cómo funciona la internet por satélite. Puede abordar estos desafíos al permitir la integración de y una adopción más amplia de aplicaciones de salud digital en diversas regiones geográficas. **Resultados.** Las inquietudes respecto a la brecha digital y su impacto sobre la equidad en atención médica enfatizan la importancia de la investigación que explora si la internet satelital puede cerrar las brechas de acceso y proporcionar una prestación más equitativa de servicios de salud digital. Este comentario sugiere que un mejor acceso a la atención médica en áreas remotas, una mayor eficiencia en la prestación de servicios, un mayor empoderamiento del paciente y un mejor uso de los datos de salud son beneficios potenciales clave de la conectividad habilitada por satélite. **Conclusión.** Se necesita más investigación para evaluar el impacto sobre el acceso a la atención médica, realizar estudios longitudinales sobre la adopción y el uso sostenido de tecnologías de salud digital, integrar herramientas digitales avanzadas, desarrollar marcos regulatorios de políticas y apoyos, abordar las barreras socioculturales y realizar evaluaciones económicas integrales.

Palabras clave.: Salud digital, Internet satelital, Conectividad, Indonesia

Introduction.

As the world becomes increasingly interconnected through advanced information technologies, the future of digital health in Indonesia holds significant potential[1]. The emergence of satellite internet represents a major milestone in the country's digital health transformation. By providing high-speed and reliable connectivity even in remote and geographically isolated regions, satellite-based internet enables digital health solutions to reach a broader population. This connectivity supports the seamless transfer of medical data, telemedicine consultations, and remote patient monitoring. Previously, many healthcare facilities—particularly in rural areas—faced limited or no internet access, which hindered effective healthcare delivery and communication[2].

The accessibility and affordability of healthcare services can be substantially improved as digital health platforms leverage satellite-based internet to bridge the gap between patients and healthcare providers[3]. Through telehealth systems, individuals in underserved regions can access medical consultations from specialists regardless of geographic location[4]. In addition, satellite-based connectivity enhances healthcare data management[5] by allowing medical records to be securely stored and accessed by healthcare professionals, thereby improving care coordination and patient outcomes[6].

Furthermore, the integration of satellite internet into digital health systems will facilitate remote training and continuing education for healthcare professionals. Access to online courses, virtual conferences, and collaborative platforms will strengthen clinical skills and knowledge. This, in turn, will contribute to the development of a more capable healthcare workforce and improve the overall quality of healthcare services in Indonesia.

The Indonesian Ministry of Health has launched a comprehensive **Digital Health Transformation Strategy (DHTS) for 2025–2029**, focusing on the standardization of data, technology, and infrastructure across the health sector[7]. The strategy emphasizes collaboration with multiple stakeholders. A study by the Tony Blair Institute for Global Change highlights that health technology initiatives are aligned with national development goals and promote equitable access to healthcare services across regions[8].

Satellite internet is enabling online medical consultations, remote training for healthcare workers, and real-time data reporting from healthcare facilities[5]. This enhanced connectivity supports the government's digitalization agenda by helping bridge the digital divide and ensuring that even the most remote areas can access quality healthcare services [5, 9].

Furthermore, analyses of market opportunities for e-health in private hospitals indicate a growing demand for digital healthcare services, underscoring the need for strategic adaptation by healthcare providers[10]. This transition requires a comprehensive approach, including upgrading healthcare facilities to integrate digital technologies effectively[11]. At the same time, the importance of protecting personal data in e-health services has been emphasized, highlighting the need for robust regulatory frameworks to ensure privacy and data security [6, 10]. Collectively, these findings illustrate that advancing digital health in Indonesia requires coordinated efforts in technological innovation, policy development, and strategic planning.

Implementing satellite internet for digital health in Indonesia faces several significant barriers. The country's diverse geography, with its numerous islands, poses challenges for establishing consistent and reliable internet connectivity, requiring substantial investment in infrastructure such as ground stations and satellite technology. High costs associated with deploying and maintaining satellite internet further complicate implementation, as the initial investment for satellites and ground equipment is considerable and operational costs must be managed to ensure affordability for users [12].

Regulatory and policy challenges also play a role, as the regulatory environment must balance innovation with safety and compliance, particularly with respect to data privacy and security [12]. Technical expertise is another critical factor, since the implementation and maintenance of satellite internet require specialized skills, making local capacity building essential [5]. Finally, integrating satellite internet with existing healthcare systems requires interoperability and seamless data exchange, which poses additional technical and logistical challenges. Addressing these barriers requires coordinated efforts involving government policy, infrastructure investment, capacity building, and public–private partnerships to create a sustainable and effective digital health ecosystem supported by satellite internet [5, 9].

A structured approach such as the Indonesian Ministry of Health's 2025–2029 Digital Health Transformation Strategy (DHTS) has the potential to serve as a reference model for other developing nations, particularly those facing similar infrastructure and healthcare accessibility challenges. To objectively assess its global applicability, several key factors must be considered, including policy alignment with international digital health strategies, technological infrastructure and interoperability, healthcare equity and access, economic feasibility, and sustainability of implementation [7].

The DHTS leverages **satellite internet**, telemedicine, and AI-driven healthcare solutions to bridge urban–rural disparities, but its success depends on overcoming regulatory, financial, and digital literacy barriers. Comparing Indonesia's approach with models from India, Thailand, Kenya, and Rwanda can provide valuable insights into scalability, funding models, and policy effectiveness. The strategy's emphasis on public–private partnerships, health data standardization, and digital literacy programs makes it a promising framework, though its replicability depends on country-specific adaptations to legal, technological, and socio-economic conditions [13].

For example, India's national telemedicine service (eSanjeevani) has facilitated millions of remote consultations, Kenya's mobile health platforms have improved maternal and child health in rural areas, and Brazil's SUS digital initiative integrates electronic health records to support universal healthcare [13]. These real-world cases provide valuable insights into how digital technologies can be effectively scaled in diverse socio-economic contexts, offering a globally relevant framework for Indonesia's strategy. Developing nations seeking to implement similar policies must consider customizing digital infrastructure, addressing cybersecurity risks, and ensuring financial sustainability while drawing on Indonesia's best practices in healthcare digitalization.

Social determinants such as income, education, geography, and digital literacy directly influence individuals' ability to access and benefit from digital health technologies. In Indonesia, populations in remote areas with lower educational attainment and limited infrastructure remain the most affected by the digital divide. Civil society organizations (CSOs) have played a crucial role in addressing these gaps by facilitating digital literacy training, community-based telemedicine initiatives, and advocacy for inclusive health policies. For example, local NGOs in Eastern Indonesia have collaborated with healthcare workers to implement mobile health clinics powered by satellite connectivity [14]. Internationally, Brazil's Telehealth Program has incorporated community health agents to deliver education and support in rural areas, while Kenya's mHealth platforms rely heavily on community-based organizations for outreach and trust-building. These cases illustrate that technology alone is insufficient; its equitable deployment depends on strong partnerships between government, civil society, and local communities, as well as policies that address underlying socio-economic disparities.

Developing nations seeking to implement similar policies must consider customizing digital infrastructure, addressing cybersecurity risks, and ensuring financial sustainability while

drawing on Indonesia's best practices in healthcare digitalization.

In Indonesia, the intersection of digital technology and healthcare is reshaping consumer participation while also exposing challenges within existing legal frameworks. One case illustrates this tension, revealing the complexities of digital communication's impact on public discourse and medical privilege [7]. Despite these challenges, the ambition for universal health coverage and existing legal frameworks provides a foundation for facilitating Health Technology Assessment (HTA) [7]. However, barriers such as a lack of local expertise and data persist. Overcoming these obstacles requires strategies such as international networking and the establishment of clear HTA frameworks, which align with Indonesia's goals for comprehensive healthcare access [7].

Additionally, disparities in healthcare accessibility between remote and urban regions underscore the importance of effective primary care systems, especially for reaching marginalized populations. While the COVID-19 pandemic exacerbated healthcare disruptions, it also accelerated the adoption of telemedicine, offering a promising response to access barriers [2, 4, 7.] Digital health services, which are integral to Indonesia's Smart City initiatives, show promise but face uneven implementation. A Smart City initiative leverages technology, data analytics, and connectivity to enhance urban living, improve public services, and optimize resource management. In Indonesia, this includes integrating IoT, AI, and big data to improve governance, transportation, energy management, and, most importantly, healthcare services. However, disparities in infrastructure and access continue to hinder equitable healthcare delivery. To bridge this gap, efforts must focus on infrastructure enhancement, stakeholder collaboration, and addressing regional disparities to ensure equitable access to healthcare across the nation while aligning with Indonesia's broader digital transformation goals.

How can satellite internet benefit remote healthcare in Indonesia?

In Indonesia, the COVID-19 pandemic caused significant disruptions to healthcare services, prompting many patients to avoid hospital visits and discontinue medications without medical guidance. Telemedicine emerged as a viable alternative during this period, with approximately 26% of patients with autoimmune rheumatic diseases using telemedicine services and reporting high satisfaction [15]. However, the implementation of telemedicine faces legal and ethical challenges, including concerns about the legality of healthcare practices, therapeutic transactions, and patient data confidentiality. To ensure the equitable delivery of quality healthcare, specific regulations addressing these issues are required.
Remote areas in Indonesia face persistent challenges in healthcare access, primarily due to shortages of physicians. Efforts to address these challenges include initiatives to improve healthcare and information and communication technology (ICT) infrastructure, although barriers such as inadequate technology and policy gaps remain [7, 16]. Mobile telehealth applications nevertheless hold promise for bridging these gaps by enabling digital medical records and improving communication among patients, healthcare providers, and policymakers [17]. These innovations have the potential to strengthen healthcare delivery and capacity building in rural communities, promoting more inclusive healthcare access nationwide.

The COVID-19 pandemic further accelerated shifts in healthcare delivery, reinforcing the need for adaptable solutions. Telemedicine became a critical tool, providing continuity of care for patients facing treatment disruptions and concerns about virus transmission [4].

Moreover, disparities in healthcare access between urban centers and remote regions continue to reflect systemic inequalities within Indonesia's healthcare system 18. Shortages of medical professionals in rural areas further exacerbate these gaps. Although government

initiatives aim to strengthen healthcare infrastructure in underserved regions, persistent limitations in ICT infrastructure require sustained investment. Despite these challenges, mobile telehealth applications offer a promising pathway forward by improving service delivery and empowering both patients and providers. Through coordinated efforts to address regulatory gaps and strengthen digital infrastructure, Indonesia can move toward a more equitable and responsive healthcare system for all citizens.

Indonesia's experience in leveraging **satellite internet** for digital health provides valuable insights for other low- and middle-income countries (LMICs) seeking to improve healthcare access amid infrastructural constraints. Its comprehensive Digital Health Transformation Strategy (DHTS), combined with efforts to integrate telemedicine, e-health regulations, and public–private partnerships, offers a scalable model adaptable to similar socio-economic and geographic contexts [19]. The Indonesian case demonstrates how digital innovation, when aligned with national development goals and inclusive governance, can promote health equity. Furthermore, the focus on interoperability, local capacity building, and multisector collaboration can serve as guiding principles for countries seeking to modernize their healthcare systems without deepening existing disparities. Indonesia's challenges, such as the digital divide, regulatory fragmentation, and limited rural infrastructure, are shared by many nations, making its solutions particularly instructive [19]. Thus, Indonesia's evolving approach contributes not only to national health resilience but also enriches the global discourse on equitable digital health policymaking.

What are the challenges of implementing satellite internet in Indonesia?

The available evidence highlights several technological challenges related to satellite-based communication, particularly in Space IoT systems using nanosatellites. These challenges include maintaining stable signals in the presence of limited power, satellite orientation issues, and signal interference. Innovative solutions such as the Teager Energy Decoder (TED) offer potential ways to address these technical barriers [20].

The Teager Energy Decoder (TED), based on the Teager Energy Operator (TEO), is also widely used in healthcare for analyzing biomedical signals with high sensitivity to transient energy changes [20]. TED plays an important role in EEG analysis for seizure detection, brain–computer interfaces, and sleep disorder diagnosis. In ECG processing, it enhances arrhythmia detection and heart rate variability analysis, while in EMG signal processing, it supports the diagnosis of neuromuscular disorders and improves prosthetic control. TED also contributes to respiratory health monitoring by detecting conditions such as COPD, sleep apnea, and respiratory infections. In addition, it is used in speech pathology to identify early signs of Parkinson's disease and voice disorders. Its capacity for real-time, non-invasive, and cost-effective signal processing makes it well suited for modern healthcare applications, including wearable health monitoring and AI-driven diagnostics [20]

Meanwhile, the impact of the Internet on Indonesian rural youth illustrates the dual nature of connectivity, which enhances social capital while also encouraging migration due to increased access to information and opportunities elsewhere [2]..

In Indonesian democracy, the Internet has played a pivotal role—from fostering free speech and anti-statist movements to facilitating transparent elections—thereby strengthening electoral democracy [21]. As Indonesia embraces Industry 4.0, IoT integration into compact housing has emerged as a critical frontier, promising enhanced convenience and security through adaptable smart home technologies [7].

Table 1. Comparative Analysis of Global vs. Indonesia's Challenges in Implementing Satellite-Based Internet for Digital Health

Category	Global Challenges	Indonesia Specific Challenges
Infrastructure	Limited infrastructure in remote and underserved regions, requiring extensive satellite ground stations.	Geographical barriers (islands, mountains) make infrastructure deployment complex, with limited electricity in rural areas.
Cost & Affordability	High deployment and maintenance costs, making satellite-based internet unaffordable for low-income nations.	High costs of satellite internet access, making it expensive for government and healthcare institutions to sustain.
Regulatory & Policy Issues	Varying international regulations and spectrum allocation issues complicate global deployment.	Regulatory challenges in aligning satellite internet policies with healthcare data governance and national health frameworks.
Technical Expertise	Lack of skilled professionals for satellite communication and digital health integration.	Shortage of local expertise in satellite operations and digital health technology integration.
Interoperability	Difficulty in integrating satellite internet with existing healthcare IT systems and standards.	Challenges in ensuring compatibility between existing hospital IT infrastructure and satellite-based networks.
Security & Privacy	Risk of data breaches and cybersecurity threats due to reliance on satellite communication.	Weak enforcement of cybersecurity laws, raising concerns over patient data protection.
Digital Divide	Unequal access to digital health services due to varying levels of technological adoption.	Disparities between urban and rural areas in internet connectivity and healthcare service availability.
Environmental & Orbital Risks	Orbital congestion, space debris, and potential environmental impact from satellite launches.	Potential environmental concerns related to Indonesia space program and sustainability policies.

However, the proliferation of satellite megaconstellations poses new challenges. These megaconstellations refer to the rapid expansion of large-scale networks of low Earth orbit (LEO) satellites deployed by companies such as SpaceX (Starlink), Amazon (Project Kuiper), OneWeb, and China's Guowang to provide global broadband and communication services. Often consisting of thousands of interconnected satellites, these systems aim to expand connectivity, particularly in remote and underserved areas [22]. At the same time, they highlight the delicate balance between technological advancement and preserving essential resources such as dark skies for scientific research and human well-being [22].

Collectively, these developments underscore the intricate interplay between technology, society, and governance in shaping Indonesia's trajectory in the digital age.

The challenges Indonesia faces in implementing satellite internet and digital health are not unique but reflect broader patterns observed across other Southeast Asian and African countries. In nations such as the Philippines, Myanmar, and Laos, fragmented infrastructure, archipelagic geography, and limited investment in digital capacity similarly hinder equitable access to digital health services [19]. African countries such as Nigeria, Ethiopia, and Uganda also grapple with low broadband penetration, workforce

shortages, and difficulties integrating emerging technologies into overstretched public health systems [23]. In both regions, the digital divide is shaped by rural–urban disparities, socio-economic inequalities, and weak regulatory frameworks. Moreover, the need for affordable satellite connectivity, locally adapted telehealth solutions, and robust cybersecurity policies echoes across these contexts. Thus, while Indonesia's specific geography and policy environment shape its experience, the underlying structural barriers and opportunities for innovation are shared across many developing countries, making cross-country learning and collaboration highly valuable.

The insights provided offer a multifaceted understanding of technology's evolving role across diverse spheres of Indonesian society. Challenges in Space IoT communication highlight the technical complexities of satellite systems, necessitating innovative solutions to ensure reliable data transmission [21]. Meanwhile, the impact of the Internet on Indonesian rural youth underscores the profound social implications of connectivity, balancing the opportunities it creates with the risk of rural depopulation as individuals seek better prospects.

Conclusion

The integration of satellite internet into Indonesia's digital health infrastructure presents a significant opportunity to enhance the accessibility and quality of healthcare services, particularly in geographically isolated and underserved regions. To fully harness this potential, it is imperative that policymakers implement targeted strategies focused on infrastructure expansion, intersectoral collaboration, and the advancement of digital health literacy. By systematically addressing existing connectivity disparities and fostering innovation, Indonesia can move toward a more equitable and resilient healthcare system, ensuring that advances in medical technology are accessible to all segments of the population.

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Highlight. Satellite internet's deployment in Indonesia is a pivotal step towards achieving a more connected and efficient healthcare system, laying the groundwork for future advancements in digital health across the country.

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