Digital TB Surviellance System Assessment Report

For 19 Global Fund TB Strategic Initiative (SI) Priority Countries

As part of The Global Fund Strategic Initiative (SI) for Data system, this report provides a rapid assessment of the digital TB surveillance systems in 19 TB SI countries and provide strategic recommendations and roadmap for the countries towards a comprehensive digital, case-based, real time, TB surveillance system.

Stop TB Partnership

A partnership hosted by UNOPS

Digital TB Surviellance System Assessment Report

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FOREWORD

DR. LUCICA DITIU

Executive Director, Stop TB Partnership

The clock is ticking, and we are approaching the deadlines for the 2018 United Nations High-Level Meeting targets, the Sustainable Development Goals (SDGs) and End TB targets. The chaotic biennium of the COVID-19 pandemic has challenged the resilience of health systems since 2020 and has been partially responsible for slowing down the rapid progress in the TB response post-2015. However, the pandemic has also opened new doors in terms of the prevention of airborne infection, and peripheral availability of molecular diagnostics and facilities for differentiated care. It has also unveiled the highest political commitment of national governments and unprecedented global collaborations for health. I believe that the COVID-19 pandemic has demonstrated the power of the human race to conquer epidemics, and shown that funding can be made available and actions taken rapidly, if there is the will..

Since March 2020, we have had access like never before to data about the COVID-19 pandemic – people tested, diagnosed and cured, disaggregated by age, gender, small administrative units and so on. The daily reporting has been the most critical enabler of the global response to COVID-19.

For many years already, we at Stop TB Partnership have been of the strong belief that what we need to strengthen in our response is the availability of real-time temporospatial TB epidemiological information for precise, local rapid response with high-efficiency resource management and concurrent monitoring. It is encouraging to see that a small number of countries have started to report TB notification monthly and a few daily – we need many more.

Stop TB Partnership is working to contribute to and strengthen the TB response. One of the areas of interest is to strengthen the local TB surveillance systems to rapidly advance towards real-time, case-based and digital modes so that there is zero gap in timely information for action. The Global Fund, WHO and technical partners have been fortifying the Partnership's efforts. It is therefore an amazing step forward for all partners to have the current assessment of real-time digital case-based TB surveillance systems in 19 priority countries in order to support these systems to rapidly evolve into perfect response-drivers. To the best of my knowledge, this is the first assessment of its kind, and it is encouraging for all of us to see that the local digital systems are at various stages of evolution, set out for the final war-room.

I want to thank the national leaderships for their vision, work and commitment to make their digital TB surveillance systems more sensitive, timely, intelligent and responsive, and I am looking forward to working together to use the latest available data and information for action. It is 2022 – we need rapid action based on reliable and timely information. We saw it done for COVID-19; we need the same approach for TB (as an airborne disease) and all infectious diseases.

MESSAGE

MARIJKE WIJNROKS

Chief of Staff, Global Fund

Real-time digital case-based surveillance systems play a key role in the proper management of people with TB across the continuum of care. They also ensure the timely availability of people-centric data that supports the monitoring of notification results and treatment outcomes, and facilitates prompt decision-making. The Global Fund recognizes this importance and, together with other donors, technical partners and stakeholders, has continuously supported ministries of health and national disease programmes to build and strengthen in-country digital surveillance systems.

Through the Global Fund Strategic Initiative on Data and in synergy with the TB Strategic Initiative, the Stop TB Partnership has assessed the TB surveillance systems in 19 of the 20 Global Fund high-priority TB countries, with a special focus on the real-time digital TB surveillance systems. Understanding the digital case-based TB surveillance systems and challenges in these 19 countries is critical, as they account for 82% of the TB burden and about 66% of the TB funding in Global Fund-supported countries in the 2020–2022 cycle.

It is our hope that the findings and recommendations from this assessment facilitate knowledge transfer between country programmes on the health and TB data needs, inform stakeholder collaboration and help to catalyse the progressive transition from paper-based to functional digital case-based surveillance systems in countries. The Global Fund also acknowledges the valuable role of the World Health Organization, Stop TB Partnership, and other technical partners and donors in moving this priority forward.

ACKNOWLEDGEMENTS

About the Global Fund Strategic Initiative:

The Global Fund Data Strategic Initiative (Data SI) aims to improve monitoring and evaluation systems in countries, and the collection, collation, analysis and use of such data for decision-making and quality improvement. The Stop TB Partnership (STBP) and World Health Organization (WHO) are among the implementers of this SI. As part of the first phase of this SI, STBP has assessed and reported on the availability, readiness and requirements for a real-time case-based tuberculosis (TB) surveillance system in the 19 TB SI countries, in consultation with national TB programmes/ministries of health, in-country stakeholders, WHO and other relevant technical partners. This assessment will be followed by the necessary facilitation to transition to real-time digital case-based surveillance systems in the TB SI countries.

About Stop TB Partnership:

The Stop TB Partnership is a unique United Nations-hosted entity based in Geneva, Switzerland, committed to revolutionizing the TB space to end the disease by 2030. The Stop TB Partnership's various teams and initiatives take bold but measured risks to identify, fund and support innovative approaches, ideas and solutions to ensure the TB community has a voice at the highest political levels and that all TB-affected people have access to affordable, high-quality and people-centred care. Learn more at www.stoptb.org.

DIGITAL TB SURVIELLANCE SYSTEM ASSESSMENT REPORT

EXECUTIVE SUMMARY

Tuberculosis (TB) is one of the world's leading infectious disease killers. The End TB Strategy aims to end the global TB epidemic and has a vision of a world free of TB, with no deaths, disease or suffering due to TB. A strong, responsive TB surveillance system that is digital, case-based and real-time, with data on the full cascade of care and necessary analytics for national TB programmes (NTPs), is critical in the global fight against TB. The COVID-19 pandemic has shown the importance of the availability of real-time data globally, nationally and locally to mount the necessary actions for prevention and care. Most high TB burden countries currently have digital case-based TB surveillance systems at various scales of implementation. While some countries use TB-specific and locally developed ICT systems, many others use platforms including DHIS2. However, there are challenges related to software, hardware, coverage, human resources, training, data regulations, data hosting and ownership, political and administrative will, and so on that need to be systematically identified and prioritized.

Part of the critical task of the Global Fund Data Strategic Initiative (Data SI) is to facilitate countries to rapidly adapt and scale up real-time digital case-based surveillance systems for TB. Stop TB Partnership, as a partner implementing the SI, has initiated this project to conduct a rapid assessment of the real-time digital case-based surveillance systems in TB SI priority countries virtually and to provide country-specific recommendations. Following this, the SI will provide the necessary support to implementers, including national governments, NTPs and partners, to strengthen countries' real-time TB surveillance systems. This assessment was done with the intention to understand the timeliness of data availability, use and coverage of digital tools, granularity of data, use of the information for surveillance and action, and the system to develop, maintain, integrate and innovate such tools with adequate data security measures.

The assessment was done virtually, primarily through a series of in-depth interviews with various stakeholders in the country, including NTPs and partners supporting TB surveillance, using structured questionnaires, online surveys, desktop review of published reports and other relevant documents. The assessment was done for 19 high TB burden SI priority countries.

The report consists of two parts: one multi-country systems analysis with the key findings and recommendations, and much more detailed information on the individual countries.

Key findings of the assessment:

All 19 NTPs have a digital TB surveillance platform. However, each country differs in terms of the maturity of its tools and the scale of implementation. The functional maturity of the digital TB surveillance platform to capture data at different stages of the continuum of care (screening, testing, treatment, treatment adherence, treatment outcome, etc.) varies with country programmes. Although some countries have progressed further in digital data on contact-tracing and preventive treatment, these have yet to be scaled up in most countries.

While all assessed countries have a digital TB surveillance system, 10/19 (53%) countries have a case-based system with at least diagnosis, treatment initiation and treatment outcome reported digitally; 5/19 (26%) countries have case-based systems, but with limited data variables; and 4/19 (21%) countries have yet to develop a case-based system. Countries use different digital platforms for TB surveillance. While many countries have transitioned to case-based digital data entry at facility level, others are still reporting aggregated data primarily from the district level, abstracted from paper-based line lists at the health facilities. The DHIS2 platform is used in 10 countries, whereas e-TB Manager is being leveraged in five countries. Some of the countries use a mix of different platforms, while other NTPs use their own in-house digital TB surveillance systems.

All surveyed countries, especially those with well-developed case-based TB surveillance systems, expressed the need to have an interoperable and integrated system that could allow data exchange between the different systems, such as diagnostic laboratory modules, digital adherence tools, and private sector notification tools. Apart from the core digital system available for TB surveillance and notification, countries have been implementing a range of other complementary digital innovations for their TB programme, including modules for digital adherence, private sector TB notification/monitoring, logistics management, laboratory information management, digital X-ray supported by artificial intelligence (AI), community-led monitoring (CLM), contact investigation/TB preventive treatment (TPT), pharmacovigilance, and so on.

EXECUTIVE SUMMARY

Key priority needs identified:

The key priority needs identified include in-house IT capacity, hardware for data entry, data servers, and software development for necessary linkages. NTPs often have limited in-house IT capacity and depend on external private or public IT service providers. This limits their flexibility and autonomy in upgrading and enhancing the system. The lack or limited availability of devices (mobile devices or laptops etc.) and the right infrastructure, such as servers, internet connectivity and a dedicated technical team at the central level, is a challenge in many countries.

Digital tools are most often used in addition to paper-based tools by the generally overburdened local health staff at the health facilities and outreach. Furthermore, the lack of a training mechanism limits operationalization of the digital tools and results in data quality issues.

Countries with case-based TB surveillance systems also have some form of data dashboard. However, there is a tangible need for advanced analytics and AI-based approaches to ensure real-time information for action. CLM is still a weak link in programme monitoring and surveillance systems.

Key recommendations:

Investment to enhance the hardware infrastructure: Most of the countries need devices for data entry at the peripheral level to ensure real-time TB surveillance and data use at the lowest level units. Providing mobile devices and securing Internet connectivity are crucial steps to ensure successful implementation of the digital case-based TB surveillance system.

Case-based monitoring across the continuum of care: While case-based TB notification is the most basic indicator for the digital TB surveillance system that all countries should strive to achieve, a comprehensive workflow-based system to monitor individual cases throughout the entire continuum of care – from client enrolment and risk assessment through to screening, referral, testing, treatment and follow-up – needs to be ensured.

Interoperability and system integration: The existing digital platform for TB surveillance should have the capacity to integrate and facilitate seamless data exchange between different data systems such as medicine inventory, laboratory information management systems, GeneXpert (GxAlert) system, CLM system, etc.

Advanced analytics for better data use: Real-time big data analytics that provide the right information for action need to be built into the digital TB surveillance architecture. Existing tools like DHIS2 have strong data analytics and dashboard functionality with robust indicator configuration. It is also recommended to explore the best-of-breed tools such as Tableau, Power BI and AI solutions for improved use.

e-Training: Developing a comprehensive e-Training/e-Learning platform is necessary to improve data collection and data use processes, and can also be used for continuing medical education.

Costed action plan for digital TB surveillance: An estimated budget has been recommended for each country to strengthen the digital TB surveillance system based on the current e-readiness and IT capacity, maturity of the existing platform (case-based vs. aggregated), number of facilities and users, and other parameters. However, countries need to develop a costed action plan for strengthening their digital TB surveillance system.

DIGITAL TB SURVIELLANCE SYSTEM ASSESSMENT REPORT

BACKGROUND

Tuberculosis (TB) is one of the leading infectious causes of death worldwide. Throughout human history, it is estimated that over 1 billion people have succumbed to TB. At the 2018 United Nations High-Level Meeting on TB, world leaders agreed to end TB by 2030. A robust TB surveillance system is the foundation on which to build and adapt locally appropriate strategies for ending TB. TB surveillance is the continuous and systematic collection, analysis and reporting of data related to TB infection and TB disease in the population [1]. While the coverage and quality of data are critical in making the surveillance system supportive for end-TB actions, the availability of real-time surveillance data helps in making timely decisions and taking proactive actions to meet the end-TB timelines. Real-time digital and case-based surveillance systems for TB have several advantages over paper-based reporting of aggregated data. Digital systems enable automated data quality checks, timely access to data and the availability of individual-level data on people with TB – from community level up to the national level. Strengthening the technology platforms to make the surveillance real-time is a key enabler in the global fight against TB. Such technology is also integral to the daily management of people with TB and provides critical data on the reach and efficacy of programmes.

Currently, there are many high TB burden countries with digital case-based TB surveillance systems at various scales of implementation. While some countries use TB-specific and locally developed ICT systems, many others use ICT tools including DHIS2. However, there are gaps and challenges that prevent uniform uptake of and benefit from such tools to establish a good TB surveillance system that is real-time and responsive. Challenges are related to software, hardware, coverage, human resources, training, data governance, policies and regulations, digital health architecture, data hosting and ownership, political and administrative will, and so on. These challenges need to be systematically identified, prioritized and addressed. There is also a need for smart analytics, including the potential scope of artificial intelligence (AI) in linking programme data with other ecological data to generate predictive models and other epidemiological information. Another challenge is data fragmentation; different tools are often used by public and private providers, or by different branches of a health department, even for managing comorbidities such as TB and HIV. There are also challenges in local implementation and timeliness of reporting; even the best tools need customization, maintenance and support, as well as strong local champions to ensure effective training, monitoring and ongoing use of new technologies.

The COVID-19 pandemic has shown the importance of the availability of real-time data globally, nationally, and locally to mount the necessary actions for prevention and care. This pandemic has also shown the power of digital data and the feasibility of quickly setting up information systems in almost every country [2]. The impact of COVID-19 disruptions on TB notification was first reported in India very early in the pandemic, thanks to the daily reporting of TB notification on a publicly available website [3] and data from the country programme's well-developed case-based TB surveillance system called 'Nikshay'. Later, countries were encouraged to report TB notification at least monthly, and more than 80 countries reported their TB notification data to WHO monthly to the end of 2021 [4]. Timely availability of data on TB notification and treatment outcomes at the national and subnational levels is critical for monitoring the results of TB catch-up plans and impact mitigation plans. There has recently been high demand for and political commitment to real-time data; therefore, it is the right time for further aggressive efforts in this area.

The Global Fund Data Strategic Initiative (Data SI) has the important task of facilitating countries to quickly adapt real-time TB notification systems. Stop TB Partnership, as a partner implementing the SI, has conducted an assessment of the TB surveillance systems virtually, with a special focus on the real-time digital TB surveillance systems in 19 SI countries, and provided necessary high-level advocacy support to implementers, including national governments, national TB programmes (NTPs) and partners, to enable the programmes to strengthen their real-time TB surveillance systems.

The assessment aimed to understand the timeliness of data availability, use and coverage of digital tools, granularity of data, use of the information for surveillance and action, and the system to develop, maintain, integrate and innovate such tools with adequate data security measures as a real-time digital case-based TB surveillance system.

- Data availability timelines are considered real-time when the relevant data on people with TB/cohorts are entered/reported immediately after diagnosis or initiation of treatment, or reported within a period of one month, since at least monthly notification is encouraged.

- Data are considered case-based when individual data are made available to the relevant levels of monitoring and decision-making units for validation, analysis and feedback.

BACKGROUND

- Data tools are considered digital when a digital application (web-based, mobile-based online or offline) is used to capture data, as opposed to the data being captured using pen and paper.
- Surveillance is when the gathered data are linked to epidemiological action beyond service delivery.
- A system implies that there is a systematic approach to the development/customization and maintenance of the tools used for recording, reporting, analysis and feedback.

Each of the components of the real-time digital case-based TB surveillance system are highly relevant in order to give the system the highest efficiency and have the desired impact on the country's TB burden. Real-time systems, for example, reduce the redundancy of information and time lag in decisions and actions. Digital systems enhance ease of operation in data entry, enhance the granularity of data, and facilitate the transmission, storage, validation and processing of data at multiple levels. Case-based systems improve the people-centric orientation and customization of the TB care continuum, and promote accountability of health programmes and individual care providers. Such systems also have the potential to evolve to accommodate treatment support, grievance redressal, adverse reaction management, differentiated TB care and access to low or no cost TB services. Although surveillance has been an integral part of disease programmes, provision of prompt feedback, linkage of surveillance to timely action, transparency and data accessibility improve with a well functioning and quality-controlled digital system.

Most country programmes currently use the relevant TB data and analytics for feedback to subnational levels, programme reviews and performance reports.

However, digital TB surveillance systems can make key programme performance indicators, such as TB notification and treatment outcomes, available in the public domain for necessary action by various key stakeholders. Access to real-time programme data by all stakeholders can also augment programme transparency.

The assessment also aimed to understand the challenges and gaps in political/administrative support, infrastructure, funding, human resources, system development, maintenance capacity and training.

The digital TB surveillance systems in the countries have developed over time and are continuously evolving with the addition of diverse features, supported by various technical and funding agencies including the World Health Organization (WHO), University of Oslo, United States Agency for International Development (USAID), Stop TB Partnership, KNCV Tuberculosis Foundation, the International Union Against Tuberculosis and Lung Disease (The Union), and the Global Fund to Fight AIDS, Tuberculosis and Malaria. The current assessment gained many insights from existing global guidance and reports, including WHO's Digital, case-based, real-time surveillance for TB: status of progress [1]; WHO Toolkit for routine health information systems data [5]; A new digital platform for timely analysis and use of TB data [6]; Microsoft Research, the Global Fund, Stop TB Partnership's Mapping the technology landscape of national TB programmes [7]; the Stop TB Partnership's field guide: Strengthening Information systems and linkages to care [8]; and USAID's TB DIAH Project.[9]

OBJECTIVES

The key objectives of the assessment were: :

❖ To describe the existing digital TB surveillance systems in the countries in terms of the systems and technologies, coverage, timeliness of reporting, data ownership and dissemination modalities, and hosting arrangements;

❖ To describe the e-readiness and capacity of the countries to implement a comprehensive digital case-based TB surveillance system;

❖ To describe the capacity at the national and subnational levels to analyse and use data for evidence-based decision- and policy-making and overall strengthening of programmatic monitoring and evaluation (M&E) efforts;

❖ To describe the challenges in implementing digital case-based TB surveillance systems in terms of software, hardware, human resources, training, connectivity, private sector involvement, political and administrative commitment, data housing and ownership, data through the entire cascade of care, and information dissemination with appropriate dashboards;

❖ To provide country-level recommendations for addressing identified challenges, including resource needs, to enable the NTP to implement a real-time digital case-based TB surveillance system and make the information accessible to all concerned at the appropriate levels for real-time actions;

❖ To share innovative solutions and success stories with the NTPs on real-time digital case-based TB surveillance systems.

APPROACH AND METHODOLOGY

The approach was devised for a rapid, remote assessment over a short study period, as time was of the essence, especially during the COVID-19 crisis. The assessment attempted to identify the digital TB surveillance systems operational at country level, relying mainly on the inputs from programme implementers, and to make recommendations based on country programme aspirations, system requirements and practical considerations including resource availability. The approach was to optimize the time and effort of the NTPs and other stakeholders yet assess key components that would help countries to better articulate their digital capacitation needs.

A structured process-led approach was designed to execute this assessment, which involved multistakeholder consultations and participation (see Figure 1). The assessment team tried to promote insight, introspection, and cross-learning as the core philosophy throughout the process of assessment and reporting.

The assessment was done primarily through a series of in-depth interviews with various stakeholders in the countries, including NTPs and partners supporting TB surveillance, along with structured questionnaires, online surveys, and desktop review of published reports and other relevant documents. Repeat interviews with probing questions were also conducted to gather more technical information, especially on the existing digital systems, fill information gaps and triangulate information from different stakeholders. Non-English-speaking countries were supported by interpreters and translated information was made available for cross-verification by the respective NTPs and stakeholders.

Following the data collection process, data gathered by the team from different sources (i.e. desktop research, online survey, introductory meetings, and detailed workshops) were curated to extract meaningful insights for country-wise compilation. Data analysis was done using the country assessment template. The analytical template consisted of the complete country assessment information put into a structured format. The framework enabled the team to convert subjective and unstructured information into more structured and analysed insights. It also enabled them to capture relevant recommendations from participants.

The filled in country analytical frameworks with all findings and recommendations were sent to the participants (NTPs and partners) for validation. Further iterations were made following the feedback from the NTPs, and the draft reports were shared again with the NTPs and partners for further validation.

In addition to the individual country reports, the data were further analysed with characteristics such as types of digital platforms, timeliness, coverage and comprehensiveness, collated for multi-country analysis and presented in this report.

Some core principles were followed when designing the approach:

- Multistakeholder engagement and participation
- Open-minded discussion
- Proactive information collection
- Avoidance of any conflict of interest
- Validation of information at each stage
- Sign-off and approval by countries.

The methodology was formulated to conform to the above-mentioned principles. The detailed step-by-step process is further explained in Annex 2

COLLECTION   **CURATION**   **VALIDATION**   **ANALYSIS** **RECOMMENDATION**

Figure 1. The methodology was divided into five main steps, starting from collection through to curation, validation, analysis and recommendation

COUNTRIES ASSESSED

The 19 TB priority countries assessed were: Bangladesh, Cambodia, Cameroon, Democratic Republic of the Congo (DR Congo), Ethiopia, Ghana, India, Indonesia, Kenya, Mozambique, Nigeria, Pakistan, Philippines, South Africa, Ukraine, Uganda, United Republic of Tanzania, Viet Nam and Zambia.

Key findings of the assessment

MULTI COUNTRY COMPARISON AND ANALYSIS

STATUS OF DIGITAL TB SURVEILLANCE
SYSTEMS – FUNCTIONAL MATURITY LEVEL

All NTPs across the 19 countries acknowledge the value of a real-time digital TB surveillance system. All 19 countries have created a TB surveillance platform to the best of their capacity. However, each country differs in terms of the maturity of these tools and scale of implementation, which is a function of resource availability, access to the existing digital ecosystem, political will and the presence of an enabling digital environment. Figure 2 and Table 1 show the level of maturity of the digital case-based TB surveillance systems in the 19 countries during the assessment period. The maturity level was assessed on a scale of 1 (basic) to 4 (full maturity) based on six parameters: 1) timeliness of data availability (score of 1 for quarterly reporting to a score of 4 for daily data entry and real-time analytics); 2) digital case-based (score of 1 for no case based systems to 4 for case-based for both drug-susceptible [DS-] and drug-resistant [DR-] TB); 3) coverage (score of 1 for pilot to 4 for full national coverage); 4) level of granularity and use of data for surveillance (score of 1 for national-level reporting only to 4 for dashboards, line lists, job aids and feedback, including publicly available key information); 5) IT systems, including human resources (score 1 for externally supported limited resources to 4 for full IT systems, a dedicated IT team and necessary data entry tools at all levels); and 6) cascade of care (score 1 for notification only to 4 for presumptive TB to outcome data). The assessment found that India and Philippines have fully mature digital case-based TB surveillance systems in operation. Bangladesh, Cambodia, Indonesia, Nigeria, South Africa, Ukraine and Viet Nam have fairly advanced systems, and, with some additional effort, these countries could quickly move to fully functional digital case-based TB surveillance systems. DR Congo, Kenya and the United Republic of Tanzania have digital case-based systems; with additional support for scale-up and IT support systems including data entry tools, these countries are on their way to achieving a mature system. Cameroon, Ethiopia, Ghana, Mozambique, Pakistan, Uganda and Zambia have a strong vision and political will to create a comprehensive digital case-based TB surveillance system, but need additional support in system development and scale-up.

Composite Country score

09   16   24
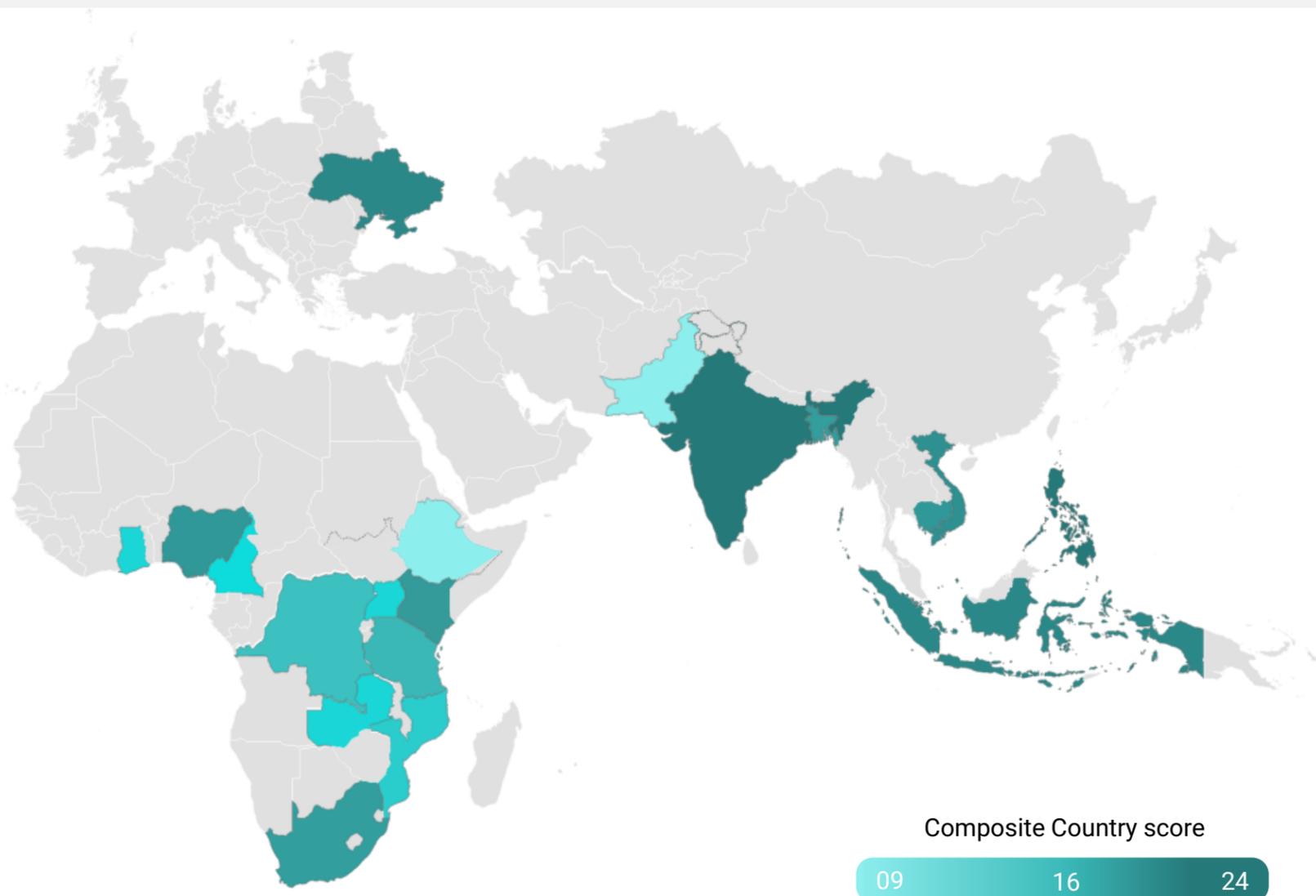
Figure 2. Countries' functional maturity in implementing digital case-based TB surveillance systems based on a composite score

Disclaimer

The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of the Stop TB Secretariat concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. White discontinuous lines are used to represent boundaries under dispute and to approximately show the line of control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. This map is based on UN Map No. 4170 Rev. 15 (July 2018). Every effort is made to ensure this map is free of errors but there is no warrant the map or its features are either spatially or temporally accurate or fit for a particular use. This map is provided without any warranty of any kind whatsoever, either express or implied.

	TIMELINESS OF DATA ENTRY	DIGITAL AND CASE-BASED	SCALE/ COVERAGE CASE-BASED	SURVEILLANCE LEVEL AND GRANULARITY	IT SYSTEM AND SUPPORT TEAM	CASCADE OF CARE	COMPOSITE COUNTRY SCORE
BANGLADESH	3	4	3	3	2	3	18
CAMBODIA	2	4	4	3	3	3	19
CAMEROON	1	1	1	2	3	2	10
DR CONGO	2	4	1	2	2	4	15
ETHIOPIA	1	1	1	2	2	2	09
GHANA	2	1	1	3	1	3	11
INDIA	4	4	4	4	4	4	24
INDONESIA	3	4	4	3	3	4	21
KENYA	2	4	3	3	2	3	17
MOZAMBIQUE	2	3	1	2	2	2	12
NIGERIA	3	4	3	3	3	3	19
PAKISTAN	1	1	1	2	2	2	09
PHILIPPINES	4	4	4	4	4	4	24
SOUTH AFRICA	3	4	3	3	2	3	18
UGANDA	3	1	1	2	2	2	11
UKRAINE	4	4	4	3	3	3	21
UNITED REPUBLIC OF TANZANIA	2	4	3	3	2	2	16
VIET NAM	3	4	4	3	2	4	20
ZAMBIA	2	1	1	2	2	3	11

Table 1. Digital TB surveillance systems – functional maturity level

VARIABLES	SCORE 1	SCORE 2	SCORE 3	SCORE 4
Timeliness of data entry	Quarterly	Monthly	Weekly	Daily
Digital and case-based	No case based system	Only DR TB case based	Only DS TB case based	Both DR TB and DS TB case based
Scale/ coverage case-based	No case based system functional at facilities or Pilot	DR TB full coverage	DS TB expanding (at least 25% national coverage)	Both DS TB and DR TB full national coverage
Surveillance level and granularity	Data use-blank (no evidence of any use)	Offline data analysis at national/sub national level	Dashboards, feedbacks -Data in programme domain	Publicly available data at all levels
IT system and support team	No, supported externally	Yes, IT system software available, more hardware needed, Team supported externally	Yes, inhouse team and software available, need more hardware support	Full IT system, inhouse team ready
Cascade of care	Notification only	Treatment initiation to outcome	Testing to outcome	Presumptive to outcome

STATUS OF DIGITAL TB SURVIELLANCE SYSTEMS – CONTINUUM OF CARE

It was encouraging to learn that all 19 TB priority countries have some form of digital tool for TB notification and surveillance. Although some countries are ahead of others in terms of the maturity of the tools, the vision for moving to a fully interoperable digital case-based TB surveillance system was clearly articulated by each NTP. The functional maturity of the digital TB surveillance platform in terms of its ability to capture data variables at the different stages of the continuum of care – from screening and TB testing through to treatment, treatment adherence and treatment outcome – varies with the respective country programmes (see Table 2). Although some countries have progressed further in digital data on contact-tracing and preventive treatment, this has yet to be scaled up in most countries.

	PRESUMPTIVE TB SCREENING	TB TESTING	TREATMENT INITIATION	TREATMENT ADHERENCE	TREATMENT OUTCOME	CONTACT TRACING
BANGLADESH	Aggregated	Case-based	Case-based	Case-based	Case-based	Manual
CAMBODIA	Manual	Case-based	Case-based	Case-based	Case-based	Case-based
CAMEROON	Manual	Manual	Aggregated	Manual	Aggregated	Manual
DR CONGO	Case-based	Case-based	Case-based	Manual	Case-based	Manual
ETHIOPIA	Manual	Manual	Aggregated	Manual	Aggregated	Manual
GHANA	Aggregated	Aggregated	Case-based	Case-based	Case-based	Aggregated
INDIA	Case-based	Case-based	Case-based	Case-based	Case-based	Case-based
INDONESIA	Manual	Case-based	Case-based	Case-based	Case-based	Case-based
KENYA	Aggregated	Case-based	Case-based	Case-based	Case-based	Case-based
MOZAMBIQUE	Manual	Case-based	Aggregated	Manual	Aggregated	Manual
NIGERIA	Manual	Case-based	Case-based	Case-based	Case-based	Manual
PAKISTAN	Manual	Manual	Aggregated	Manual	Aggregated	Manual
PHILIPPINES	Case-based	Case-based	Case-based	Case-based	Case-based	Case-based
SOUTH AFRICA	Aggregated	Aggregated	Case-based	Case-based	Case-based	Aggregated
UGANDA	Manual	Case-based	Aggregated	Manual	Manual	Manual
UKRAINE	Manual	Case-based	Case-based	Manual	Case-based	Manual
UNITED REPUBLIC OF TANZANIA	Manual	Manual	Case-based	Case-based	Case-based	Aggregated
VIET NAM	Case-based	Case-based	Case-based	Case-based	Case-based	Manual
ZAMBIA	Manual	Aggregated	Aggregated	Manual	Aggregated	Aggregated

Legend: Case-based · Aggregated · Manual

Table 2. Data systems for continuum of care

While all assessed countries have digital TB surveillance systems sin their programmes, 10/19 countries (53%) have a case-based system reporting at least TB testing, treatment initiation and outcome digitally; 5/19 countries (26%) have case-based systems, but have data only for either notification or treatment initiation and outcome; 4/19 countries (21%) have yet to develop a case-based system. Countries such as Bangladesh, Cambodia, Kenya, India, Indonesia, Nigeria, Philippines and Viet Nam have fairly advanced systems. However, the national-level coverage and comprehensiveness vary.

DIGITAL TB SURVEILLANCE PLATFORMS

Countries use different digital platforms for TB surveillance. While many countries have transformed to case-based digital data entry at facility level, others are still reporting aggregated data primarily from the district level, abstracted from paper-based line lists at the health facilities.

Table 3 shows the different platforms used by the programmes, data types (case-based or aggregated) and point of data entry. (Note: The scale/coverage of the platform or data entry point is not depicted here. This can be seen in Table 1 describing the functional maturity.)

	NATIONAL DIGITAL TB SUVIELLANCE TB PLATFORM	DATA TYPE	POINT OF DATA ENTRY
BANGLADESH	e-TB Manager	💻	Facility level (Upazila Health Complex and other hospitals)
CAMBODIA	e-TB Manager (Cam TBMIS)	💻	Facility level (Treatment health centres)
CAMEROON	DHIS2	▦	Regional level
DR CONGO	DHIS2	💻	Health zone level
ETHIOPIA	DHIS2	▦	Facility level
GHANA	DHIS2, e-Tracker (high burden facilities)	💻 + ▦ (High burden facilities)	Facility level
INDIA	NIKSHAY	💻	Facility level
INDONESIA	SITB	💻	Facility level
KENYA	TIBU, KHIS 2	💻	Sub-county level (on behalf of health facilities)
MOZAMBIQUE	SIS-MA (DHIS2)	▦	Facility level
NIGERIA	e-TB Manager, DHIS2	💻	High Burden facilities, District level
PAKISTAN	DHIS2, ENRS	▦	DHIS2 - District level, ENRS - Facility level
PHILIPPINES	ITIS	💻	Facility level
SOUTH AFRICA	Tier.Net (DS TB), EDR web (DR TB)	💻	Facility level
UGANDA	DHIS2	▦	Facility level
UKRAINE	e-TB Manager , MIS SSD	💻	Facility level (TB servicing units)
UNITED REPUBLIC OF TANZANIA	DHIS2	💻	Facility level
VIET NAM	VITIMES, e-TB Manager	💻	VITIMES - District level eTB manager - Facility level
ZAMBIA	DHIS2	▦	District level

Table 3. Digital platforms   💻 Case-based   ▦ Aggregated

The DHIS2 platform is used in eight countries (Cameroon, DR Congo, Ethiopia, Ghana, Pakistan, Uganda, United Republic of Tanzania and Zambia), whereas e-TB Manager is being leveraged in five countries (Bangladesh, Cambodia, Nigeria, Ukraine and Viet Nam). Some of the countries in the list also use a mix of different platforms (Ghana, Nigeria and Viet Nam). For the remaining countries, the NTP has taken leadership to develop its own in-house TB surveillance system (Kenya, India, Indonesia, Mozambique, Philippines and South Africa).

COMPLEMENTARY DIGITAL INNOVATIONS, INTEROPERABILITY AND SYSTEM INTEGRATION

All surveyed countries, especially those with well developed case-based TB surveillance systems, expressed the need to have an interoperable and integrated system that could enable data exchange between different systems, such as diagnostic lab modules/GxAlert, digital adherence tools, private sector notification tools, etc. Countries have yet to implement comprehensive data warehouses and interoperable standards such as FHIR (Fast Healthcare Interoperability Resources) or HL7 (Health Level Seven International).

Apart from the core digital system available for TB surveillance and notification, countries have been implementing a range of other complementary digital innovations for the TB programme (see Table 4). Some of the key modules/platforms assessed include the following:

Digital adherence module/platform

This module/platform enables either adherence reporting by health workers/community/facility treatment supporters or self-reporting of adherence by the people on TB treatment themselves. The format can range from a software application to devices like a pill box integrated with an application to a 2G channel-based (USSD, Missed Call, IVRS, SMS) solution like 99DOTS.

Private sector TB notification/ monitoring module/platform

Many programmes use separate apps/modules for notification/monitoring from the private sector. While some mobile applications for this purpose are well integrated into the main digital TB surveillance platform, other standalone apps also exist.

Logistic management module/platform

This includes medicines/diagnostics reagents/commodities/consumables inventory and logistics management systems. Most often, these solutions cut across different health programmes and are not necessarily dedicated to one single programme like TB.

Laboratory information management module/platform

This includes different activities from test result updates – including for culture, drug susceptibility testing (DST) and line probe assay (LPA) – to sputum collection and transport systems, and integrated system/applications for GeneXpert/Truenat.

Digital X-ray supported by AI

Digital X-ray machines are being scaled up in many countries. Computer-aided detection (CAD) technology is also increasingly used to provide presumptive screening. However, these data often exist in silos and are not linked to laboratory diagnostic data, for example. Therefore, health care workers have to double-enter the X-ray screening data into the existing platforms. Interoperability solutions between X-ray/CAD databases and the main TB surveillance platform are crucial.

Community Led Monitoring module/ platform

This is a very essential yet new area of focus. Many countries realize the importance of community-centric approaches and the use of CLM systems and different digital innovations to facilitate community-based reporting, grievance redressal, access to information, community forums and discussion platforms.

Contact investigation/TB Preventive Treatment (TPT) module/platform

These apps/modules contain screening, contact investigation and TPT data. Most of the countries follow WHO's screening and contact investigation pathways to ensure access to TPT for eligible clients.

Pharmacovigilance module/platform

This involves systems or modules to report adverse events from TB medicines. In most of the countries, pharmacovigilance platforms cater to different programmes and medicines including TB medicines.

OTHER COMPLIMENTARY DIGITAL MODULES

As far as the integration of the complementary digital modules into the national digital TB surveillance system is concerned, three main categories were identified:

Module within the national TB surveillance platform: Some of the advanced systems have most of the complementary modules already built into the TB surveillance system. This means that the modules share a common code base and are deployed in the same data environment, which ensures complete harmonization and data exchange with the national TB surveillance platform.

External platform fully integrated into the national TB surveillance platform: Modules/platforms falling under this category are those that, despite using a different code base and having been developed as a separate platform, have all the necessary data exchange capabilities and integrations. Systems such as GxAlert or QureAI, WHO's Prevent TB platform, 99DOTS and OneImpact that are integrated into TB surveillance systems fall under this category.

External platform not integrated into the national TB surveillance platform: These are systems where a data exchange mechanism has yet to be put in place. These systems often have their own database and deployment in different environments.

	DIGITAL ADHERENCE	LOGISTICS MANAGEMENT	LAB INFORMATION SYSTEMS	COMMUNITY LED MONITORING	CONTACT TRACING	PHARMACO-VIGILANCE
BANGLADESH	99DOTS	QuanTB	GxAlert, CAD4TB	mHealth, ConnecTB	e-TB manager	
CAMBODIA	Cam TBMIS		Cam TBMIS	OneImpact	Cam TBMIS	
CAMEROON		DHIS2	GxAlert, Data2Care		Household survey	
DR CONGO		QuanTB		OneImpact		
ETHIOPIA			GxAlert	eCHIS		VigiLyse, VigiBase
GHANA		QuanTB	GxAlert, ASPECT		DHIS2	
INDIA	NIKSHAY, 99DOTS, evriMED/ MERM box	NIKSHAY Aushadhi	LIPMS, Qure.ai	NIKSHAY Arogya Sathi, TB Mitra	Prevent TB	PVPI Pharmacovigilance system
INDONESIA	EMPATI	SITB, SITRUST	GxAlert, SITB	EMPATI	SITB, SITK	
KENYA		TBMeds, KEMSA LMIS	GxAlert, LabWare		TIBU	TIBU
MOZAMBIQUE	SIS-MA	Ferramenta Central	GxAlert, Disalink	OneImpact	DHIS2	
NIGERIA	99DOTS, VideoDOTS	LMIS	GxAlert, CAD4TB		EWORS, Commcare	e-TB manager
PAKISTAN		TB DMIS	GxAlert, CAD4TB	OneImpact		
PHILIPPINES	99DOTS, VideoDOTS, Smart Pillbox, ConnecTB, CareTB	QuanTB, PMIS	GxAlert, Data2Care, C360	OneImpact (CareTB)	CareTB, ITIS, ConnecTB	PVIMS
SOUTH AFRICA	Wisepill, PCAM	Stock Visibility System	GxAlert, Qure.ai	Ritshitze (SMS to patients)		EDR Web, PVIMS
UGANDA	VideoDOTS, 99DOTS	DHIS2	DHIS2, GxAlert	Toll Free call centre	DHIS2	
UKRAINE	VideoDOTS, evriMED pill box	e-TB manager, QuantTB	e-TB manager, LMIS	OneImpact		
UNITED REPUBLIC OF TANZANIA	99DOTS, TambuaTB	eLMIS	GxAlert	OneImpact		
VIET NAM	VITIMES, e-TB manager	VITIMES, e-TB manager	VITIMES, e-TB manager, GxAlert, PACS, Qure.ai, DrAids	ZeroTB Vietnam	ACIS	e-TB manager
ZAMBIA		eLMIS	GxAlert, DISA, Data2Care			

Table 4. Other complementary digital modules

KEY PRIORITY NEEDS IDENTIFIED

The following are some of the key priority needs identified. The specific needs and urgency assessed during the stakeholder discussions form the basis of the recommendations outlined in the next sections of this document.

IT capacity

Many countries highlighted that the in-house IT capacity of the NTP was limited, often dependent on external private or public IT service providers, thus limiting the flexibility and autonomy of upgrading and enhancing the system. There was a clear need to strengthen internal IT capacity. Doing so will not only provide autonomy to innovate, but also ensure sustainability and scalability in the long run in terms of expanding to different modules and different user groups. Lack of a dedicated technical team at the central level for digital TB surveillance is another challenge in many countries

Hardware and devices

One of the most common challenges faced by countries is the availability of devices (mobile devices, mobile Internet or laptops, etc.) and the right infrastructure such as Internet connectivity or even electricity. Providing the necessary devices to health functionaries at the lowest level units will help to optimize the work of health staff and ensure timely collection of data, which is crucial for the success of any digital TB surveillance system.

Double systems for data entry

Most often the health staff at the local levels are overburdened, and the digital entry tool is often being used in addition to the paper-based tools (rather than the digital tool as the only data collection tool). This duplication of data entry adds to the workloads of the health staff at the facilities or outreach.

Despite having advanced digital systems, most countries continue to rely on paper-based data entry at the periphery. The lack of complete coverage of digital systems, and thus the need to maintain paper-based systems, continues to present a challenge Data validation is another important issue, which is different when using a paper-based system. Digital systems can provide necessary quality checks/deduplication etc. and instil better confidence in programme managers to do away with paper-based systems

There have been concerns about transfer/migration of historical data from paper-based systems to the digital system and the availability and use of the historical data during the transition period. Countries that have fully transitioned to digital systems have made extra effort to enter the backlog of case-based data for the last few years.

Training and capacity-building

Training has multidimensional challenges. First, the ongoing COVID-19 pandemic has paused training to a considerable extent in most countries. Assessment of training needs and provision of fresh/update training on TB surveillance systems have been replaced by the more demanding need for COVID-19 infection prevention and control and impact mitigation. Virtual training/training with remote assistance are being promoted by many NTPs. Some national programmes, such as those in India and Philippines, have developed e-Learning platforms and self-learning modules with release alerts. Provision of self-learning and assisted learning opportunities to complement or reinforce physical learning has proven helpful. However, complete transition to remote or self-learning may not be an option for the most peripheral staff, especially general staff who additionally manage TB data. Furthermore, the lack of a scalable remote training mechanism limits the operationalization of digital tools and results in data quality issues at the source of collection during restricted access situations.

Cascade of care monitoring

Although many countries have case-based TB surveillance systems, many often lack a comprehensive workflow-based model to monitor a person with TB through the continuum of care – from risk assessment to screening and referral. However, all countries unequivocally expressed the importance of capturing real-time data across the entire cascade of care, as this has the potential to increase the yield and plug the leaks in the cascade.

KEY PRIORITY NEEDS IDENTIFIED

Community linkages/CLM

CLM is still a weak link in providing holistic TB care. Although many countries are implementing community screening/sputum collection and outreach work using community workers and volunteers, the countries have yet to implement standardized CLM frameworks or use the data to strengthen the TB response through community and civil society organization (CSO) participation. However, all NTPs recognize the importance and value of strengthening community and civil society engagement, and addressing community challenges such as social barriers to access, stigma, TB support services, and human rights challenges.

Data science, analytics and AI for a comprehensive TB surveillance system

Most of the countries with a case-based TB surveillance system also have some form of dashboard. Some countries are ahead of others, but the need to effectively analyse data for programmatic decision-making is acknowledged by all. Countries in advanced stages of digital platform implementation envision the use of advanced data science and AI-based approaches not only for analysing data, but also for predictive modelling to facilitate better resource planning and programme management, smart digital job aids powered by AI solutions, epidemiological intelligence, impact assessment, etc.

The use of AI enables reasoning with uncertainty in complex environments and helps find missing cases. Using survey or programme data at high resolution can help to predict risk of disease, health-seeking behaviour, vulnerabilities and treatment outcomes at the individual or population level. Predictive modelling approaches can be used to map at-risk population groups and support active case finding through the engagement of local stakeholders, including private health care providers.

KEY PRINCIPLES AND APPROACHES

Leveraging and maximizing existing IT infrastructure and capacity

One of the core principles considered in the country recommendations is to maximize the existing IT infrastructure and data ecosystems already in place, instead of creating a parallel system and "reinventing the wheel". In general, the approach should be "build on what you have". The digital systems will keep on evolving and, at some point, every country programme will need to jump systems. For some, that shift might come sooner, while for others it might be a better option to shift at a later time. There should always be consideration of when it may make sense to change systems, followed by a full cost–benefit analysis, aligning with the country's national HMIS/M&E plans and digital health national strategies.

In addition, if there is an opportunity to integrate the TB surveillance system into an existing sound general electronic medical records (EMR) system, it might be a better option, but without compromising the need for comprehensive TB surveillance. The recommendations aim to leverage the following key strengths of the countries.

Existing software/Data ecosystem

The assessment revealed that almost every country has some form of digital infrastructure and capacity in place. As indicated earlier, eight countries have DHIS2-based systems in different phases of implementation, and five countries are already using e-TB Manager-based systems. Kenya, India, Indonesia, Mozambique, Philippines and South Africa have systems developed by their internal IT teams.

This infrastructure provides the country with an excellent launchpad for creating a comprehensive digital TB surveillance system without much need to depend on external systems. However, while the existing platforms provide a core foundation, countries may use this assessment report to discover different functional and technical innovations and modules that other countries are implementing. There is also a great deal of scope to integrate external digital innovations into the core foundation countries already have in place.

This approach makes the digital roadmap not only cost-effective, but also sustainable in the long run, as it has the potential to integrate with

the overall health system and help to reduce health data silos.

Human resource/IT capacity

In line with this core principle, countries should maximize and strengthen the human resources and IT capacity already available in countries. For example, one of the most common recommendations is to leverage the existing DHIS2 resources or other technical experts already in the countries. Capacitating and increasing existing resources will not only lead to a smooth transformation of the digital landscape in the country, but also ensure long-term sustainable growth. The recommendation is for these digital initiatives to be increasingly country-led, strengthening the country's in-house technical team and capacity.

Hosting and deployment environment

Like software applications, the recommendation ensures that countries' existing hosting and deployment environments, such as servers, clouds, data warehouses and repositories, are maximized.

Align recommendations with the country's vision and challenges

One of the other core principles followed is to align the recommendations with the country's existing vision and priorities in order to address the key challenges faced by the country. These challenges can differ significantly from country to country based on different factors discussed below.

Stage and maturity of TB surveillance system

The recommendations vary from country to country based on the stage and maturity of the TB surveillance system. For example, for countries that have only an aggregated TB notification system, the typical recommendation is to first create a case-based TB surveillance system for the entire continuum of care, whereas for countries that already have a case-based TB surveillance system, the recommendation is to explore other advanced features/modules such as contact investigation, GxAlert integration, etc.

Alignment with roadmap and vision

The approach is also to keep the recommendations aligned with the country's existing vision and roadmap, shared as part of the assessment exercise.

Prioritization based on challenges

The recommendations also reflect the challenges highlighted by the countries as part of the assessment. While many of the basic challenges are similar across the countries, the countries also vary significantly in terms of how and when they can resolve the challenges.

Non-prescriptive

Another core principle of the recommendations is to keep them non-prescriptive. The idea is to share the best practices based on our combined understanding from multiple countries and stakeholders. However, the countries should evaluate these recommendations based on their country context, budget availability, priorities and mandates.

KEY GENERIC RECOMMENDATIONS

While the recommendations vary from country to country based on the principles indicated in the previous section, some of the common recommendations provided to achieve the ideal functional and technical architecture for a case-based TB surveillance system are as follows:

Interoperability and system integration

One of the biggest opportunities and enabling environments is the digital ecosystem that already exists within the national programme – whether fully owned and managed by the NTP or managed by an external private or public entity, including other programmes in the Ministry of Health, and across Ministries such as Information or Telecommunications.

These existing data ecosystems form a strong foundation for promoting interoperability, which would enable countries to integrate and facilitate seamless data exchange between different data systems such as medicine inventory, laboratory information management systems, GeneXpert (GxAlert) system, CLM and more. The idea is to create an integrated and harmonized data exchange system in which each part is complementary and duplication of effort is avoided. This ensures that existing efforts are better optimized and utilized, instead of introducing a new system.

As part of the assessment, we recommend that countries implement the following broad measures to ensure interoperability:

Leverage interoperability standards like FHIR: (Fast Healthcare Interoperability Resources). FHIR is a standard describing data formats and elements and an application programming interface for exchanging electronic health records. This would enable NTPs to exchange data with other health records or data systems such as diagnostic devices, logistics management systems and other data systems. It would also ensure high-level data security and privacy during the data exchange processes.

Recommended exchange/ETL tools: Tools like Talend or Informatica that include these features make data management and data governance tasks much easier.

Creation of a centralized data warehouse: A strong data warehouse, data governance and analytics framework are core to ensuring interoperability. These aspects will not only enable the sharing and reporting of TB data with other national health information systems, but also facilitate the consumption and triangulation of data from other data sources, including open data repositories.

Develop the necessary application program interface (API) and single sign-on: TB surveillance systems that have already been developed or are in the process of development should ensure development of the necessary APIs so that they can integrate with other systems.

Enhancing hardware infrastructure

All countries without exception expressed the need for and highlighted the importance of devices to ensure real-time TB surveillance and data use at the lowest levels. Providing mobile devices and mobile Internet could be a crucial and cost-effective way to ensure successful implementation and adoption of these tools, and investing in hardware as the backbone of the case-based TB surveillance system and other ancillary data systems. The investment made in devices can be optimized by maximizing their use in other health programmes, as most health functionaries at the lowest level units are often tasked with responsibilities from multiple programmes.

Hardware includes mobile devices/tablets/laptops for outreach/facility staff for real-time data entry and access to analytical dashboards/job aids, etc.

Although servers are also an important component of the hardware infrastructure, in most of the countries assessed, servers and deployment infrastructure are already available either directly within the TB programme or within the broader Ministry of Health or national government. Cloud-based hosting is generally recommended, as it offers appropriate security and ease of operation.

RECOMMENDATIONS

Case-based monitoring across the continuum of care

While digital case-based TB notification is the most basic and important data variable and early indicator for the development of a digital TB surveillance system that all countries should strive to achieve, one of the key processes and functional recommendations common to all countries is to achieve a comprehensive workflow-based system to monitor individual cases throughout the entire continuum of care – from client enrolment and risk assessment through to screening, referral, testing, treatment, treatment adherence, treatment outcome, comorbidity management and post-treatment follow-up. This should also ideally include the complete screening pathway for TB disease and infection for vulnerable groups such as HIV patients and contacts of people with TB in order to identify and refer clients for TPT.

Advanced analytics for better data use

One of the most crucial aspects of the assessment was to review the status of data use in the countries. Most country programme leaderships unequivocally consider this to be one of the most crucial areas. Although most countries have some form of data and data use tool, very few countries have a real-time dashboard with data at the lowest levels, not only for M&E purposes but also for better patient management and care. There are various innovations that can result in the most effective use of data for programmatic improvement. Some of the recommendations include:

- Enabling real-time monitoring of the cascade of care pathway;
- Big data analytics and AI-based predictive modelling, mapping, risk profiling and prioritization for actions of people with TB using appropriate machine learning and AI systems;
- Geospatial analytics;
- Integration of CLM indicators with programme indicators;
- Automated AI-based job aids for programme staff, etc.

Given that there are different data systems working in conjunction, it is also recommended to explore creation of a centralized data repository/data warehouse system, bringing data from multiple sources into one place.

Existing country tools like DHIS2 have strong data analytics and dashboard functionality with robust indicator configuration.

It is also recommended to explore best-of-breed tools such as Tableau and Power BI, which offer these features. APIs can be generated and connected with these applications, and these can be used as an extended analytical component of the data analysis framework.

Community Led Monitoring (CLM)

Community-based monitoring (CBM)/CLM is one way of generating granular data to provide feedback to service providers and decision-makers in order to collaboratively solve barriers and bottlenecks to services and improve the quality of services. Examples of CBM models include community treatment observatories, human rights complaints mechanisms, and scorecards. Users and communities gather, analyse and use information to improve access to services, better target resources, and address human rights and gender barriers. This is crucial for the overall success of the programme. One of the key recommendations is to fully integrate CLM into the programmatic framework of the country. This can be achieved in different ways, as outlined below:

- Include CLM indicators among the core indicators of the NTP – mainly in terms of how different barriers to services reported by the community are impacting programmatic targets and outcomes.
- Promote CLM data collection by CSOs and other human rights organizations, or include key CLM data variables as part of the M&E of the national programme.

e-Training

Providing training to health staff at the lowest level units has always been a challenge. The COVID-19 crisis has only broadened the training gaps, resulting in huge data quality issues related to the completion of data, timeliness of data, and authenticity of data in the M&E process across the globe.

Developing comprehensive e-Training/e-Learning platforms to facilitate synchronous and asynchronous video and audio training sessions, dynamic training content management systems and the use of gamification has the potential to improve data collection and data use processes and contribute to CME and Manuals of Procedures for TB programmes.

A costed action plan for digital TB surveillance

An estimated budget has been recommended for each country for strengthening its digital TB surveillance system based on the country's current e-readiness and IT capacity, maturity of the existing platform (case-based vs. aggregated), number of facilities and users, and other parameters (see Figure 3). However, countries need to develop a costed action plan for strengthening their digital TB surveillance system.

The estimated budget is only designed to provide a rough estimate of the costing and should by no means be considered to be the final budget requirement. Each country is encouraged to evaluate its country-specific budget needs based on the current funding available and vision for creating a case-based TB surveillance system. Based on the NTP's vision and the recommendations for improvements, the plan should clearly define targets with actionable interventions and funding requirements, supported by a detailed work plan with timelines.

.
Figure 3 Estimated resource need for digital TB surveillance system

- **NIGERIA** (eTB Manager + DHIS2) **US$ 10.5-11.5 million**
- **INDONESIA** (SITB) **US$ 6.5-7.0 million**
- **KENYA** (TIBU + KHIS2) **US$ 4.5-5.0 million**
- **PHILIPPINES** **US$ 4.0-4.5 million**
- **GHANA** (DHIS2 + e-Tracker) **US$ 2.5-3.0 million**
- **DR CONGO** (DHIS2) **US$ 8.5-9.0 million**
- **ETHIOPIA** (DHIS2) **US$ 5.5-6.0 million**
- **SOUTH AFRICA** (Tier.Net + EDR web) **US$ 2.5-3.0 million**
- **INDIA** (NIKSHAY) **US$ 2.0-2.5 million**
- **BANGLADESH** (e-TB Manager) **US$ 1.5-2.0 million**
- **CAMBODIA** (e-TB Manager) **US$ 1.5-2.0 million**
- **UNITED REPUBLIC OF TANZANIA** (DHIS2) **US$ 2.5-3.0 million**
- **UGANDA** (DHIS2) **US$ 2.0-2.5 million**
- **CAMEROON** (DHIS2) **US$ 1.5-2.0 million**
- **PAKISTAN** (DHIS2 + ENRS) **US$ 1.5-2.0 million**
- **ZAMBIA** (DHIS2) **US$ 1.5-2.5 million**
- **MOZAMBIQUE** (DHIS2) **US$ 1.5-2.0 million**
- **VIET NAM** (VITIMES + e-TB Manager) **US$ 1.5-2.0 million**
- **UKRAINE** (e-TB Manager + MIS SSD) **US$ 1.0-1.5 million**

HOW TO READ THE COUNTRY REPORTS

AUDIENCE

The primary audience of the report is the NTP and IT cells within the Ministry of Health of each country. The assessment report also targets a broader audience that includes donor organizations, implementation organizations, NGOs and CSOs, among others. Table 5 shows the ways in which each stakeholder can benefit from this report.
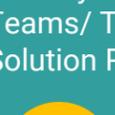
Stakeholders	How it will benefit
National TB Program	Devise operational strategies to achieve real-time case-based surveillance and plan and advocate for resources.
Ministry of Health	Make policy decisions on integrated surveillance, data security, use of technologies and budgets.
Donors/Funding Organizations	Make high-impact investments for rapid transitions to real-time TB surveillance systems.
Country IT Teams/ Tech Solution Providers	Learn from best practices from all countries to further enhance existing digital offerings to countries.
Public Health Researchers	Better understand the data ecosystem in the countries that can be leveraged for epidemiological and other public health research.
Implementation Partners /NGOs	Converge different digital innovations being implemented by NGO partners to complement the existing national data ecosystem through integration and data harmonization.
Civil Society Partners/Advocacy / CLM partners	Promote evidence-based CLM and advocacy by harnessing and integrating with national data systems.

Table 5. How the assessment can benefit each stakeholder

KEY COMPONENTS OF THE COUNTRY FACT SHEET

Background

This provides a high-level overview of the country's TB programme, starting with the TB disease burden in the country using the latest data up to 2020 and other key indicators regarding TB care and prevention. This is then followed by the country's vision and commitments indicated in its latest National Strategic Plan (NSP). The background also gives a high-level overview of the enabling environment and digital ecosystem, which have a direct influence on the adaptation of digital TB surveillance tools and their scale-up within the country. This overview includes influencing factors such as a country's digital capacity, Internet penetration, mobile penetration, and so on.

The background also provides a brief summary of the current status of digital TB surveillance tools used in the country, whether these tools capture case-based or aggregated data, and the level of data collection (i.e. facility vs. district vs. provincial, etc.).

Brief of digital TB surveillance system

This section provides a comprehensive snapshot of the digital TB surveillance tool that is being used or scaled up to a national scale. It is important to keep in mind that many countries have multiple systems for capturing TB data that might be deployed at different scales (i.e. proof of concept or pilot stage); however, this section only considers the system that is used for national reporting of TB cases.

This section captures a narrative about the national system currently in place, the granularity of data collected (case-based or aggregated, the lowest level of data collection, country capacity, ownership of the platform and other related aspects).

Success stories

The success stories attempt to capture the most innovative components and major achievements in a country in terms of its conceptualization and development of a digital TB surveillance system. These stories can range from highlights of specific innovative modules such as contact-tracing modules, presumptive screening modules, or CLM modules that complement the main TB surveillance system to details of how countries have enabled integration of the digital TB surveillance system with external systems such as GeneXpert, laboratory information system or logistics management/medicine inventory systems.

Private sector

This section provides information on how countries are leveraging their digital TB surveillance systems to enable and improve private sector notification and the current private sector notification status.

Enabling environment

This section provides a narrative about the enabling environment and digital ecosystem, which have a direct influence on the adaptation of digital TB surveillance tools and their scale-up in the country. The narrative discusses influencing factors such as the country's digital capacity, Internet penetration, mobile penetration and so on.

Available resources

This section provides an overview of the current funding resources available to the country that can potentially be leveraged for digital case-based TB surveillance. However, this section by no means provides the entire NTP budget available or future funding expected. Therefore, this section should only be used as an additional piece of information and not for any future budget considerations.

Cascade of care

This section provides a snapshot of the different components of the entire continuum of TB care and a person's journey from presumptive TB screening and testing through to treatment, treatment support and adherence, treatment outcome, post-treatment follow-up and contact-tracing. This section also captures how data are captured at each stage along the continuum of care (digitally or manually and, if digitally, whether case-based or aggregated). It is important to note that this section captures whether the country has developed modules to capture data at each of these stages and not necessarily whether it has scaled these up to the national level.

Data variables

This section provides a high-level overview of what data variables are captured by the national programme and whether these variables are captured through a digital medium. The table is colour-coded for easy comprehension of whether the data captured are manual or digital and, if digital, whether they are case-based (indicated by a green tick mark) or aggregated (indicated by a yellow tick mark).

Indicators

Very similar to the data variable section, this provides a high-level overview of what indicators are reported by the national programme and whether these indicators are reported through a digital medium. The table is colour-coded for easy comprehension of whether the data reported are manual or digital and, if digital, whether they are case-based or aggregated.

Roadmap

This section provides a pictorial representation of the national programme's digital TB surveillance journey. It captures key milestones and achievements by the NTP from the inception of the digital TB notification tools to their current status and the programme's future vision and plans. This section tries to capture as concretely as possible specific modules or digital components that the NTP is planning to develop to further strengthen TB surveillance.

Ancillary systems

The table provides a compilation of various complementary digital tools (identified with the NTP) that are being used in the country to support TB treatment adherence, logistics management, laboratory record-keeping, result dissemination, CLM, pharmacovigilance and contact-tracing. These digital tools are further mapped with the primary channel of data inflow, details of the development and supporting agencies, and the scale of implementation for each of the identified technology solutions.

Challenges

Based on the country inputs, this section provides an account of the key challenges faced by the country in terms of planning, implementing, monitoring, integrating and/or scaling up the technology interventions. As a common indication, the challenges encountered by a country are most often dependent on the stage of development and implementation of the country's TB surveillance system.

Vision

These are a few key areas of focus for the country's NTP, as discussed in the various steps of this assessment. As a general practice, the points included here are further aligned with the suggested strategies and directives of the NSP and important milestones for establishing a case-based TB notification and surveillance system.

Budget requirement

Based on the country's feedback and recommendations, this section provides an estimate of the budget required to address the challenges and make progress towards the vision over the next three years. The budget is broken down to include specifics for hardware and infrastructure, software development, and capacity-building at various administrative levels of the health system.

Recommendation

To address the gaps and challenges identified through the assessment, this section provides a list of country-specific recommendations with timelines for execution over the next three years. These recommendation points have also been aligned with the system of choice and the suggested efforts of the TB programme (as per the NSP), and thus are projected to meet the broader vision for establishing a well functioning real-time digital case-based surveillance system for TB in the country.

DISCLAIMER

Some disclaimers need to be considered while reading this report.

Budget

The country snapshots provide information on the estimated budget required for each country. The numbers shared are only ballpark figures based on certain assumptions and standard budgeting principles designed for the purpose of this report based on guiding principles and typical budgeting components. Countries should independently evaluate their resource needs and budgets accurately based on the current maturity and e-readiness of the digital platforms, IT capacity and funding availability. We recommend countries to come up with a detailed budget plan for developing and scaling up a comprehensive digital TB surveillance and reporting system.

Recommendations

The recommendations in the country fact sheets provide a high-level plan that takes into consideration multiple factors, such as countries' future digital roadmap, challenges, vision and current status of the digital platform and capacity already available. Countries need to leverage the existing capacity and complement current efforts they are already making. The recommendations provide structured guidelines and best practices that could help countries to reach their digital goals and fulfil their vision. However, countries should independently evaluate each of the recommendations and timelines based on different factors such as budget availability, e-readiness, capacity and so on.

CONTINUITY

As many of the countries' vision and advancement in digital transformation are constantly evolving based on different programmatic and political needs, this assessment report should be a living document that is periodically and incrementally revised by countries once every six months in order to yield the most benefit from this report.

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DATA COLLECTION

Country engagement process

As an initial introduction to the project and to seek the NTP's support, the Executive Director's Office of Stop TB Partnership shared an official letter in the month of July 2021 informing and inviting 20 NTP managers of high TB burden countries to participate in this assessment process. The countries were Bangladesh, Cambodia, Cameroon, DR Congo, Ethiopia, Ghana, Myanmar, India, Indonesia, Kenya, Mozambique, Nigeria, Pakistan, Philippines, South Africa, Ukraine, Uganda, United Republic of Tanzania, Viet Nam and Zambia. All countries responded except for Myanmar; it was decided to postpone the assessment of Myanmar. A series of follow-ups were done to seek a convenient time to organize the workshop from the office of Stop TB Partnership. The following were the areas for which countries' engagement and participation were requested:

- As a first step, all countries were invited for an introductory meeting wherein they were introduced to the project, objectives and expected outcome.
- Countries were also requested to complete the online questionnaire shared with them beforehand.
- Countries were also requested to appoint a point of contact who could lead the coordination on behalf of the NTP.

The list of NTPs who were contacted with dates can be found in Annex 1

Tools for data collection

Various tools and documentation templates were used as part of the data collection process. The following are some of the tools and templates used:

- Detailed survey questionnaire: A detailed questionnaire was administered during the assessment workshop calls with the national programme representatives. This involved real-time data transcription by the assessors using an Excel tool during the focus group discussions.
- Online survey: This online tool was developed to gather responses from the NTP team members in each country. The objective was to better optimize time during the assessment workshop calls.
- Desktop research data collection template: Detailed desktop research was done before the introductory workshop and assessment in order to optimize time during the calls and help with targeted and specific probing questions.

- Probing questionnaire: Based on the desktop research, specific and focused questions were asked and validated.
- Analytical framework/country assessment template: This was the most important and elaborate tool of the entire assessment. The analytical template consists of the complete country assessment information put into a structured format. The framework enabled subjective and unstructured information to be converted into more structured and analysed insights. This also enabled recommendations to be captured as one of the core components of the assessment report.
- Minutes of the meeting (MoM): There were primarily 3–4 calls (introductory call, detailed functional assessment, detailed technical and financial assessment call, follow-up call) per country as part of the core assessment process. Each call was recorded and detailed minutes were shared and re-captured with the country representatives. All video recordings have been archived and can be obtained upon request.
- Introductory PowerPoint: This was an anchor presentation that was used for the first introductory meeting with the NTP, highlighting the objectives and rationale for this assessment and seeking the representative's support for the entire assessment duration.

CURATION

Once the data collection process was complete, the data gathered by the team from different sources (i.e. desktop research, online survey, introductory meetings, and detailed workshops) were curated to extract meaningful insights for country-wise compilation of this report. The exercise was repeated periodically during the assessment, and a step-by-step process was followed to conduct the data curation:

Documenting the data

The first step in the process was to make sure that the data were adequately documented. A designated team worked on compiling all the data in country-specific folders and proofreading the first-version files to check for any inconsistencies or errors, which would help to identify areas requiring more information or clarification. The primary intention of this exercise was to assess and improve the intelligibility and ease of use of the collected information by putting it in a logical order.

ANNEX 2 – APPROACH AND METHODOLOGY

Asking questions

Based on the issues noted in the last step, the curator gathered more clarity around the identified inconsistencies or gaps in the documents. This was first done internally by either taking a further dive into desktop research or reviewing the meeting notes from other team members, or by asking questions of the documenter. In instances where the collected information was still insufficient to fill in the gaps, questions were shared with the country point of contact and follow-up meetings were convened if required.

Translating into standardized formats

With all the information in place, the data were translated and put together in standardized formats, mostly by standardizing the MoM document and further detailing the assessment template with the additional data. In doing so, the information was in a more usable format and presented logically for the country NTP teams and the report documenters in the next steps.

VALIDATION

A crucial step after each round of country engagement was to validate the findings internally, as well as with the country teams. The validation process for each country consisted of three steps:

1. After the initial introductory meetings, the MoM document (in a standardized format) was shared with the country NTP team. Their comments were sought to ensure that the understanding gathered from the discussions was correct. The feedback received was incorporated in the final versions of the country documentation.

2. The detailed assessment template for each country was pre-populated with basic findings from the desktop research and introductory meetings, and further filled out during the detailed functional and technical workshop in screen-sharing mode. The country NTP teams were encouraged to validate the data presented, provide more inputs to refine the recorded data and suggest corrections wherever required.

3. The compiled analytical frameworks (templates for country factsheets) were subject to the following process:

- First, the frameworks were shared internally with the assessment team – Dure Technologies and Stop TB Partnership – for the first round of validation. The received feedback was incorporated.

- The improved versions were sent to the country NTPs for their validation of the processes, challenges, vision and other components of the template. The final versions of the country factsheets were thus compiled by incorporating the country feedback received.

ANALYSIS

The collected data for each country was analysed using a standardized template that was designed specifically for this assessment project. The "Analytical Framework" template was designed at the onset of the assessment and was mapped to various data points in the other tools (like the assessment tool) used for engaging with the country teams. The data analysis process focused broadly on the following areas:

Technical feasibility analysis

- Technical/IT capacity analysis

- Information system architecture analysis

- Enabling environment and ecosystem analysis

Functional analysis

- Workflows and processes

- Functional modules analysis

- Data variables analysis

- Indicators and data use analysis

Policy and budget analysis

- o   Political commitment and vision

- o   Financial availability and commitment

RECOMMENDATIONS

In line with the assessment objectives, the ultimate outcome of the country engagement and data analysis was to formulate specific recommendations for strengthening current systems and fast-tracking the plans envisioned by the NTPs. This final step of the broader exercise started with the preparation of a detailed master recommendation directory with inputs from internal and external stakeholders.

These recommendations were defined to match the country requirements identified in the desktop research, online survey responses, introductory meetings, and detailed workshops. These recommendations were classified in multiple groups and mapped against the general level of maturity of the national-level digital TB surveillance systems and country plans. Ultimately, the recommendations were customized for each country based on its specific needs. All country recommendations were drafted to address these fundamental questions:

• What can be done? The recommendations include steps that are needed to implement specific policies or actions that align with the country's interests, and the resources that would be required to take forward these initiatives.

• What benefits? Recommendations also comment on the feasibility of implementing the solutions and the adaptations induced by these actions. They talk further about the future of these enhancements and the related upgrades needed to bring the tools closer to the benchmarked standards for TB surveillance.

• What additional changes? Apart from the technical enhancements, the recommendations also point to policy-level interventions and strategic initiatives that should be practiced by countries to create a conducive ecosystem and sustain the solutions over time.

REFERENCES

1. Case-based TB surveillance. In: Global tuberculosis report 2021. Geneva: World Health Organization; 2021 (https://www.who.int/publications/digital/global-tuberculosis-report-2021/featured-topics/case-based-surveillance, accessed 1 March 2022).

2. Agarwal S, Jalan M, Pandya S, Ferguson R, Moustafa D, Ng C, et al. Digital solutions for COVID-19 response: an assessment of digital tools for rapid scale-up for case management and contact tracing. Baltimore: John Hopkins Global mHealth Initiative – Johns Hopkins Bloomberg School of Public Health; 2020 (http://dhsi.med.jhmi.edu/news/digital-solutions-covid-19-response, accessed 1 March 2022).

3. Nikshay reports: dashboard. Delhi: Ministry of Health & Family Welfare, Government of India (https://reports.nikshay.in/, accessed 1 March 2022).

4. Tuberculosis data. In: Global Tuberculosis Programme. Geneva: World Health Organization (https://www.who.int/teams/global-tuberculosis-programme/data, accessed 1 March 2022).

5. WHO Toolkit for routine health information systems data. Modules. Geneva: World Health Organization (https://www.who.int/data/data-collection-tools/health-service-data/toolkit-for-routine-health-information-system-data/modules, accessed 1 March 2022).

6. A new digital platform for timely analysis and use of TB data. Geneva: World Health Organization; 2019 (https://www.who.int/news/item/22-03-2019-a-new-digital-platform-for-timely-analysis-and-use-of-tb-data, accessed 1 March 2022).

7. Mapping the technology landscape of national TB programs: report. Geneva: The Global Fund to Fight AIDS, Tuberculosis and Malaria; 2021 (https://www.theglobalfund.org/en/updates/other-updates/2021-10-18-mapping-the-technology-landscape-of-national-tb-programs-report/, accessed 1 March 2022).

8. Stop TB field guide 9: strengthening information systems and linkages to care. Geneva: Stop TB Partnership; 2018 (https://stoptb-strategicinitiative.org/elearning/wp-content/uploads/2019/04/STBFG_09.pdf, accessed 1 March 2022).

9. TB Data Hub – Enhance data. Expand data analysis. End tuberculosis. Chapel Hill: TB DIAH Project, University of North Carolina (https://www.tbdiah.org/, accessed 1 March 2022).

ADDITIONAL RESOURCES

1. Guideline: Recommendations on Digital Interventions for Health System Strengthening

2. Classification of Digital Health Interventions

3. National eHealth Strategy Toolkit

4. https://www.digitalhealthindex.org/

5. Digital Implementation Investment Guide

6. Digital Health Platform: Building a Digital Information Infrastructure (Infostructure) for Health

7. https://www.who.int/data/data-collection-tools/health-service-data/toolkit-for-routine-health-information-system-data/modules

8. https://dhis2.org/metadata-package-downloads#tb

9. https://docs.dhis2.org/en/topics/metadata/tuberculosis/tb-aggregate/design/tb-notifications-and-outcomes.html

10. https://docs.dhis2.org/en/topics/metadata/tuberculosis/tb-case-surveillance-tracker/design.html