



Enhancing Digital Health Services in ASEAN Countries: Comparison of Indonesia, Singapore, and Thailand

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Abstract

Digital health is transforming healthcare globally, with ASEAN nations like Singapore, Thailand, and Indonesia, which reveal diverse progress. This study analyzes and compares their digital health services to pinpoint best practices and potential enhancements. Employing a mixed-methods approach involving literature reviews, policy analysis, and data gathering on infrastructure and service adoption from government and academic sources, the research focuses on governance, investment, infrastructure, and service uptake. Findings reveal Singapore as a digital health frontrunner due to its strong governance, substantial investment, advanced infrastructure, and high adoption. Thailand shows progress but grapples with decentralized governance and urban-rural divides. Indonesia's developing sector faces fragmented governance, limited investment, and infrastructure deficits. The study underscores the importance of centralized governance and robust investment for successful digital health implementation, highlighting Singapore's cohesive strategy as a beneficial model. Thailand and Indonesia need to enhance policy consistency and infrastructure development to improve the effectiveness of digital health services in ASEAN. Ultimately, advancing digital health in ASEAN requires a comprehensive strategy encompassing strengthened governance, increased investment, recommended infrastructure, and greater public awareness, drawing lessons from successful models to improve regional healthcare access and quality.

Introduction

Digital technologies have profoundly changed healthcare delivery systems globally, enhancing accessibility, quality, and efficiency. Digital health, which includes tools like telemedicine, electronic health records (EHRs), mobile health applications, and health information systems, is now recognized as a crucial component of modern healthcare infrastructure (World Health Organization (World Health Organization, 2020)). The global adoption of digital health technologies is a rapidly evolving field filled with both opportunities and challenges, as highlighted by various academic studies. Digital health services comprise a range of technologies

aimed at improving health systems, such as telemedicine, health apps, and wearable devices. According to the WHO, digital health services utilize information and communication technology to support health and healthcare. These technologies seek to enhance access, quality, and efficiency of health services while reducing healthcare disparities.

Implementing digital health technologies involves navigating a range of complex challenges that span technical, ethical, financial, and social dimensions. A major technical hurdle is the lack of interoperability among digital health systems, which hampers the smooth exchange and integration of data across platforms. This fragmentation creates

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information silos, undermines coordination, and reduces the overall efficiency of healthcare delivery. Addressing these challenges is essential to ensure that digital health solutions are not only effective but also equitable and sustainable (Pant *et al.*, 2022). While the adoption of digital health solutions promises improved quality of care at more sustainable costs, widespread implementation is still lagging (Pérez Sust *et al.*, 2020). The WHO has introduced a global strategy on digital health to guide the development and expansion of digital health services, emphasizing the need for alignment between national strategies and global guidelines (Dhingra & Dabas, 2020; Holl *et al.*, 2024). The rapid expansion of digital technologies, especially mobile platforms, is transforming global health by creating new pathways to improve outcomes. Telemedicine and remote patient monitoring, in particular, have significantly widened access to care for communities in rural and underserved areas. These innovations reduce the need for travel, lowering both time and financial burdens, while enabling continuous oversight and management of chronic conditions, thus fostering more responsive and equitable healthcare delivery (Chandrakar, 2024).

The number of health apps available has exceeded 350,000 apps, providing people worldwide with greater access to health information and self-care tools (Morley *et al.*, 2025). Countries have formulated digital health strategies that align with their national health priorities and global frameworks, such as the WHO's Global Strategy on Digital Health 2020-2025 (Holl *et al.*, 2024). Although adopting information and communication technologies in the health sector has been slower than in other sectors, successful implementations, like electronic health records in remote Western Australia, have showcased the potential for improved health outcomes. The adoption of digital health technologies involves not only implementing technology but also fostering a digital culture to achieve better results. In summary, the global adoption of digital health technologies is a complex and multifaceted process with the potential to significantly enhance healthcare outcomes, while also necessitating careful consideration of ethical,

cultural, and regulatory factors.

Digital health is rapidly gaining importance across the ASEAN region as countries confront mounting healthcare challenges driven by urbanization, aging populations, and the rise of chronic diseases. With the region hosting the fastest-growing internet market globally, digital technologies are transforming healthcare delivery by improving access, efficiency, and quality of care. Nations such as Indonesia, Malaysia, Singapore, and Thailand are leading the way in adopting eHealth solutions, investing in research and implementation to modernize their health systems and meet the diverse needs of their populations (Suranto *et al.*, 2025). For example, Indonesia has begun integrating artificial intelligence into chronic disease management, particularly in diabetes care, to enhance screening and treatment outcomes (Lians *et al.*, 2025). However, organizational readiness remains a critical factor, as shown in studies of EMR adoption in Indonesian hospitals, where leadership and openness to innovation significantly influence success (J. K. Lee & Antonio, 2025).

The establishment of the ASEAN Network for Drugs, Diagnostics, Vaccines, and Traditional Medicines Innovation (ASEAN-NDI) demonstrates efforts to combat prevalent infectious tropical diseases in the region (Montoya *et al.*, 2014). The pandemic highlighted the potential of teledentistry within ASEAN, showcasing it as a cost-effective solution for dental care and education while underscoring the necessity for robust legislation to fully harness its capabilities (Jin-Yu *et al.*, 2024). Health Technology Assessment (HTA) processes vary across ASEAN, with some countries having well-established systems and others still in the early stages of development (Sharma *et al.*, 2021). The adoption of eHealth technologies is accelerating across the region, marked by dynamic trends in innovation, spatial expansion, and evolving research priorities (Lwin *et al.*, 2023). Within ASEAN, countries are progressing at different rates in integrating digital health solutions, shaped by disparities in economic capacity and technological infrastructure. These variations underscore the complex interplay between national

development contexts and the feasibility of implementing effective digital health systems.

Singapore, Thailand, and Indonesia each offer distinct contexts for examining how digital health services can be optimized within the ASEAN region. Singapore stands out with its advanced healthcare system and high digital readiness, making it a model for integrated eHealth solutions. Thailand, with its strong public health initiatives and growing tech sector, represents a middle ground where innovation meets broad population needs. Meanwhile, Indonesia's vast geography and diverse socio-economic conditions pose unique challenges and opportunities for scaling digital health interventions across varied regions.

Singapore's National Electronic Health Record (NEHR) system plays a pivotal role in advancing a more cohesive and efficient healthcare framework. At its core, the Next Generation Electronic Medical Record (NGEMR) platform enables streamlined data exchange among healthcare providers, allowing both general practitioners and specialists to access patient records from a centralized database. It reduces duplication in diagnostic procedures and fosters better coordination of care, ultimately enhancing clinical efficiency and patient outcomes (Chen *et al.*, 2025). The implementation of NEHR, however, requires careful navigation of stakeholder relationships and institutional dynamics. Positive engagement has been linked to the presence of boundary spanners—individuals who bridge organizational divides—and active involvement of medical professionals in the process (Klecun *et al.*, 2019). Complementing this infrastructure, Singapore has also rolled out a suite of digital health innovations, including HealthBuddy and MyCare apps, as well as AI-driven tools for managing COVID-19, reflecting its commitment to leveraging technology for public health (Perdana & Mokhtar, 2023; Stona, 2023; Weng *et al.*, 2024).

Indonesia has experienced rapid growth in digital health, particularly in telemedicine and e-health laboratory systems. The country has around 10 digital health services in operation, with the potential to become a unicorn startup (Vauzia & Sumitra, 2020). These services focus on epidemic surveillance,

telemedicine, and data systems for COVID-19 management (Ainur *et al.*, 2022; Shifa *et al.*, 2024). However, challenges such as limited internet access and infrastructure in remote areas persist, although interest in digital health is growing, especially in Western and Central Indonesia (Aisyah *et al.*, 2024; Rohmah *et al.*, 2023; Shifa *et al.*, 2024). An assessment of ICT maturity in Indonesian healthcare services revealed an average score between basic and good, with significant provincial variations (Aisyah *et al.*, 2024). Telemedicine has rapidly evolved, facing challenges related to human resources, infrastructure, and ethical regulations (Ainur *et al.*, 2022; Wijaya *et al.*, 2022). Effective implementation of digital health technologies requires supportive policies, stable electricity, and affordable mobile internet services, particularly for older patients and those in rural areas (Hui *et al.*, 2022).

Thailand has demonstrated a strong commitment to advancing digital health, with particular emphasis on e-health applications, such as telepsychiatry and telemedicine to strengthen primary care services (Raza *et al.*, 2024). A notable example is the development of the OSOMO Prompt app, designed using the ADDIE model, Analysis, Design, Development, Implementation, and Evaluation, which ensured that the app was contextually relevant and user-centered, especially for elderly populations in rural areas. This structured approach contributed to high levels of user acceptance and underscored the app's practical utility in promoting digital inclusion and health equity (Aydin *et al.*, 2023). Thailand has also pioneered the 'Tele-ICU' model, enabling remote critical care support by linking intensivists with patients in underserved regions. Despite these promising developments, existing research often falls short of offering a comprehensive view of Thailand's digital health ecosystem. There remains a need for more holistic analyses that examine the full spectrum of technologies in use, their measurable impacts on health outcomes, and the systemic challenges that influence their implementation and scalability. This study explores the optimization of digital health services across ASEAN, concentrating on the experiences of Indonesia, Singapore, and Thailand. These countries exhibit varied socio-

economic landscapes, healthcare structures, and stages of technological advancement, providing a rich comparative basis for understanding regional digital health trajectories. Through an in-depth analysis of their unique challenges and opportunities, the research seeks to guide the development of inclusive and impactful digital health strategies tailored to ASEAN's diverse contexts.

Method

This study employs a comparative cross-country analysis to explore the optimization of digital health services in Singapore, Thailand, and Indonesia. The choice of these three countries is based on their diverse levels of economic development, healthcare infrastructure, and digital health adoption, making them suitable for a comparative study that seeks to derive insights relevant to the broader ASEAN region's data sources. The study draws on secondary data sources. Secondary data were collected from a review of relevant literature, including peer-reviewed journal articles, government reports, policy documents, and publications from international organizations such as the World Health Organization (WHO) and the International Telecommunication Union (ITU). The literature review aimed to provide a comprehensive understanding of the digital health landscape in each country, covering aspects such as policy frameworks, technological infrastructure, and digital health outcomes.

The study utilizes the Digital Health Framework developed by the WHO as a guiding analytical tool. This framework provides a structured approach to analyzing digital health systems, focusing on four key domains: governance, strategy and investment, infrastructure, and services and applications (World Health Organization, 2019). Each of these domains was examined in the context of Indonesia, Singapore, and Thailand to assess the current state of digital health and identify areas for optimization. The study is anchored in the World Health Organization's Digital Health Framework, which offers a structured lens for analyzing national digital health systems. Central to this framework are four interrelated domains that shape the development and

delivery of digital health services. The first domain, governance and policy, encompasses the institutional arrangements, regulations, and national policies that guide digital health initiatives. In this study, each country's regulatory landscape was examined to understand how governance influences digital health applications.

The second domain, strategic investment, focuses on how nations plan and allocate resources to sustain digital health services. This includes an analysis of national strategies that outline long-term visions and funding priorities. Infrastructure development forms the third domain, referring to the technological and organizational foundations necessary to support digital health systems. Here, the study explored both the challenges and opportunities in building robust infrastructure across diverse national contexts. Finally, the services implementation domain encompasses the range of digital health applications in use, including telemedicine platforms, electronic health records (EHRs), mobile health tools, and health information exchanges. By examining these four domains in Indonesia, Singapore, and Thailand, the study provides a comprehensive view of each country's digital health landscape and identifies key areas for optimization. The study relied on secondary data sources and employed descriptive statistical methods to analyze the digital health landscape in Indonesia, Singapore, and Thailand. This approach enabled the identification of key performance indicators such as internet penetration rates, the number of registered telemedicine users, and the adoption levels of electronic health records (EHRs). Through this analysis, the study offers a comparative snapshot of digital health progress across the three countries.

Although the findings contribute meaningful insights into the optimization of digital health services within the selected ASEAN nations, the study is not without limitations. Its narrow focus on three countries may restrict the applicability of the conclusions to other ASEAN members, especially those with differing healthcare systems and technological readiness. These contextual differences highlight the need for broader regional analysis

to capture the full spectrum of digital health development. To address these limitations, future research could expand the geographical scope to include a more diverse set of ASEAN countries. Incorporating quantitative surveys alongside qualitative assessments would enrich the data and provide a more comprehensive understanding of digital health dynamics. Such an approach would strengthen the evidence base for policy recommendations and support more inclusive regional strategies.

Result and Discussion

The comparative analysis of digital health services in Singapore, Thailand, and Indonesia was conducted using key indicators such as governance, strategic investment, infrastructure development, and service implementation. The data collected from government reports, healthcare studies, and academic sources highlight distinct differences and commonalities in the approaches taken by these three ASEAN countries. The comparative analysis highlights distinct strategies and varying levels of success in implementing digital health solutions, focused on synthesizing the findings, understanding the implications for each country, and suggesting recommendations for optimizing digital health services. In recent years, the digital health services landscape in Southeast Asia has changed notably, especially in Indonesia, Singapore, and Thailand, each exhibiting distinct governance and policy structures. The evolution of digital health services in this region has revealed considerable variations among Indonesia, Singapore, and Thailand, particularly regarding their governance frameworks and policies.

The journey toward digital health in Indonesia has accelerated, especially during the COVID-19 pandemic. The government has prioritized universal healthcare and implemented digital surveillance systems to manage the crisis (Aisyah *et al.*, 2024; Rohmah *et al.*, 2023). Despite these advancements, the country faces considerable challenges, such as limited access to health services in rural regions and a shortage of healthcare workers (Ainur *et al.*, 2022). The implementation of digital health services is notably more prevalent in the Western and Central parts of Indonesia,

while the Eastern regions struggle due to infrastructural disparities (Aisyah *et al.*, 2024).

Collaboration between government agencies and private providers has been vital in addressing these issues. Indonesia has demonstrated a high rate of digitization in the healthcare sector, particularly with the introduction of digital pandemic surveillance and reporting technologies. This initiative has succeeded by collaborating with government bodies and private providers. However, despite the progress, challenges remain, including uneven access to healthcare services in remote areas and a shortage of healthcare professionals (Aisyah *et al.*, 2024). Singapore has emerged as a leader in digital health within the ASEAN region. The nation benefits from comprehensive national ICT policies and robust health promotion strategies that support its digital health initiatives (4). Singapore has developed extensive telemedicine guidelines encompassing various aspects, including clinical governance, ICT infrastructure, and data privacy (Isbayuputra *et al.*, 2024). These guidelines position Singapore at the forefront of telehealth services in Southeast Asia, ensuring a well-regulated and efficient healthcare system.

Singapore has achieved notable progress in digital health, propelled by sustained political commitment and strategic government investment. These efforts have fostered a more cohesive and patient-focused healthcare system. Through continuous enhancement of workforce competencies and the development of robust physical and legal infrastructure, the government has ensured that the health sector remains aligned with rapid technological evolution (Erh, 2023). Meanwhile, Thailand has also made significant strides in digital health, propelled by national ICT policies designed to enhance the digital economy (4, 6). However, the country grapples with challenges such as low investment in digital health and unequal access to digital technologies. While there are promising trends in the implementation of digital health services, Thailand still faces obstacles, including modest penetration of digital technology across different sectors and a limited number of workers with advanced IT skills (Jongwanich, 2023).

In Thailand, the government has

introduced key policies to enhance the country's digital economy, with positive trends in digital services, including health. However, concerns persist regarding relatively low investment and limited penetration of digital technology in certain sectors (Jongwanich, 2023). Despite the significant potential, Thailand faces challenges in ensuring that all regions benefit from these digital innovations. Indonesia, Singapore, and Thailand each demonstrate distinct pathways in the development and implementation of digital health systems. Their varied experiences reflect a wide spectrum of challenges and strategic responses, shaped by differing socio-economic conditions and technological capacities. These contrasts underscore the critical need for governance and policy frameworks that are context-specific, enabling each country to effectively address the complexities of healthcare in the digital era (see Table 1).

Regarding regulatory oversight, Indonesia has seen the introduction of digital health technologies through collaboration among various stakeholders, including government agencies, private providers, and higher education and research institutions (Aisyah *et al.*, 2024). On the other hand, studies on digital health implementation in Thailand have highlighted the need for stable electricity infrastructure and affordable mobile internet services to effectively support the deployment of digital health technologies (Hui *et al.*, 2022). Although the Indonesian government has designated the implementation of digital health as a national goal, challenges such as clinician resistance, financial constraints, and cybersecurity threats continue to pose

significant barriers (Isbayuputra *et al.*, 2024).

The COVID-19 pandemic has accelerated the application of digital health services in Indonesia, with nearly 10 digital health services currently operating in the country. This sector is expected to evolve into a significant startup opportunity (Vauzia & Sumitra, 2020). In Thailand, regional variations in the implementation of digital health services are evident, with the Western and Central regions leading compared to the Central and Eastern areas (Rohmah *et al.*, 2023). However, Indonesia still faces main obstacles, including the digital divide and privacy concerns, that hinder the broader adoption of digital health technologies, despite a notable increase in the use of digital media for health communication during the pandemic (Andi *et al.*, 2024).

Regarding adoption and implementation, the maturity of ICT usage in Indonesian healthcare services is assessed to be between basic and proper levels, with notable variations across provinces. It highlights the diversity in ICT readiness and the need for regionally customized follow-up actions (Aisyah *et al.*, 2024). Additionally, studies have highlighted the need for improving digital literacy and technological infrastructure to address the existing digital divide and privacy challenges (Andi *et al.*, 2024). The ASEAN Digital Masterplan 2025 emphasizes the importance for Thailand and other member nations to prioritize the development of digital technology and foster innovation to strengthen the impact of the ASEAN Economic Community (Wongwuttivat *et al.*, 2024).

In conclusion, the governance and policy

TABLE 1. Level of Digital Health Services Implementation

No.	Countries	Governances and Policies	Implementations	Challenges
1.	Indonesia	Universal health care, digital pandemic surveillance	Regional disparities, collaboration with private providers	Limited access, healthcare worker shortage
2.	Singapore	Comprehensive ICT and health policies	Extensive telemedicine guidelines	N/A
3.	Thailand	National ICT policies, digital economy focus	Promising trends, low investment	Unequal access, low IT-skilled workforce

Source: compiled by the authors

frameworks shaping digital health in Indonesia, Singapore, and Thailand reflect markedly different stages of development, institutional maturity, and regulatory approaches. These differences illuminate how each country navigates its unique socio-economic and technological landscape, influencing the pace and effectiveness of digital health adoption. As such, the findings underscore the importance of context-specific strategies that not only align with national priorities but also address persistent challenges, like unequal digital access and data privacy concerns. Tailored policy responses will be essential to ensure that digital health systems are both inclusive and resilient across the ASEAN region.

The comparison of digital health services among three countries regarding strategic investment shows that Indonesia has experienced a significant rise in digital health services, particularly during the COVID-19 pandemic, with over 15 million daily users of health applications (Aisyah *et al.*, 2024). The country has adopted various technologies, including the Internet of Things (IoT), cloud computing, and telemedicine (Rohmah *et al.*, 2023; Vauzia & Sumitra, 2020). However, despite these advancements, Indonesia faces several challenges, such as the digital divide, privacy concerns, and regional disparities in the implementation of digital health services (Andi *et al.*, 2024; Rohmah *et al.*, 2023). The maturity of infrastructure and ICT varies significantly across different regions (Aisyah *et al.*, 2024). To address these challenges, Indonesia's strategic investments focus on improving infrastructure, enhancing digital literacy, and fostering public-private partnerships (Andi *et al.*, 2024; Rohmah *et al.*, 2023).

In contrast, Singapore has emerged as a leader in digital health initiatives, making substantial investments in digital health infrastructure. The country emphasizes e-mental health solutions and telemonitoring for chronic diseases (Kristina & Mahyuni, 2024; Stona, 2023), driven by the government's commitment to promoting mental health (Stona, 2023). Singapore's success in digital health can be attributed to well-designed national ICT policies and continuous investment in digital skills and tools (Aung *et*

al., 2022). Public-private partnerships play a crucial role in advancing these services, ensuring that the healthcare system remains efficient and patient-centric (Stona, 2023). Meanwhile, Thailand shows promising trends in digital health services, although overall investment in the digital economy is relatively low (Jongwanich, 2023). The Eastern Economic Corridor, in particular, sees more intense investment compared to other regions. Despite these developments, Thailand grapples with challenges such as unequal access to digital technologies and a shortage of workers with advanced IT skills. To enhance its digital health landscape, Thailand recognizes the need for strategic investments focused on improving digital infrastructure and developing workforce skills, which are critical for boosting the effectiveness of digital health services across the country (Aung *et al.*, 2022; Jongwanich, 2023).

Indonesia, Singapore, and Thailand each demonstrate distinct strengths and face unique challenges in their pursuit of digital health transformation. These differences are shaped by a combination of socio-economic factors, technological readiness, and institutional capacity. Strategic investments and well-designed policy frameworks are essential in guiding the development of digital health systems and ensuring that innovations are effectively integrated into national healthcare landscapes. As illustrated in Table 2, the levels of digital health service adoption and strategic investment vary significantly across the three countries. Singapore shows high levels of implementation and investment, while Indonesia and Thailand are progressing at different paces, each influenced by their respective infrastructure and policy environments. This comparative analysis underscores the importance of crafting country-specific strategies that address localized barriers and leverage existing strengths to optimize digital health outcomes.

The analysis of strategic investment differences reveals that Thailand experiences relatively low investment in its digital economy. This situation raises concerns about unequal access to digital technologies and high prices, posing significant challenges for the optimal

Table 2. Levels of Digital Health Service Adoption and Strategic Investments

No.	Countries	Key Focus	Challenges	Strategic Investments
1.	Indonesia	IoT, telemedicine, cloud computing	Digital divide, privacy, regional disparities	Infrastructure improvement, digital literacy, public-private partnerships
2.	Singapore	E-mental health, telemonitoring	None specified	National ICT policies, continuous investment, public-private partnerships
3.	Thailand	Digital health services	Low investment, unequal access, IT skill shortage	Digital infrastructure, workforce skills enhancement

Source: compiled by the authors

development of digital health services. These challenges hinder the ability to effectively leverage digital solutions that could enhance healthcare delivery, improve patient outcomes, and ensure equitable access to essential health services across different regions. Addressing these issues is crucial for Thailand to capitalize on the potential benefits of digital health innovations (Jongwanich, 2023).

Indonesia has shown remarkable momentum in adopting digital health, with over 15 million daily users engaging with health applications and approximately 10 digital health services actively operating nationwide (Aisyah *et al.*, 2024; Vauzia & Sumitra, 2020). This rapid uptake was significantly accelerated by the urgent demands of the COVID-19 pandemic, which highlighted the country's capacity for swift digital adaptation in times of crisis. The Indonesian experience underscores how necessity can catalyze innovation and scale in digital health delivery. In contrast, to encourage the uptake of digital health, the Singaporean government has launched a range of initiatives, including a project centered on active aging. This initiative leverages wearables, mobile applications, and exergames to support healthy lifestyles among older adults. By combining community engagement with gamified technology, the program seeks to enhance digital literacy and empower seniors, health coaches, and caregivers with the skills and confidence to navigate and benefit from digital health tools (E. W. J. Lee *et al.*, 2024).

Thailand is advancing rapidly in digital health, underpinned by strong ICT infrastructure and a national commitment to

improving healthcare quality, efficiency, and accessibility. This progress is supported by strategic leadership, sound governance, and the development of comprehensive legislation and policy frameworks. Despite facing challenges such as regulatory alignment, technological integration across varied healthcare environments, and digital equity, Thailand's efforts open pathways for building a more inclusive and resilient health system (Mulati *et al.*, 2022). In parallel, Indonesia is focusing on integrating health data and applications to strengthen primary care and accelerate its digital health transformation (Aisyah *et al.*, 2024), while Singapore demonstrates the value of sustained political commitment and stakeholder engagement in shaping effective digital health policies. Studies show that organizational factors—such as leadership, digital readiness, and openness to innovation—play a critical role in the successful adoption of electronic medical records in Indonesian hospitals, highlighting the importance of institutional culture in digital transformation (J. K. Lee & Antonio, 2025).

Indonesia has experienced an accelerated digital transformation of health service applications due to the COVID-19 pandemic. However, challenges include limited access to health services, discrimination in accessing care, and an inadequate doctor-resident ratio, particularly between urban and rural areas (Ainur *et al.*, 2022). In Thailand, challenges include relatively low investment in the digital economy, unequal access to digital technologies, and high prices. Nonetheless, there are opportunities for promising trends

within digital services and other sectors involving digital technology (Jongwanich, 2023). Singapore has achieved cost-effective service excellence in healthcare through digital health, focusing on costs, productivity, standardization, and digitization, while being intensely focused on health outcomes and the patient experience (Wirtz *et al.*, 2022).

In Indonesia, the COVID-19 pandemic has accelerated the digital transformation of health service applications, emphasizing health services, health information systems, and customer management systems. This aims to eliminate geographic isolation in meeting the basic needs for timely and quality medical care (Ainur *et al.*, 2022). Thailand has seen a significant increase in literature on eHealth in Southeast Asia since 2018, reflecting a substantial demand for eHealth in the region, with mobile health technology emerging as a key research theme. A recent study on digital tools for stunting intervention in Indonesia reveals how frontline health workers adapt to technological challenges through informal learning and community support, underscoring the need for inclusive digital capacity-building strategies (Batubara *et al.*, 2025). Singapore has transformed its fragmented, provider-centric healthcare system into a more integrated, patient-centric model through digital health, improving operational efficiency, reducing administrative costs, and empowering patients to contribute to treatment decisions.

In conclusion, the strategic investment, regulatory frameworks, challenges, opportunities, and technological advancements in digital health services vary across Indonesia, Singapore, and Thailand. While Indonesia has rapidly embraced digital health, Thailand faces challenges related to low investment in the digital economy. In contrast, Singapore has achieved cost-effective service excellence in healthcare through digital health. The regulatory frameworks in these countries play a crucial role in shaping their respective digital health landscapes, influencing the effective implementation and growth of digital health initiatives.

In Indonesia, the journey toward digital health infrastructure has been notably accelerated by the COVID-19 pandemic. The

government introduced initiatives such as the JKN Mobile application and telemedicine services to enhance healthcare accessibility. However, this progress is not without its hurdles. The country grapples with significant regional disparities in ICT maturity, leaving rural areas particularly underserved. Additionally, the need for improved infrastructure and skilled human resources remains pressing. Major challenges include limited access to health services, a pronounced digital divide, and concerns surrounding data privacy (Ainur *et al.*, 2022; Aisyah *et al.*, 2024; Rohmah *et al.*, 2023; Wijaya *et al.*, 2022). Despite these obstacles, ongoing efforts are focused on strengthening infrastructure and fostering collaboration among various stakeholders (Aisyah *et al.*, 2024; Rohmah *et al.*, 2023).

In contrast, Singapore exemplifies a well-established digital health ecosystem, underpinned by sustained investment in technological innovation. The government has spearheaded initiatives such as Mindline—a mental health platform that has achieved notable user uptake (Stona, 2023; Weng *et al.*, 2024). Drawing on insights from past public health crises, Singapore has strategically embedded public-private partnerships (PPPs) into its pandemic preparedness and response framework. These collaborations have played a pivotal role in fast-tracking the implementation of novel health solutions, thereby reinforcing the system's resilience and capacity to adapt under pressure (Kim *et al.*, 2022; C. Lee *et al.*, 2023).

Meanwhile, Thailand has developed a robust eHealth infrastructure that includes telemedicine services and the Medical Cloud system, enabling efficient data exchange across diverse healthcare platforms. To ensure uniform standards of care, the government has also introduced national guidelines for telemedicine practices (Sharma *et al.*, 2021). Despite these advancements, the country continues to face significant challenges in its digital health rollout, particularly in rural areas where the need is most acute. Inconsistent mobile data service quality undermines the reliability of remote healthcare delivery, while gaps in ICT infrastructure hinder widespread access to digital tools. Bridging these connectivity

Table 3. Health Infrastructure Development

No.	Countries	Infrastructures Development	Key Challenges
1.	Indonesia	Infrastructure Development Key Challenges Indonesia	Limited access in rural areas, digital divide, privacy issues
2.	Singapore	Robust infrastructure with initiatives like midline; high user engagement	Ensuring data privacy, and integration across sectors
3.	Thailand	Comprehensive eHealth infrastructure; Medical Cloud system	Inconsistent mobile data service in rural areas need for better ICT infrastructure

Source: compiled by the authors

divides is crucial for fostering inclusive and sustainable digital health integration nationwide (Choosri *et al.*, 2018). To conclude, Indonesia, Singapore, and Thailand have each advanced their digital health ecosystems, yet they encounter distinct hurdles that influence the reach and effectiveness of these services. Addressing these country-specific challenges is crucial for improving both access to care and the overall quality of health outcomes. Strengthening regional collaboration and prioritizing targeted infrastructure investments will be key to building a more cohesive and resilient digital health environment across ASEAN (see Table 3).

The comparison of digital health services in Indonesia, Singapore, and Thailand reveals significant differences in infrastructure development and regulatory frameworks. In Indonesia, the COVID-19 pandemic has notably accelerated the digital transformation of health service applications. It focuses on health services, health information systems, and customer management systems (Ainur *et al.*, 2022; Aisyah *et al.*, 2024). The government is prioritizing the development of health data and application systems upon an integrated healthcare technology ecosystem, particularly enhancing primary healthcare services nationwide (Aisyah *et al.*, 2024). A cross-sectional survey conducted in nine provinces indicated that the ICT maturity of healthcare providers ranges from basic to good levels, highlighting the need for improvements in human resources, infrastructure, hardware, and information systems (32). The trajectory of digital health development in Indonesia has been further influenced by the introduction of digital pandemic surveillance and reporting

technologies, resulting from collaborations between government bodies, private providers, and higher education institutions.

Singapore stands out for its mature and well-integrated digital health infrastructure, reflecting years of strategic investment and policy alignment. The country has successfully transitioned toward a patient-centric healthcare model, leveraging digital technologies to enhance coordination, accessibility, and service quality. This transformation has positioned Singapore as a benchmark for digital health innovation in the region. In contrast, Indonesia's digital health landscape has expanded rapidly, particularly in response to the COVID-19 pandemic, which accelerated the adoption of mobile health applications and telemedicine platforms. Despite this progress, the country continues to grapple with uneven ICT readiness and significant disparities in digital infrastructure across its provinces (Aisyah *et al.*, 2024). These challenges highlight the need for targeted interventions to bridge the digital divide and ensure equitable access to digital health services nationwide.

Thailand, on the other hand, faces significant challenges in its digital health infrastructure. A review of digital transformation in Thailand highlights concerns about relatively low investment in the digital economy, modest penetration of digital technology in certain sectors, and unequal access to digital-related technologies (Jongwanich, 2023). The ASEAN Digital Masterplan 2025 emphasizes the need for Thailand to prioritize digital technology development and foster innovation to boost economic growth while addressing challenges and reducing income disparities (Wongwuttawat *et al.*, 2024). Although comparative studies of

healthcare systems in Hong Kong, Taiwan, and Singapore offer useful perspectives, they fall short of examining the regulatory frameworks that govern digital health infrastructure in Indonesia, Singapore, and Thailand. This gap in the literature leaves a limited understanding of how each country structures its legal and institutional support for digital health services. As a result, the nuances and differences in regulatory oversight across these three ASEAN nations remain insufficiently explored.

Indonesia's digital health landscape has been shaped largely by the urgency of the COVID-19 pandemic, which catalyzed rapid digital transformation and exposed challenges in ICT readiness, particularly across its diverse provinces. Singapore, by contrast, benefits from a well-established digital health infrastructure supported by long-term strategic planning and strong governance. Thailand, meanwhile, continues to face hurdles in mobilizing investment and fostering innovation in digital health technologies. Despite these varied trajectories, a clear picture of how regulatory frameworks influence digital health infrastructure in each country is still lacking. Understanding these frameworks is essential for identifying policy gaps, harmonizing standards, and guiding future development. Further research is needed to map and compare the regulatory environments to support more effective regional collaboration and digital health integration.

Digital health services in Indonesia have seen significant growth, particularly during the COVID-19 pandemic. The primary focus has been on telemedicine, teleconsultation, and e-prescribing (Ainur *et al.*, 2022; Panggabean *et al.*, 2023; Rohmah *et al.*, 2023). However, implementation varies widely across regions, with the Western and Central parts being more advanced compared to the Eastern regions (1). Despite this potential, adoption rates remain relatively low, with only 24% of surveyed individuals having utilized digital health services. Key barriers to adoption include limited internet access, low digital literacy, and trust issues (Panggabean *et al.*, 2023; Shifa *et al.*, 2024). In contrast, Singapore boasts a well-developed digital health infrastructure. The country has established comprehensive

telemedicine guidelines and enjoys a high level of digital inclusion among its population (Aung *et al.*, 2022; Intan & Defi, 2021). Various eHealth technologies, including teleconsultation and mobile health applications, have been successfully integrated into the healthcare system (Intan & Defi, 2021). Adoption rates in Singapore are high, supported by robust guidelines and a substantial percentage of the population using the internet and digital health services (Aung *et al.*, 2022; Intan & Defi, 2021).

Thailand has also made significant strides in digital health, particularly in online healthcare and mobile health technologies. The country has updated its specific telemedicine guidelines post-COVID-19. While adoption is growing, challenges such as digital literacy and inadequate infrastructure in rural areas persist. However, the Thai government is actively working to address these challenges (Intan & Defi, 2021; Sharma *et al.*, 2021). In conclusion, Singapore remains a regional leader in both the deployment and uptake of digital health technologies. Meanwhile, Indonesia and Thailand are progressing steadily, though they face persistent challenges related to infrastructure gaps and regional disparities. These differences highlight the need for tailored strategies that address each country's unique context and support inclusive digital health development across ASEAN (see Table 4).

Indonesia has made significant strides in digital health adoption, particularly during the COVID-19 pandemic, which catalyzed widespread use of mobile health applications. With over 15 million daily users, the country has demonstrated a strong demand for digital health solutions. In response, the government is actively working to develop an integrated healthcare technology ecosystem that strengthens primary care and supports long-term digital transformation (Aisyah *et al.*, 2024). Singapore, although not the central focus of this particular analysis, continues to benefit from its advanced healthcare infrastructure and high digital readiness. These strengths contribute to a smoother and more coordinated implementation of digital health services, setting Singapore apart from its regional counterparts. Its established systems and strategic investments provide a solid

Table 4. Digital Health Implementation and Adoption

No.	Countries	Implementations	Adoption
1.	Indonesia	Varies by region; focus on telemedicine and e-prescribing	Low adoption due to internet access and trust issues
2.	Singapore	Advanced infrastructure; comprehensive guidelines	High adoption supported by digital inclusion
3.	Thailand	Growing focus on telemedicine; updated guidelines post-COVID-19	Increasing adoption; challenges in rural areas

Source: compiled by the authors

foundation for innovation and scalability in digital health.

Adoption variations are notable in Indonesia, where the use of digital media for health communication has significantly increased during the pandemic. However, challenges such as the digital divide and privacy concerns persist. The need to improve digital literacy and technological infrastructure is crucial to addressing these gaps (32). In Thailand, there is an emphasis on adopting internet-based ICT for healthcare, with public health services funded by the Ministry of Public Health and monitored by the Department of Medical Services (Saengchai *et al.*, 2019).

Indonesia and Thailand offer contrasting yet complementary perspectives on the challenges and enablers of digital health integration. In Indonesia, systemic barriers such as the digital divide, privacy concerns, limited healthcare access, and unequal doctor-to-resident ratios, specially between urban and rural populations, continue to hinder progress. These issues are compounded by inadequate internet connectivity and infrastructure in remote areas, making the implementation of digital health solutions particularly difficult (Ainur *et al.*, 2022; Andi *et al.*, 2024). Meanwhile, Thailand's experience highlights the critical role of digital health literacy in primary care. Patients who possess the skills to navigate digital platforms are more likely to engage effectively with telehealth services, leading to higher satisfaction and improved health outcomes. It underscores the importance of not only technological infrastructure but also human capacity in realizing the full potential of digital health (Chairuengitjaras *et al.*, 2024).

Factors contributing to successful adoption differ between the countries. In

Indonesia, research indicates that digital healthcare is perceived as a necessity, with a combination of necessity and trend-related aspects underscoring the potential market for digital healthcare services. It suggests a genuine demand for such services (36). In Thailand, the perceived value and social influences considerably impact the intention to use digital health services. Most respondents perceive greater value in using digital health services, with social influences from family, friends, and mass media amplifying this intention (Panggabean *et al.*, 2023). In conclusion, the implementation and uptake of digital health services across Indonesia, Singapore, and Thailand reflect varying degrees of progress shaped by differences in digital literacy, infrastructure readiness, and public perception of value. These disparities underscore the importance of addressing persistent challenges such as the digital divide, data privacy concerns, and unequal access to healthcare services. Tackling these issues is essential for ensuring that digital health innovations translate into meaningful improvements in health outcomes.

Although specific data on Singapore's digital health initiatives may be limited in this context, its advanced healthcare system and robust digital infrastructure suggest a smoother and more integrated adoption process compared to its regional counterparts. Singapore's leadership in governance, strategic investment, and service deployment positions it as a model for digital health transformation in ASEAN. In contrast, Indonesia and Thailand continue to face structural and regional barriers that complicate the optimization of their digital health ecosystems. To move forward, coordinated governance, sustained investment, and infrastructure development must be paired

with efforts to raise public awareness and digital literacy. By learning from successful national models and tailoring strategies to local contexts, ASEAN countries can strengthen their digital health systems. Such progress holds the potential to expand healthcare access, enhance service quality, and build more resilient and equitable health systems across the region.

Conclusion

Enhancing digital health services across ASEAN countries requires a comprehensive approach that integrates stronger governance structures, increased investment, infrastructure development, and greater public engagement. By learning from successful examples and applying targeted strategies, countries can improve their healthcare systems, ensuring better access and quality of services throughout the region. A comparative study of digital health services in Indonesia, Singapore, and Thailand reveals varying levels of development and challenges. Singapore leads with its cohesive governance, substantial investments, and advanced infrastructure, creating an efficient ecosystem. Conversely, Indonesia and Thailand face obstacles such as fragmented governance, infrastructure gaps, and regional disparities. Addressing these challenges through unified strategies and targeted investments can significantly enhance the effectiveness of digital health systems in these nations, contributing to broader regional progress.

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