BUILDING A FUTURE-PROOF DIGITAL HEALTH ECOSYSTEM: A CASE STUDY OF SRI LANKA'S NATIONAL DIGITAL HEALTH BLUEPRINT

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CHAPTER 1: INTRODUCTION

Brief Overview of Sri Lanka's Healthcare System

Sri Lanka boasts a robust public health system that offers free healthcare services to its entire population. The Ministry of Health operates a comprehensive network of more than 1,100 hospitals and clinics, which serve as the primary providers of outpatient and inpatient care throughout the country (World Health Organization, 2018). This extensive infrastructure has been instrumental in Sri Lanka's impressive progress in improving population health outcomes, particularly in areas such as maternal and child health and the control of communicable diseases (Perera, 2015; Editorial, 2023). However, the system is not without its challenges. Overcrowding and disparities in utilization across facilities remain significant issues, with some facilities overburdened while others are underutilized (Perera, 2015; Kurowski et al., 2024). Furthermore, the country is now facing an epidemiological transition, with an increasing prevalence of non-communicable diseases and an aging population. These factors, coupled with the need for healthcare financing reforms, have put additional strain on the existing healthcare system (Perera, 2015; Kurowski et al., 2024).

The Need for a Digital Health Blueprint

Recognizing the potential of digital health technologies to address the challenges faced by its healthcare system, Sri Lanka identified the need for a comprehensive national digital health blueprint. With rising demand for healthcare services and limited resources, the country seeks to leverage digital solutions to improve efficiency, cost-effectiveness, and service delivery across its healthcare facilities (World Health Organization, 2018). However, the lack of a coordinated

approach to digitalization has led to the creation of information silos, hindering effective data sharing and integration among different healthcare entities (Perera, 2015). This fragmentation has further exacerbated the challenges posed by the country's aging population, increasing burden of non-communicable diseases, and disparities in healthcare access and utilization (Perera, 2015; Kurowski et al., 2024). To address these issues, a well-designed digital health strategy is crucial. Such a strategy could help streamline operations, facilitate data-driven decision-making, and enable better coordination among healthcare providers and stakeholders (World Health Organization, 2018; Editorial, 2023). By leveraging digital solutions, Sri Lanka aims to enhance the quality, accessibility, and affordability of healthcare services, ultimately improving health outcomes for its population.

CHAPTER 2: BACKGROUND AND EARLY EFFORTS

Initial Interest in Digital Health Among Medical Practitioners

The early 2000s marked a significant shift in the Sri Lankan healthcare landscape as medical practitioners began to recognize the potential of digital health initiatives. This growing interest led to the establishment of service centers and family health clinics that leveraged databases to store and manage patient information (Lubell-Doughtie, 2023). These early efforts signaled a nascent understanding of the benefits that technology could bring to the healthcare sector, such as improved efficiency, better patient management, and enhanced access to care.

Establishment of the Health Informatics Society of Sri Lanka

As interest in digital health grew, the Sri Lanka Medical Association (SLMA), the country's premier organization for medical professionals, took steps to formalize the exploration of technology in healthcare. Initially, the SLMA created a committee dedicated to information and communication technology (ICT) within its ranks. However, it soon became apparent that a more comprehensive approach was necessary to fully harness the potential of digital health. Recognizing the need for collaboration between medical and IT professionals, the ICT committee evolved into the Health Informatics Society of Sri Lanka, bringing together experts from both fields to drive the adoption and development of digital health solutions (World Bank, 2017).

Efforts to Coordinate and Streamline Digital Health Initiatives

As digital health initiatives began to proliferate across the country, the Ministry of Health identified the need for a coordinated approach to ensure the effective and efficient implementation of these solutions. To address this challenge, the Ministry established the

National E-Health Steering Committee, tasked with streamlining activities and ensuring interoperability among the various digital health systems (Lubell-Doughtie, 2023; World Health Organization, 2023).

One of the key achievements of the National E-Health Steering Committee was the development of the Digital Health Blueprint, a comprehensive national strategy for the systematic adoption and integration of digital technologies in the healthcare system (Lubell-Doughtie, 2023).The Blueprint aimed to align digital health initiatives with the country's broader health priorities and goals, providing a roadmap for the sustainable and scalable implementation of technology-driven solutions (Lubell-Doughtie, 2023).

In addition to the Digital Health Blueprint, the Ministry of Health, in collaboration with the World Health Organization (WHO), has been working on the development of a Planning Management Information System (PMIS) (World Health Organization, 2023, October 5). The PMIS is designed to harness the power of digital technologies to enhance healthcare planning and management processes, enabling data-driven decision-making and resource allocation (World Health Organization, 2023). By leveraging advanced data collection, analysis, and visualization tools, the PMIS aims to optimize the efficiency and effectiveness of healthcare planning and management, ultimately leading to improved patient outcomes and better overall health system performance (World Health Organization, 2023).

The establishment of the National E-Health Steering Committee and the development of initiatives such as the Digital Health Blueprint and the PMIS demonstrate the Sri Lankan government's commitment to leveraging technology to transform the healthcare sector. By coordinating and streamlining digital health initiatives, ensuring interoperability, and aligning these efforts with national healthcare objectives, Sri Lanka has laid a solid foundation for the

successful adoption and scaling of digital health solutions (Lubell-Doughtie, 2023; World Health Organization, 2023).

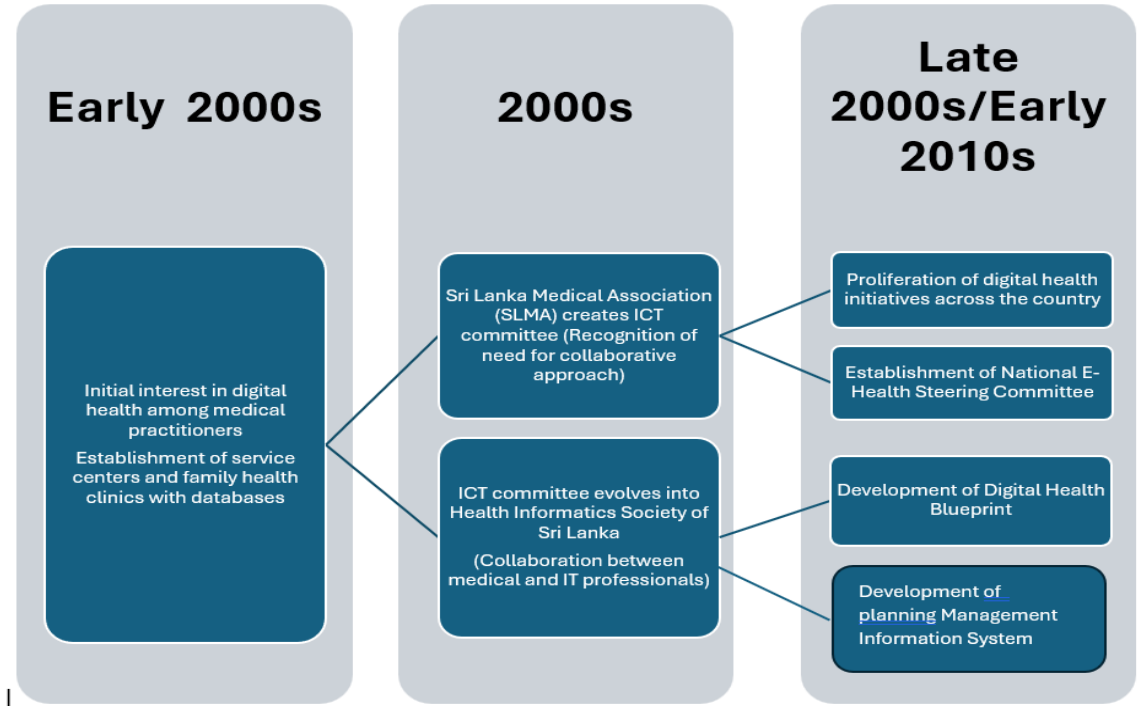

Figure 1Timeline of Events

Figure 2 Present

CHAPTER 3: DEVELOPMENT OF DIGITAL HEALTH BLUEPRINT

Influence of global standards and best practices

In developing the digital health blueprint, Sri Lanka recognized the importance of aligning with global standards and best practices. The country drew inspiration from the digital health strategies and blueprints of nations like Australia, Canada, and Singapore, which have been at the forefront of leveraging technology in healthcare (Australian Digital Health Agency, 2024; Canada Health Infoway, n.d.; Ministry of Health Singapore, n.d.).

Australia's National Digital Health Strategy provided a comprehensive framework for promoting digital health adoption, addressing aspects such as interoperability, data governance, and healthcare workforce development (Australian Digital Health Agency, 2024). Canada's Health Infoway organization has been instrumental in driving the country's digital health initiatives, focusing on electronic health records, telehealth, and virtual care (Canada Health Infoway, n.d.). Singapore's National Electronic Health Record (NEHR) Blueprint outlined a roadmap for integrating healthcare data from various sources, enabling seamless information exchange and improving patient care (Ministry of Health Singapore, n.d.) . Ministry of Health Singapore, n.d.).

Sri Lanka aimed to align its digital health blueprint with international best practices by studying and adapting lessons from these global exemplars, ensuring interoperability and the adoption of proven strategies and architectures.

Adoption of enterprise architecture principles (TOGAF)

To develop its digital health blueprint, Sri Lanka adopted a structured and holistic approach based on the TOGAF (The Open Group Architecture Framework) principles for enterprise architecture (The Open Group, n.d.). TOGAF provided a comprehensive methodology for identifying business services, data requirements, supporting architecture, and appropriate technologies within the healthcare domain (The Open Group, n.d.) .

By embracing TOGAF, Sri Lanka ensured that its digital health blueprint was grounded in a well-established and widely adopted enterprise architecture framework. This approach facilitated the alignment of business goals, technology solutions, and stakeholder needs, enabling the development of a cohesive and scalable digital health ecosystem (The Open Group, n.d.).

Collaboration with WHO and regional organizations (SEARO, AeHIN)

Sri Lanka collaborated closely with the World Health Organization (WHO) and regional organizations like SEARO (South-East Asia Regional Office) and AeHIN (Asian eHealth Information Network) to leverage global expertise and resources in developing its digital health strategy and blueprint (AeHIN, n.d.).

The WHO, through its digital health and innovative initiatives, provided guidance and support to Sri Lanka, sharing best practices, and facilitating knowledge exchange SEARO, the regional arm of the WHO, played a crucial role in promoting digital health initiatives within the South-East Asia region, offering technical assistance and capacity-building opportunities. Additionally, AeHIN, a network of eHealth professionals and organizations in Asia, provided a platform for collaboration, knowledge-sharing, and collective problem-solving (AeHIN, n.d.).

By collaborating with these international and regional organizations, Sri Lanka aimed to leverage their expertise, resources, and networks, ensuring that its digital health blueprint aligned with global trends and standards while addressing regional and local contexts.

Creation of a working group within the National Steering Committee

To drive the development of the digital health blueprint, Sri Lanka formed a dedicated working group within its National E-Health Steering Committee. This working group comprised representatives from various stakeholders across the country's provinces and districts, including healthcare professionals, policymakers, technologists, and subject matter experts (Ministry of Health, Nutrition & Indigenous Medicine Sri Lanka, 2023).

The inclusive composition of the working group ensured that diverse perspectives and experiences were considered during the blueprint's development. This approach fostered a collaborative and participatory process, ensuring that the digital health blueprint addressed the unique challenges and opportunities within Sri Lanka's healthcare landscape (Ministry of Health, Nutrition & Indigenous Medicine Sri Lanka, 2023).

By leveraging the expertise and inputs from this multidisciplinary working group, Sri Lanka aimed to create a comprehensive and contextually relevant digital health blueprint that aligned with national priorities and had buy-in from key stakeholders across the healthcare ecosystem.

CHAPTER 4: FUNDING AND TECHNICAL ASSISTANCE

Securing the German Government Grant and Global Fund support

During an interview, Chaminda shared that Sri Lanka's efforts to leverage digital health technologies received a significant boost when it secured a 20 million euro grant from the Federal Government of Germany. This grant was managed by the Global Fund, a prominent international financing institution dedicated to supporting public health initiatives worldwide. A substantial portion of the grant funds was earmarked for scaling up digital health solutions and expediting the development of a comprehensive national digital health blueprint.

Involvement of an international technical assistance team

To leverage global expertise and best practices, Sri Lanka brought in an international technical assistance team, primarily composed of experts from Canada. This team was tasked with supporting the development of the digital health blueprint, drawing upon their extensive experience in creating similar artifacts and deliverables for other countries. The collaboration with international experts allowed Sri Lanka to benefit from the latest developments and lessons learned from successful digital health initiatives worldwide (Lubell-Doughtie, 2023).

Deliverables

With the support of the technical assistance team and the dedicated funding from the Global Fund, Sri Lanka was able to publish several key deliverables within the first year of the grant period. These included the national digital health blueprint, an interoperability plan to ensure seamless data exchange between different systems, a procurement plan to guide the acquisition of digital health solutions, and comprehensive plans for advocacy and training to facilitate adoption and effective utilization of these solutions (World Health Organization, 2018).

The blueprint served as the overarching strategic document, outlining the vision, objectives, and roadmap for Sri Lanka's digital health transformation. The interoperability plan ensured that the various digital health solutions implemented across the country would be able to communicate and share data effectively, enabling better coordination and data-driven decision-making. The procurement plan provided a structured approach to acquiring and implementing digital health solutions, ensuring transparency, cost-effectiveness, and alignment with the country's specific needs and priorities.

Meanwhile, the advocacy and training plans aimed to raise awareness, build capacity, and foster widespread adoption of digital health technologies among healthcare providers, policymakers, and the public. These comprehensive deliverables, developed with the support of international expertise and dedicated funding, laid a solid foundation for Sri Lanka's digital health transformation, paving the way for improved healthcare service delivery, better health outcomes, and more efficient resource utilization.

CHAPTER 5: KEY FACTORS IN THE BLUEPRINT DEVELOPMENT

Importance of internal capacity within the Ministry of Health

The Ministry of Health's strategic decision to invest in building internal capacity by training doctors in health informatics through specialized master's programs, such as the one offered by the University of Colombo (University of Colombo, 2022), proved to be a critical factor in the success of the blueprint development process. These clinician-informaticians brought their domain expertise to the table, ensuring that the proposed digital health interventions aligned with clinical workflows and processes, thereby increasing the likelihood of user acceptance and adoption among healthcare professionals.

The involvement of these professionals from within the healthcare system lent credibility and buy-in to the blueprint, as they were seen as colleagues rather than external consultants. Their intimate understanding of the local context and challenges faced by healthcare providers was invaluable in shaping solutions tailored to the specific needs of Sri Lanka's healthcare system.

Opportunities arising from challenges

The economic crisis faced by Sri Lanka during this period presented significant challenges, but it also opened doors to explore alternative solutions that may not have been considered previously. With limited financial resources and an inability to procure proprietary software solutions, the blueprint embraced the adoption of open-source systems, such as the Picture Archiving and Communication System (PACS) for medical imaging.

This shift towards open-source technologies demonstrated the importance of seizing opportunities amidst adversity and the potential for cost-effective digital health solutions that could be customized and scaled as needed (Wijesinghe, 2021). By leveraging the collaborative

nature of open-source communities, Sri Lanka could benefit from continuous improvements and updates, while also contributing to the development of these solutions based on their specific requirements.

Challenge	**Solution**
Limited financial resources	Adoption of open-source technologies like the Picture Archiving and Communication System (PACS) for medical imaging
Lack of internal digital health expertise	Training doctors in health informatics through specialized master's programs to build internal capacity
Need for structured approach and global best practices	Adoption of enterprise architecture principles (TOGAF) and collaboration with WHO, SEARO, and AeHIN
Coordination and streamlining of digital health initiatives	Establishment of the National E-Health Steering Committee and creation of the Digital Health Blueprint
Ensuring interoperability and data sharing	Alignment with global standards and architectures like OpenHIE and FHIR
Securing funding and technical assistance	Securing German government grant and Global Fund support, involvement of international technical assistance team
Infrastructure and vendor support gaps in remote locations	Plans for maturity assessment and monitoring across different tiers of healthcare facilities

Challenge	Solution
Evolving priorities, standards, and technological advancements	Revisiting and updating the blueprint, developing detailed technical standards and profiles, securing continued funding, and maintaining alignment with global best practices
Lack of internal digital health expertise	Training doctors in health informatics through specialized master's and doctoral programs to build internal capacity (Information and Communication Technology Authority, n.d.).
Lack of national level coordination and integration with non-health sector partners	Close collaboration with the Information Communication and Technology Agency, the apex government agency for national digitization efforts (University of Peradeniya, n.d.).

Value of external support and technical assistance in expediting progress

While Sri Lanka had a strong foundation of internal expertise, the involvement of an international technical assistance team, primarily from Canada, brought in valuable external support and experience that allowed the country to expedite its progress (Government of Canada, 2022). These experts contributed their extensive knowledge and lessons learned from creating similar digital health artifacts and deliverables for other countries.

By leveraging globally benchmarked insights and best practices, Sri Lanka was able to rapidly develop and refine its blueprint, overcoming internal capacity constraints and accelerating the pace of its digital health transformation. The technical assistance team provided guidance on

project management, stakeholder engagement, and change management strategies, ensuring a comprehensive and well-executed approach to the blueprint development process.

Emphasis on alignment with global standards and architectures

The blueprint placed a strong emphasis on aligning with globally recognized standards and architectures, such as the Open Health Information Exchange (OpenHIE) and Fast Healthcare Interoperability Resources (FHIR) (HL7 International / Patient Care, 2024). This strategic decision aimed to ensure compatibility and interoperability across different systems and components within Sri Lanka's local healthcare context, while simultaneously maintaining the potential for future integration with global practices as they evolve.

By adhering to these widely adopted standards, the blueprint laid the groundwork for a future-proof digital health ecosystem that could seamlessly exchange data and integrate with evolving technologies. This approach not only facilitated data sharing and collaboration within Sri Lanka but also positioned the country to participate in global health initiatives and benefit from advancements in digital health solutions worldwide.

CHAPTER 6: IMPLEMENTATION AND MONITORING

Pilot implementation and feedback collection

To ensure a smooth and successful rollout of digital health solutions, the blueprint emphasized a phased approach that began with pilot implementations in select locations. This strategy allowed for the collection of valuable feedback from end-users, enabling incremental refinements and context-specific customizations before broader replication (Ministry of Health, Nutrition & Indigenous Medicine Sri Lanka, 2023). By conducting these pilot projects, the implementation team could identify and address potential challenges or usability issues, ultimately delivering solutions that were better tailored to the unique needs and workflows of Sri Lanka's healthcare system.

Challenges in infrastructure and vendor support across remote locations

One of the significant challenges encountered during the implementation phase was the lack of reliable connectivity and infrastructure support in remote healthcare facilities. These locations often lacked access to technical teams for installation, maintenance, and troubleshooting of digital health systems, posing significant adoption and sustainability challenges (World Health Organization, 2020). Concentrated efforts were required to address these infrastructure gaps and ensure that remote facilities had the necessary resources and support to effectively implement and maintain the digital health solutions outlined in the blueprint.

Plans for maturity assessment and monitoring across different tiers of healthcare facilities

To systematically bridge the variability in digital health implementation across different types of healthcare facilities, the blueprint included plans for assessing and monitoring the maturity levels of digital health adoption. These plans recognized the diverse nature of healthcare facilities, differentiated by size, specialization, and location, and aimed to establish a phased approach to implementation based on these factors (Ministry of Health, Nutrition & Indigenous Medicine Sri Lanka, 2023). By establishing maturity levels or benchmarks, the implementation team could track progress, identify areas for improvement, and allocate resources more effectively to support the digital transformation of healthcare facilities at various stages of readiness (Woods et al., 2022).

Involvement of the Sri Lanka College of Health Informatics in monitoring and evaluation

The Sri Lanka College of Health Informatics, an institution dedicated to advancing health informatics education and practice in the country, played a crucial role in the monitoring and evaluation efforts outlined in the blueprint. The College proposed standardized frameworks and methodologies for measuring and monitoring the maturity of digital health implementations across different tiers of healthcare facilities (Sri Lanka College of Health Informatics, 2022). By collaborating with governing bodies and leveraging their expertise in health informatics, the College aimed to establish rigorous and consistent evaluation processes, enabling data-driven decision-making and continuous improvement throughout the implementation phase.

CHAPTER 7: SCALING UP AND FUTURE PLANS

Revisiting and updating the blueprint as priorities and needs evolve

The digital health blueprint is not a static document but rather a living, evolving framework that requires continuous re-evaluation and updates. As sectoral priorities and needs evolve over time, the blueprint must be revisited to re-align its components and ensure alignment with the changing landscape (Ministry of Health, Sri Lanka, 2022). Additionally, the blueprint must keep pace with local contextual shifts, such as changes in healthcare policies, infrastructure developments, or demographic shifts, as well as global technological advancements that may present new opportunities or challenges (Lubell-Doughtie, 2023).

Developing more detailed technical standards and profiles

While the blueprint provides a high-level strategic framework, more detailed technical standards and specifications are imperative to guide localized implementations across different functional domains. One such example is the development of FHIR (Fast Healthcare Interoperability Resources) profiles, which define specific constraints and extensions to the FHIR standard to meet the unique requirements of Sri Lanka's healthcare system. These granular technical guidelines ensure consistent and interoperable implementations, enabling seamless data exchange and integration across various digital health solutions (Ministry of Health, Sri Lanka, 2022). The International Patient Summary (IPS) Implementation Guide, developed by HL7 International, provides a valuable reference for representing essential healthcare information about a subject of care using FHIR (HL7 International / Patient Care, 2024). Aligning Sri Lanka's technical standards with globally recognized guidelines like the IPS can facilitate cross-border interoperability and support unplanned care scenarios.

Securing funding for continued implementation and infrastructure development

Scaling up and sustaining the implementation of digital health solutions requires significant financial resources. Sustained funding secured through governmental allocations and support from international health agencies is vital to enable the procurement of necessary equipment, development of core infrastructure, user training, and multi-year maintenance and support. Without dedicated funding streams, the implementation efforts may face challenges in terms of coverage, quality, and sustainability, hindering the realization of the blueprint's goals (Ministry of Health, Nutrition & Indigenous Medicine Sri Lanka, 2023).

Aligning with global standards and best practices as they progress

As digital health technologies and practices continue to evolve globally, it is crucial for Sri Lanka's localized systems to maintain alignment with emerging international standards and best practices. This alignment ensures interoperability not only within the country's healthcare ecosystem but also with global systems and initiatives. By staying abreast of advancements in areas such as data exchange protocols, security standards, and emerging technologies, Sri Lanka can future-proof its digital health infrastructure and position itself to seamlessly participate in global health initiatives and collaborations (Lubell-Doughtie, 2023).

CHAPTER 8: CONCLUSION

Summary of key factors contributing to the successful development of the blueprint

Sri Lanka's successful development of the digital health blueprint can be attributed to several key factors. The Ministry of Health's foresight in nurturing digital health capacity among clinicians, particularly through specialized health informatics training programs, provided a strong foundation of internal expertise ("Digital health and COVID-19," 2020, p. 731). The country's ability to seize opportunities amidst challenges, such as the adoption of open-source solutions during an economic crisis, demonstrated resilience and adaptability. The involvement of an international technical assistance team, primarily from Canada, brought in valuable external support and experience, enabling Sri Lanka to expedite its progress and align with global best practices ("Digital health and COVID-19," 2020, p. 731). Finally, the blueprint's emphasis on aligning with global standards and architectures, such as OpenHIE and FHIR, laid the groundwork for a future-proof and interoperable digital health ecosystem (Ministry of Health, Nutrition & Indigenous Medicine Sri Lanka, 2023).

Potential areas for improvement and ongoing challenges

Despite the significant progress made, Sri Lanka still faces challenges in terms of infrastructure and support in remote healthcare facilities. Ensuring reliable connectivity, technical support, and capacity building in these locations remains an ongoing effort. Additionally, securing long-term financing for the continued implementation and maintenance of digital health solutions is crucial to ensure the sustainability and scalability of the initiatives outlined in the blueprint. As global

standards and best practices evolve, Sri Lanka must also maintain a concerted effort to align its digital health ecosystem with these advancements to ensure interoperability and futureproofing.

Lessons learned and insights for other countries embarking on similar digital health initiatives

Sri Lanka's experience in developing its digital health blueprint offers valuable lessons for other countries embarking on similar initiatives.

- Nurture internal capacity by training healthcare professionals in health informatics to create a strong foundation for success.
- Embrace opportunities arising from challenges, such as adopting open-source solutions during resource constraints, which can lead to cost-effective and flexible implementations.
- Leverage external expertise through international collaborations to accelerate progress and ensure alignment with global best practices.
- Emphasize alignment with global standards and architectures from the outset to lay the groundwork for interoperability and futureproofing.
- Maintain flexibility and adaptability in the face of evolving priorities, needs, and technological advancements for long-term success in digital health transformation.

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