KIT INSTITUTE

Digital Health Technologies

Using a holistic lens to increase the impact of digital health technologies

Position Paper

Authors: KIT institute - Irene de Vries, Pierre Pratley, Mirjam Bakker, Anke van der Kwaak
Date: March 2025

Lab worker in Indonesia looking at the diagnostic results of TB-testing

Credits: Mirjam Bakker

Introduction

The past decades have witnessed a surge in digital health innovations within the field of global health. While these innovations are aimed at enhancing health and well-being, their implementation can unintentionally worsen inequities, result in unethical practices, or fail entirely if not aligned with the needs of users, clients, and systems.

This position paper draws on our experience as technical partners in implementing, researching and evaluating innovative digital health technologies. It highlights cross-cutting learnings and offers reflections and practical approaches to support effective implementation and avoid common pitfalls in implementing and scaling digital health technologies.

The paper aims to support developers, donors, policy makers, implementers and users in applying a holistic lens to the equitable and sustainable implementation of digital health technologies, to ensure these technologies reach their full potential, impact and appropriate embedding in institutions and societies, using a people-centred approach.

Digital health technology | Definition

Health technologies aim to solve health problems and improve quality of life through the application of organized knowledge and skills (1). While health technology encompasses various forms and systems, this paper critically examines the use of newly introduced innovative medical devices for diagnosis and/or treatment within a health system, often combined with digital applications, such as eHealth, telemedicine and/or artificial intelligence (AI).

Credits: Mirjam Bakker

Site for computer aided diagnostic X-ray for TB in Ghana

Background

Globally there is an increase in digital tools and an accelerated adoption of digital technology within health systems. Healthcare challenges are often driving the expansion of these technologies aiming at improving access to, as well as the quality of health care (1,2). Examples include telemedicine for remote health services, mHealth applications, electronic health records, artificial intelligence applications, patient portals and communication tools, remote monitoring and wearables, drone delivery services, and digital health data tools (3).

While these technologies are often viewed as powerful solutions for improving the accessibility and quality of healthcare, evidence regarding their cost-effectiveness and overall impact remains limited. Nevertheless, their potential is seen as contributing to the health and well-being of people (4). According to a recent report by the World Health Organization (WHO) and International Telecommunication Union, an investment of just $0.24 per patient per year in digital health interventions, such as telemedicine, mobile messaging, and chatbots, could prevent over 2 million deaths from noncommunicable diseases over the next decade (5). In addition, publications conclude that digital solutions have the potential to strengthen health systems, improve health financing, and increase access to healthcare services for underserved populations (3,4,6). Nonetheless, the evidence remains scarce and context-dependent, underscoring the need for stronger data collection and analysis to inform policy and implementation. In addition, challenges such as funding, infrastructure, digital literacy, and unintended effects like over-reliance on technology or exacerbation of health inequities must also be addressed.

Digital health technologies are implemented to address specific health challenges, connect levels of care, and enhance services. When scaled, these solutions are expected to ensure equitable access to healthcare for all. However, the benefits of these technologies can only be fully realized if they are carefully contextualized and adapted to the health system's specific needs. The WHO outlines the importance of health technology assessment, regulation and management as critical elements to enable technologies to reach their full potential while aligning with national health priorities (7,8). Global leaders further emphasize the need for investment in crucial factors that enable success for digital health, including country leadership & governance, people-centred design, creating an enabling environment, data privacy & security, sustainable business models, stakeholder engagement and monitoring & evaluation (3,4,9). Moreover, the literature provides various frameworks that can be applied in implementing digital health technologies, such as (but not limited to) the social construction of technology (SCOT) (10)and the nonadoption, abandonment, scale-up, spread, and sustainability (NASSS) framework (11,12).

In this position paper we aim to build on existing knowledge and demonstrate, through the use of case study examples in our work, the KIT Institute vision and approach for holistic and sustainable implementation of digital health technologies.

Case study examples

KIT Institute's role in digital health technologies

Over the past decades, KIT Institute has been involved as research partner, evaluator and technical advisor for the use, implementation and evaluation of innovative digital technologies in global health. Here, we describe three recent cases of our work in relation to the implementation of new digital technologies that are employed to strengthen diagnostic and/or treatment of essential health burdens. They respond to a need for improving access to recommended health services and achieving universal health coverage (UHC). All these examples hold potential to bring essential services closer to the people, leveraged through task-shifting approaches, diagnosis and early interventions at the primary care level and a focus on timely referral. In this brief we do not focus on the specific results of each case, but we capitalize on the cross-cutting learnings and share reflections and tangible approaches that should be taken along in the implementation of health technologies to improve impact.

Case study 1

Evaluating the introduction of digital x-ray systems in Ghana

› The need

Through the WHO's end TB strategy (13) there is global commitment to end the TB epidemic, one of the world's deadliest infectious killers, through early diagnosis and treatment. In Ghana, only 44% of the new TB patients were put on treatment in 2023 (14). It is thus key that more people at risk for TB are being screened, subsequently diagnosed and put on timely treatment. Traditionally, people are verbally screened for TB and if symptomatic referred for further testing. Digital X-ray with computer aided diagnostics using Artificial Intelligence (AI) has the capacity to identify people presumptive for TB that do not have any symptoms.

› The technology

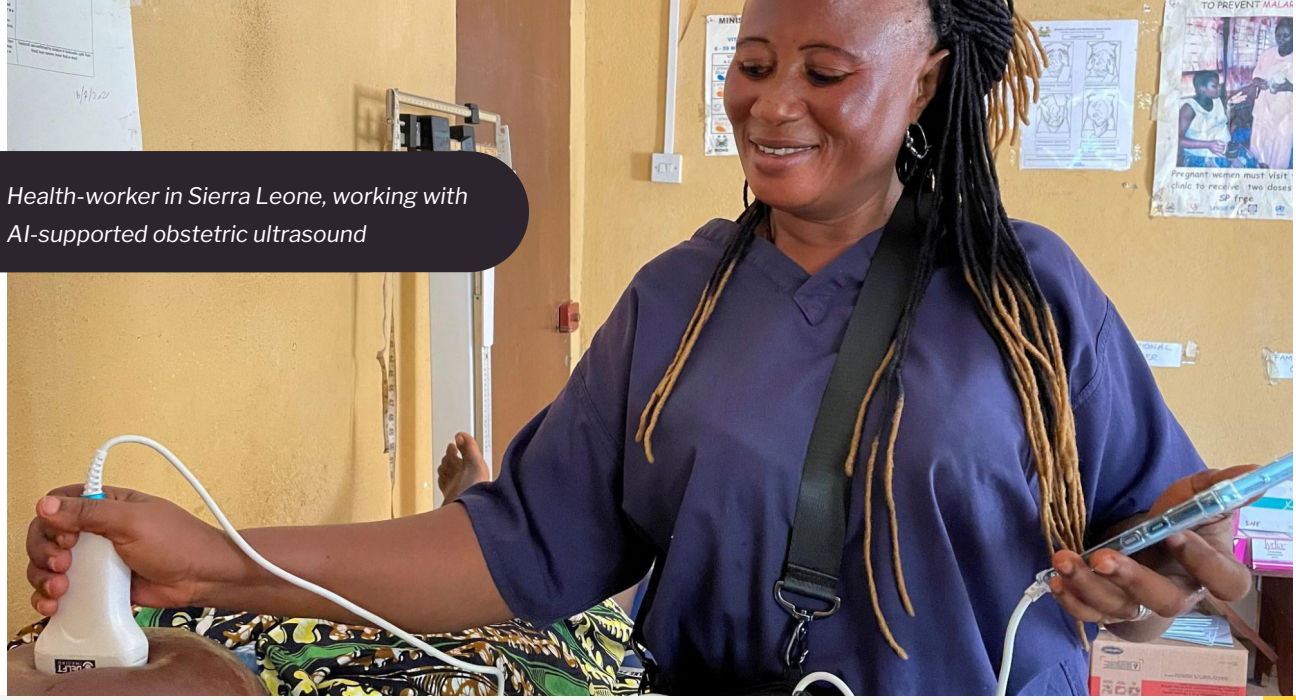
In 2016/2017 52 multi-purpose digital X-ray systems were installed across hospitals in Ghana, together with 16 radiological viewing stations. [1] The systems were installed with computer aided diagnostics, enabling healthcare workers without specialized training to use AI technology to decide whether to refer a person for further TB testing or not. The systems were also used for other diagnostic purposes, such as the identification of bone fractions. Radiologists at linked viewing sites supported the diagnostic process through a teleradiology platform. The instalment was accompanied by training and yearly maintenance which will end early 2025.

› KIT Institute's role

Upon request of Invest International, in 2022 KIT Institute together with Design Health Consult Ltd in Ghana performed an outcome evaluation to understand how and to what extent digital X-ray equipment and training contributed to improved TB case detection, improved diagnostic capacity, and improved access to diagnostic services between 2016 and 2022. For this we interviewed management, health care workers and patients and analysed secondary data.[2]

1 For more information see https://delft.care/cad4tb/ and https://delft.care/project/ghana-2/

2 Paper in progress: Mirjam I. Bakker, John Krugu, Christina Mergenthaler, Yaw Adusi-Poku, Rita Patricia Frimpong Amenyo, Bernard Wadie Adu, Felix Kwami Afutu, Mawuko Mensah, Zeleke Alebachew, Robert Asambobillah, Benjamin Apam, Chantale al Lakis, Maurits Verhagen, Nwanneka Okere. *A mixed-method outcome evaluation of the introduction of digital X-ray systems in 52 health facilities across Ghana to improve TB case finding and quality of care.*



Health-worker in Sierra Leone, working with AI-supported obstetric ultrasound

Credits: Enya Seguin

Case study 2

Researching AI powered smartphone-based obstetric ultrasound in Sierra Leone

The need

The World Health Organization recommends at least one ultrasound in pregnancy before 24 weeks (15), however global and local availability and access to these essential diagnostic services remain highly unequal.[3] The health system of Sierra Leone faces challenges in the availability of ultrasound equipment and trained sonographers. Especially in rural areas, women face issues in access, affordability and equity of the recommended ultrasound in pregnancy. Globally, different technological advancements and healthcare delivery strategies have been employed to bring obstetric ultrasound closer to people, offering immense potential to improve maternal and newborn health outcomes. Portable and hand-held obstetric ultrasound devices, supported by telecommunication or Artificial Intelligence (AI) for results, provide potential for task-shifting of diagnostic tasks to close-to-community providers.

The technology

An AI-powered smartphone-based obstetric ultrasound device has been piloted in one district in Sierra Leone since 2020.[4] Non-specialized providers got a brief video instruction to apply the ultrasound with a standard sweep protocol and get immediate results and recommendations for referral through remote analysis by ultrasound specialists or AI.

KIT Institute's role

Together with our master students[5], KIT Institute researched the effects of the pilot implementation focusing on the healthcare providers ability to use the technology, experiences of providers and pregnant women, its acceptance and potential for sustainability and scale-up.[6]

3 Paper in progress: Irene de Vries, Trust Saidi, Sam Ali, Aris Papageorghiou, Marleen Temmerman, Marcus J. Rijken. Unveiling and addressing the Deeper Dimensions of Obstetric Ultrasounds in global health: Addressing System, Provider, and Women's Needs.
4 For more information see https://delft.care/babychecker-2/
5 https://www.kit.nl/institute/programme/master-of-science-in-public-health-and-health-equity/
6 Paper in progress: Abu Dim Din Sesay, Amie Lompri Koroma, Anke van der Kwaak, Enya Seguin, Alhassan Kanu, Abdul Mac Falama, Mirjam Bakker, Irene de Vries. *Assessing the Implementation of Smartphone-based Fetal Ultrasound in Sierra Leone: A Mixed-Methods* study.

Case study 3

Supporting implementation of an app-based digital mental health intervention in the Occupied Palestinian Territories

The need

Mental, neurological, and substance use (MNS) disorders, which are major contributors to global morbidity and premature mortality, generally deal with insufficient, inequitable, and inefficiently used resources (Mental Health Gap) (15). In the Occupied Palestinian Territories (OPT) mental health challenges have been further exacerbated by ongoing political conflict and socio-economic hardship. Access to mental health services is limited, and stigma surrounding mental health further deters people from seeking help. There is an urgent need for accessible, scalable, and culturally adapted solutions that address mental health challenges while empowering individuals and communities.

The technology

A digital app-based platform connects individuals with trained lay health workers who provide mental health coaching and problem solving therapy based on the Friendship Bench Method, an evidence-based intervention that has shown to reduce self-reported mental health complaints in Zimbabwe (16). The digital version app[7], translated into Arabic and adapted for the local cultural contexts, provided coaching through a secure, private digital platform. Lay health workers were trained and supervised by experienced health professionals to maintain quality assurance and care standards. The platform also included a screening component to identify individuals in need of support and facilitated referrals to higher levels of care for those requiring more specialized mental health services. Outreach efforts, including social media campaigns and partnerships with local influencers were employed to recruit participants. Despite challenges, including the outbreak of conflict, 70 individuals received mental health coaching over a 6 month period in 2024, with 67% likely suffering from PTSD.

KIT Institute's role

KIT Institute together with its local and technical partner conducted an implementation study funded by the Dutch Agency for Enterprise (RVO) assessing the effectiveness, feasibility, and sustainability of the platform in OPT. The study included data collection through surveys, focus groups, and coaching session transcripts, focusing on client recruitment, engagement, and outcomes. The project's qualitative and quantitative findings suggest significant potential for scaling up the service, particularly in conflict-affected regions.

7 For more information see https://inukacoaching.com/foundation.

Which crucial learnings need to be taken along?

Our work with digital health technologies highlights common needs that are widely recognized (but sometimes overlooked), including the need for an enabling environment, with the appropriate structure and processes in place, such as - and in relation to - equipment, power, connectivity, maintenance, human resources, training needs, guidelines, and governance. While recognizing the importance of all enabling factors, this paper focuses on a specific set of issues that are often overlooked or bypassed during the implementation of technology. Through practical examples, we aim to unpack these challenges and emphasize their significance in the complex realities of digital health technology adoption.

The need for contextualization (and regulation)

New technologies are implemented in an existing context of culture, regulations, policies, strategic plans, guidelines, financial & human resource constraints, technical infrastructure etc. In each of our described cases, specific considerations and adaptivity for these contexts proved to be crucial for optimal usage of the new technologies.

Our work in OPT for example, demonstrates how mental health challenges in conflict-affected regions are multi-faceted, requiring more than just technological solutions. Lay health workers that were trained to use the app, faced difficulties in communicating its potential value to users, particularly in communities where stigma around mental health persists. As for any other public health intervention, this underscores the importance of the socio-cultural context and the need for continuous engagement with local communities to ensure that technologies are both used and trusted.

Other needs relate to the creation of the right policy environment. For example, in the case of obstetric ultrasound, the absence of clear national guidelines on when and how to use the tool has led to unnecessary referrals and overuse. In Ghana, the combination of a policy that only allowed radiographers to operate X-ray machines - while having a shortage of radiographers -, initially limited the operation of the implemented digital X-ray systems. Later, a consensus was reached with the Ghana Society of Radiographers to recruit and train biomedical engineers and medical physicists as operators, which improved the situation in the short run, while recruiting more radiographers into public service remained the goal. This illustrates how the “adopters” play a critical role in determining the success of new technologies and should be engaged and listened to early on. Without the necessary trained personnel or a change in policy to allow task-shifting, the adoption of new systems remains limited, despite their technical effectiveness.

> The successful adoption of digital health technologies requires careful contextualization, regulation, and engagement with local systems, policies, and communities to ensure they are effectively integrated and trusted.

Preliminary needs assessments and implementation research, embracing a socio-technical approach, can help to dissect these layers of complexity, offering guidance for how to address challenges that go beyond just implementing the technology itself, but also ensuring that it integrates with local healthcare practices and organizational capacity (figure 1).

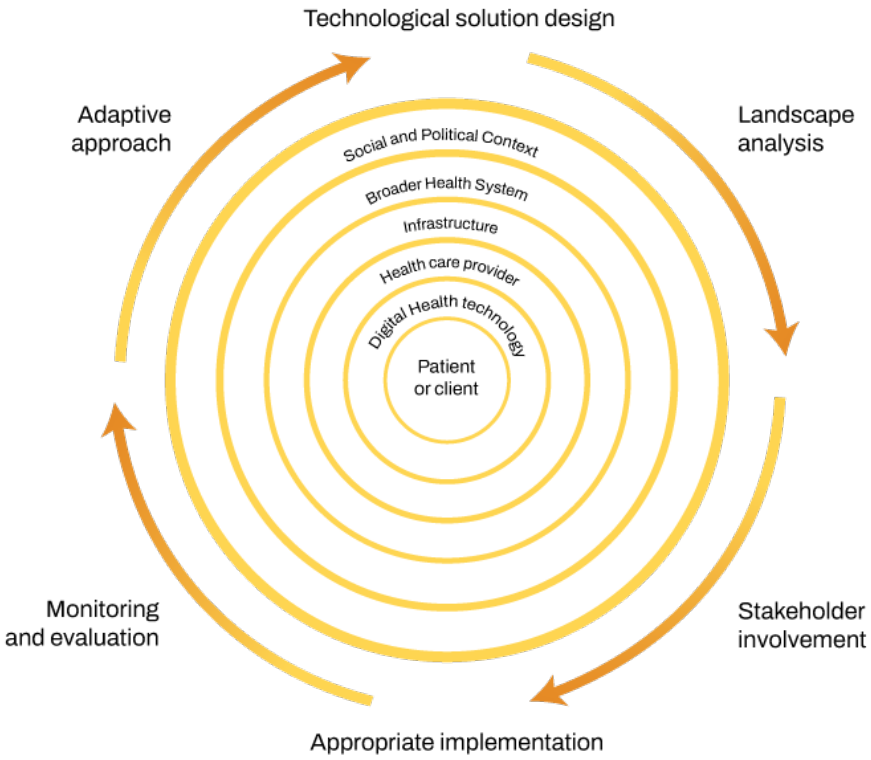


Figure 1 *The contextualization of digital health technologies*

The social lives of health technologies

Health technologies do not exist in isolation—they operate within a complex web of social, cultural, and clinical interactions. In many settings, new tools are not just added to the existing system; they reshape relationships between patients and providers, and between healthcare workers and technology.

For example, in the described cases for TB or obstetric ultrasound diagnostics, it is essential that automatically generated results (the outputs from AI), are not just accepted at face value, but critically interpreted. The application of a tool or diagnostic result must be understood in relation to the patient's overall health, their specific circumstances, and the local healthcare context. If technology is treated as infallible or its outputs are read without scrutiny, it can undermine the broader goal of providing personalized, patient-centred care. This requires specific attention when tools are applied by 'lay health workers' or by patients themselves in the home-setting.

Just as a single tool cannot solve every problem, the real impact of health technologies depends on how they are contextualized to and interact with the local environment, including the skills of healthcare providers and the needs of the population. For example, while AI-powered diagnostics can enhance decision-making, an over-reliance on these tools without thorough patient assessments or counselling can create a false sense of security, leading to missed or inaccurate diagnoses and subsequently mistrust with sometimes even (the unintended) abandonment of the technology.

To ensure successful implementation, we need a holistic approach that recognizes the social interactions between technology and its environment. Therewith, health technologies should be appropriately embedded into the continuum of care, equipping health workers at all levels not only with the tools themselves but also with the understanding of when and how to use them effectively, recognizing their limitations, understanding the consequences of their use and take these aspects along in patient's counselling and information provision.

A quality and continuum of care approach

While technologies are often implemented in a linear process (device is brought to facility), they arrive in complex systems and care continuums. This means that a health system and continuum of care approach needs to be adopted throughout the steps of implementation (from design, to implementation, to evaluation) to ensure appropriate integration into care. While systems-thinking encompasses a broad set of issues, we will pay particular attention to two aspects that appeared as commonalities in the described cases, but in our perspective receive insufficient attention in implementation plans and funding or grant mechanisms: referral networks and the complexity of task-shifting.

In our three described cases, screening/diagnostic tools aim to enable early interventions and timely referral to higher levels of care. However, guidelines on how to use the new technology within the care cascade often lack: who operates the new technology? who is eligible for screening (how to avoid under-, mis- and overuse)? at which stage? and what is the follow-up, including the possibilities for referral? A functional referral system is crucial to ensure rights-based and quality care across the continuum. This means that screening is only relevant and ethical if the next referral level is in reach (accessible and affordable) for the patient and if the referral setting is prepared to receive them. The latter relates to functional capacity (e.g. is the referral setting able to provide pregnant women with a follow-up scan and interventions to respond to detected complications?), but also to responsiveness of the health care staff that receive the referral cases. Their capacity (workload as well as technical capacity), understanding and willingness to attend to a referred case will depend on their feeling of involvement and belonging. From the start, they need to be taken along in defining the relevance, use and consequences of health technology implementation.

> Technology implementation plans and funding or grant mechanisms should pay more attention to health systems integration, including aspects related to referral networks and the complexity of task-shifting.

Particular attention is needed when task-shifting is involved, as more specialised providers may see the use of tools by lay or lower cadre health workers as a threat to their scope of practice and income, or they just have a general (and may be justified) concern for the quality of diagnosis and care. In the example of Ghana, resistance came from radiologists that were tasked with additional work without being compensated. Involvement of stakeholders at all levels throughout the continuum of care and during all phases of implementation is crucial to create their buy-in and fostering leadership.

Conclusion

The rapid adoption of health technologies is often embraced uncritically, touting the promise of expanding access to care in resource-limited settings which threatens to overshadow the need for careful scrutiny. But what if the very innovations designed to improve care exacerbate inequities, fail to connect with real-world health systems, or ultimately falter due to inadequate planning? These technologies are not a one-size-fits-all solution—they must be carefully integrated into local healthcare systems and practices to truly deliver on their potential and reach equitable impact.

> What if the very innovations designed to improve care exacerbate inequities, fail to connect with real-world health systems, or ultimately falter due to inadequate planning?

Drawing on the three example cases presented, this position paper unpacks key issues that are often overlooked or bypassed during the implementation of health technologies—issues that are crucial for their success and long-term impact. These include the need for contextualization and regulation, understanding the social interactions between technologies and their users, and ensuring a quality and continuum of care approach.

What is KIT Institute's approach?

KIT Institute's unique value lies in its ability to bridge the gap between technological innovation and practical, sustainable implementation. While in the described cases KIT Institute contributed at different moments—from design to formative and evaluation phases—our socio-technical and health system approach creates synergy for appropriate implementation, maximizing impact.

We support developers, donors, policy makers, implementers and users in applying a holistic lens (figure 1) to the equitable and sustainable implementation of health technologies, offering evidence-informed advice, research and evaluation.

Key steps for successful digital health technology implementation, where KIT Institute can provide support, include:

- **Transitioning from vertical to integrated approaches.**
  Innovations must move beyond siloed implementation to become embedded within broader health systems. KIT Institute employs system-level thinking to ensure that technologies are adopted, sustained, scalable, and targeted to those most in need.

- **Conducting needs assessments, landscape analyses, and conceptual mapping**
  Understanding the local context is essential. KIT Institute supports social and human-centered design processes to create and adapt relevant solutions that meet real-world needs. KIT Institute facilitates comprehensive assessments to map the place of new technologies within health systems, identifying potential risks and unintended consequences while proposing strategies to mitigate harm.[8]

- **Multi-level stakeholder consultation and involvement**
  Successful implementation demands buy-in from policymakers, health managers, healthcare workers, and patients. KIT Institute fosters collaboration among all stakeholders, ensuring that technologies address unmet needs and align with formal and informal systems, including socio-cultural dynamics.

8 The literature refers for this to the development of "dark logic models" (18).

› Policy formulation and alignment

KIT Institute's experts support alignment with national strategic plans and broader health policies while addressing necessary policy changes (e.g., task shifting). We also provide guidance on budget planning, accountability, and revenue generation to sustain innovations.

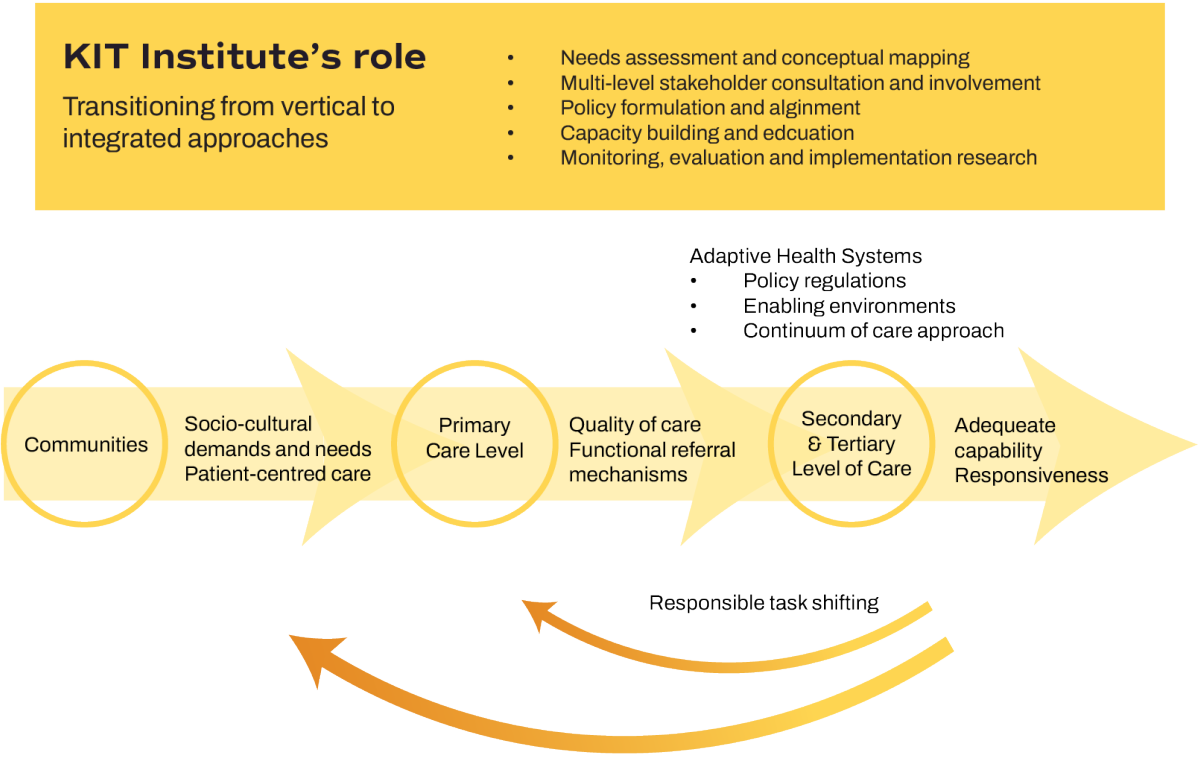
› Capacity building and education

For health providers, KIT Institute offers capacity-building initiatives and facilitates competency-based education to ensure that healthcare workers are well-equipped to use and integrate new technologies effectively. These efforts empower health providers with the skills and confidence needed to maximize the benefits of digital health tools.

› Monitoring, evaluation and implementation research

KIT Institute helps design and execute robust (real-time) M&E frameworks to guide ethical implementation, equitable reach and steering on results in an adaptive management framework.[9] Learning is crucial through the incorporation of implementation research. Questions we tackle include, but are not limited to:

- Who is eligible for screening?
- Who is responsible for costs, and how much should be charged?
- How and by whom should results be interpreted?
- What follow-up actions are required for healthcare workers and clients?
- How can underutilized tools be optimized or reallocated?



9 Balancing Learning and Accountability in Complex Systems (KIT blog) - https://www.kit.nl/institute/news/balancing-learning-and-accountability-in-complex-systems/

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KIT Institute
P.O. Box 95001
1090 HA Amsterdam
The Netherlands

Visiting address
Mauritskade 64
1092 AD Amsterdam
The Netherlands

E-mail
i.d.vries@kit.nl.

Website
https://www.kit.nl/institute/

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