TB Data-to-Action Continuum

in Ghana

Report

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TB DIAH
Tuberculosis Data, Impact Assessment and Communications Hub

MINISTRY OF HEALTH
REPUBLIC OF GHANA

TB Data-to-Action Continuum in Ghana

Report

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Abbreviations

ARC	Assessment of Reporting Capacity
CCM	Country Coordinating Mechanism
CHIM	Ghana Centre for Health Information Management
D2AC	Data-to-Action Continuum
DHIMS2	District Health Information Management System version 2
GHS	Ghana Health Service
Global Fund	Global Fund to Fight AIDS, Tuberculosis and Malaria
HMIS	health management information system
ICT	information and communications technology
JSI	John Snow, Inc.
M&E	monitoring and evaluation
MDR	multidrug-resistant
MEL	monitoring, evaluation, and learning
NSP	national strategic plan
NTP	national tuberculosis program
PBMEF	Performance-based Monitoring and Evaluation Framework
PPME	Policy, Planning, Monitoring and Evaluation
SCCP	Strengthening the Care Continuum Project
TB	tuberculosis
TB DIAH	TB Data, Impact Assessment and Communications Hub
USAID	United States Agency for International Development
WHO	World Health Organization

Executive Summary

Background

A strong tuberculosis (TB) monitoring and evaluation (M&E) and surveillance system is a vital tool for countries to reach global goals to end TB. The United States Agency for International Development (USAID) leads the U.S. Government's global efforts to end TB. USAID's Global Accelerator to End TB is the Agency's programmatic approach to fight TB. Under the Accelerator, USAID funds the TB Data, Impact Assessment and Communications Hub (TB DIAH) project, which developed a TB Data-to-Action Continuum (D2AC) Toolkit to measure countries' progress and guide efforts to improve their TB M&E and surveillance systems. The D2AC allows national TB programs (NTPs) to precisely gauge the barriers to data use and assess the decision-making capabilities of different actors across their health systems. The purpose of a D2AC workshop is to guide the evaluation of data use capabilities to routinely monitor and improve data use attributes associated with TB program management and service delivery at subnational and national levels. The objective is to use the findings from the application of the D2AC Toolkit to evaluate TB M&E and surveillance systems by (1) assessing decision-making capabilities of different actors; (2) precisely gauging the barriers to data use; (3) helping NTPs select appropriate interventions in the context of their health systems; (4) developing an implementation plan to apply in the future; and (5) using implementation recommendations for strategic planning purposes and decision making.

Methods

Ghana was selected as the first field test location for the D2AC workshop. The workshop was held in March 2022 in Accra. Twenty-six participants attended, representing all levels of the Ghana health system and other TB stakeholder groups. The D2AC workshop was conducted using a hybrid approach (virtual facilitators, all participants gathered in one room). The D2AC team applied a mixed methods approach conducted in three parts with the support of the D2AC Toolkit: (1) participants first completed the D2AC Toolkit's data collection instrument individually and then in groups; (2) individually and then in groups, participants provided evidence and justification in the data collection instrument for the response options selected; and (3) in groups, participants identified priority actions for post-workshop implementation. A semi-structured questionnaire and focus group discussion method were implemented during the assessment. The D2AC team facilitated the workshop with the use of slides and handouts, and there were several break-out group activities and report-backs. Quantitative data from the 32 (26 individual and six group) data collection instruments were automatically generated using the D2AC Analysis Tool. The qualitative data—observations, comments, and questions submitted in the 32 instruments and brought up in group discussions and report-backs—were transcribed and analyzed.

Results

The overall D2AC assessment score from the aggregate group responses was 3.18 (out of 5), putting Ghana at an "established" level according to the D2AC. The country performed best in domain 1 (Data Collection and Reporting, score of 3.68) and domain 3 (Leadership, Governance, and Accountability, score of 3.78) and worst in domain 5 (Information and Communications Technology, score of 1.83). Domain 2 (Data Analysis and Use) and domain 4 (Capacity Building)

received scores of 2.95 and 2.94, respectively. The overall score from the aggregated individual responses was very similar (3.16 out of 5), albeit slightly inferior, to the group aggregate score (3.18). Comparison of the individual and group responses revealed significant disparities for domain 5: 30 percent difference in scoring between the individual and the group responses. Five subdomains were identified as priorities: D1S3 (Data quality), D2S2 (Analytics and visualization), D2S1 (Data integration and exchange), D4S2 (Skill and knowledge development), and D5S1 (Hardware).

Discussion

The D2AC assessment in Ghana shed light on the perceived weaknesses of the Ghana TB system, primarily in the domain of information and communications technology (ICT), where hardware, network and connectivity, and ICT business infrastructure received the lowest scores across the groups, on average. Important hardware needs were identified at facility, district, and regional levels, and network and connectivity issues were found to impact weekly, monthly, or other reporting. Beyond the challenges around physical resources, equipment, and infrastructure, other challenges identified related to human resources, such as organizational structure and function, and skill and knowledge development. In terms of the ongoing COVID-19 pandemic, capacity building of health workers on bidirectional screening and testing for COVID-19 was of priority concern for the Ghana NTP. Last, a third broad category in which improvements could be made concerned data management and use practices, functionalities, and capabilities, specifically: data integration; data exchange and interoperability; data use guidance; and analytics and data visualization. These areas received scores lower than 3 out of 5, meaning that they were identified as being at a “nascent” or “defined” stage of the continuum. The D2AC assessment in Ghana also shed light on the areas of the D2AC scale that were performing the strongest. They included aspects of data availability practices, such as data reporting, and data access and sharing. Other strong areas were monitoring, evaluation, and learning (MEL) and leadership and coordination. These areas received scores superior to 4 out of 5, meaning that they were at an “institutionalized” stage of the continuum.

Recommendations

Priority recommendations were developed in small groups. They were then combined in plenary to develop a joint implementation plan, and were validated by the workshop participants to: improve data quality; integrate data quality metrics in program review; develop standards for TB data management; develop training on advanced data analytics; resolve data management software synchronization challenges; regularly orient staff on new tools and forms; implement a hardware needs assessment; allocate funds to procure hardware and essential TB diagnosis and screening equipment; and develop nationally documented specifications and requirements for all hardware needs.

Conclusion

Despite progress toward ending TB worldwide, combating TB remains a high priority in Ghana, especially in the COVID-19 era where TB case notification, screening, and contact tracing were being severely impacted. The D2AC assessment revealed good performance in certain dimensions of the D2AC, such as leadership and coordination, MEL, and data reporting, access, and sharing. However, it also highlighted gaps, such as the availability of hardware at

subnational levels, the reliability of network and connectivity, and ICT business infrastructure. These findings provided evidence of the areas needing programmatic interventions, and can inform policymakers, donors, and program managers who want to design and implement responsive programs and interventions to strengthen and improve data use capabilities for evidence-based decision making to provide targeted and data informed high-quality services for all TB patients and their families.

Background

A strong tuberculosis (TB) monitoring and evaluation (M&E) and surveillance system is vital for countries to achieve global goals to end TB. By routinely collecting high quality, detailed data and by effectively integrating various components of routine information systems (e.g., service statistics, disease surveillance, and financial and human resource data), national TB programs (NTPs) are better able to meet the many data demands of stakeholders; better target TB program implementation; improve the quality and efficiency of TB services; and effectively plan and advocate for resources.

USAID Leadership in Ending TB

The United States Agency for International Development (USAID) leads the U.S. Government's global efforts to end TB. USAID's Global Accelerator to End TB is the Agency's programmatic approach to fight TB. The Accelerator increases commitment from, and builds the capacity of, governments, civil society, and the private sector to accelerate national progress to reach global TB targets. The Accelerator focuses on countries with high burdens of TB where the Agency can unite with local communities and partners to deliver performance-based results. To ensure the Accelerator's effectiveness and increased transparency, USAID uses standardized data collection and performance-based indicators that align with the targets.

TB DIAH and D2AC

Under the Accelerator, USAID funds the TB Data, Impact Assessment and Communications Hub (TB DIAH). TB DIAH aims to ensure optimal demand for and analysis of TB data, and the appropriate use of that information to measure performance and to inform NTPs and USAID interventions and policies.

TB DIAH developed the TB Data-to-Action Continuum (D2AC) Toolkit to measure countries' progress and guide efforts to improve their TB M&E and surveillance systems. The D2AC builds on the work of the Performance-based Monitoring and Evaluation Framework[1] (PBMEF), the Assessment of Reporting Capacity (ARC), and other existing documentation (i.e., joint program reviews, epidemiological assessments). It allows NTPs to precisely gauge the barriers to data use and assess the decision-making capabilities of different actors across their health systems. It also helps NTPs select appropriate interventions in the context of their health systems and develop implementation plans to apply them.

The D2AC framework aims to gauge country and NTP capacity to translate data into action to improve NTP performance. Through a systematic review of existing literature and a phased review by experts to validate the concept and pretest the approach, the D2AC team developed the D2AC Toolkit (Kumar, Silver, Chauffour, Boyle, & Boone, 2021). More information on TB DIAH's D2AC Toolkit can be found at https://www.tbdiah.org/assessments/d2ac

[1] Available at https://www.tbdiah.org/resource-library/pbmef

TB and Ghana

Ghana has a dedicated NTP tackling a TB burden of 143 cases per 100,000 people as of 2020, with an 84 percent treatment success rate (World Health Organization [WHO], 2022; World Bank, 2019). As of 2016, an estimated 64 percent of TB patients and their households still faced catastrophic costs in Ghana (Pedrazzoli, et al., 2018) and it was estimated that USD 20.2 million was still needed to fill the gap in TB funding as of 2020 (Stop TB Partnership, 2020), despite 67 percent of the 2021 TB budget being funded by foreign countries or institutions (WHO, 2022). Considering the funding gap and the desire to reach global goals, Ghana recognized the need to identify gaps in its current M&E and surveillance system to develop a strategic plan for improvement, and to use the strategic plan to advocate for greater funding.

Since the advent of COVID-19 in 2020, TB case notification in Ghana declined 14 percent: from 14,604 cases in 2019 to 12,674 in 2020 (WHO, 2022). In 2021, the NTP notified 13,155 TB cases, a four percent increase compared with the previous year, indicating a course rectification after the focus on COVID-19 led to a low index of suspicion on the part of TB providers, among other factors (Alebachew Wagaw, 2022). The inverse correlation between the monthly TB and COVID case notifications indicated a shift of some TB services to serve the COVID-19 response, challenges due to similar symptom profiles between the two diseases for patients developing respiratory issues or coughs, and the fear and stigma associated with both diseases. This was likely a contributing cause to the 37 percent case fatality ratio for TB patients in 2020 (WHO, 2022).

Objectives

Workshop Objectives

The purpose of the D2AC workshop was to guide the evaluation of data use capabilities to routinely monitor and improve data use attributes associated with TB program management and service delivery at subnational and national levels.

The D2AC Toolkit was used for both individual and group responses. The objective was to use the findings to evaluate TB M&E and surveillance systems by:

- Assessing decision-making capabilities of different actors
- Precisely gauging barriers to data use
- Helping the NTP select appropriate interventions in the context of its health system
- Developing an implementation plan to apply in the future
- Using implementation recommendations for strategic planning purposes and decision making

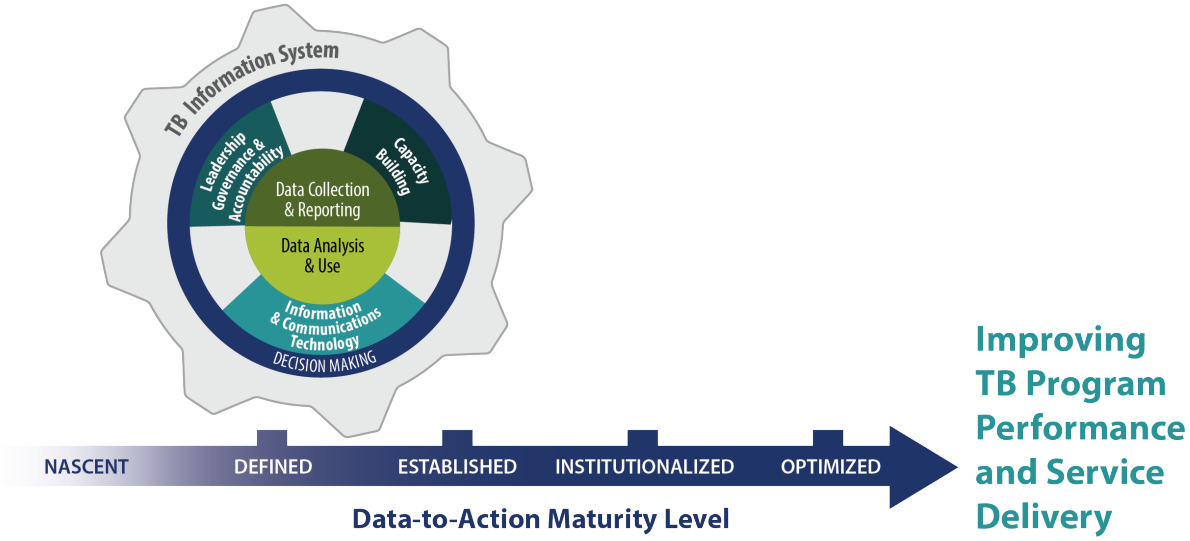
Field Test Objectives

The objective of the field test component of the D2AC assessment using the new D2AC Toolkit was to gather insights on what about the Toolkit worked well when applied in a workshop setting with real data entry and at the country level, and what were the gaps, challenges, and limitations, with the aim of taking the feedback into consideration before publishing the D2AC Toolkit and the D2AC workshop method.

Concept

The conceptual framework (Figure 1) describes the organizational, human, technology, and process-related factors affecting data use capabilities. The framework highlights an interlinked and cyclical evolution of the health information system involving TB data collection and reporting, analysis, use, and dissemination-related interventions that build on the leadership and governance and capacity building efforts of a given NTP. The framework shows that the interlinked interventions follow a continuous improvement approach to achieve the advanced maturity levels (often identified by a descriptor, such as nascent, defined, established, institutionalized, and optimized), which are associated with an improvement of NTP performance in terms of using data for proactive and responsive clinical, programmatic, managerial, and policy decision making.

Figure 1. D2AC conceptual framework



Tool Design

The D2AC Toolkit was developed under the TB DIAH project, funded by USAID's Global Accelerator to End TB. D2AC was initially developed as a framework to gauge country and NTP capacity to translate data into action to improve NTP performance. Informed by a review of peer-reviewed and gray literature, the D2AC Toolkit and process builds on previous experience with maturity models. The D2AC team documented and published a journal article on this systematic review (Kumar, et al., 2021). A phased review of the Toolkit was also conducted by the D2AC Advisory group starting in March 2021. More information on the Toolkit validation process can be found at https://www.tbdiah.org/assessments/d2ac

The D2AC Toolkit is composed of three components:

1. An Excel-based D2AC Data Collection Tool for collecting individual responses with: five defined continuum levels (Table 1); a country profile template to collect

socioeconomic, demographic, and epidemiological indicators; a D2AC scale with capability statements organized into five domains and 17 subdomains (Table 2) for each of the five continuum levels; key user roles and decisions organized according to USAID's TB objectives of reach, cure, prevent, and sustain; a data collection instrument with closed-ended capability continuum response options; an analysis matrix; and an analysis dashboard.

2. An Excel-based D2AC Data Analysis Tool that automatically aggregates responses from all completed data collection instruments and generates data visualizations and recommended priority actions. This enables decision makers to make sense of and apply the findings, and to develop an implementation plan using the template provided in the D2AC Toolkit.

3. A User Guide to facilitate the use of both tools. It provides step-by-step instructions for planning and implementing the D2AC assessment and for developing an implementation plan.

The Toolkit measures the status of current and desired TB M&E and surveillance systems data use capabilities across 17 subdomains, grouped in five domains. The domains and subdomains are then measured across five continuum levels: nascent, defined, established, institutionalized, and optimized (Table 1). This method offers a systematic way to show a measurable impact of improvements across processes (e.g., data collection processes); human resources (e.g., skill and knowledge development); and institutional attributes (e.g., policy, strategy, and governance).

Table 1. The five D2AC continuum levels

Continuum Level	Description
1 (Nascent)	• Formal processes, capabilities, experience, or understanding of data use issues/activities are limited or emerging. • Formal processes are not documented, and functional capabilities are at the development stage. • Success depends on individual effort (few committed users). • Predominantly paper-based data management system.
2 (Defined)	• Basic processes are in place, based on previous activities or existing and accessible policies. • The need for standardized processes and automated functional capabilities is known. • There are efforts to document current processes and policies, and capacity building needs.
3 (Established)	• There are approved documented processes and guidelines tailored to data use. • There is increased collaboration and knowledge sharing. • Need for external technical assistance is clearly identified. • Innovative methods and tools can be implemented and used to extend functional capabilities.

4 (Institutionalized)	• Activities are under control using established processes. • Requirements and goals have been developed and a feedback process is in place to ensure that they are met. • Detailed measures for processes and products are being collected.
5 (Optimized)	• Best practices are being applied, and people and the system are capable of learning and adapting. • The system uses experiences and feedback to correct problems and continuously improve processes and capabilities. • Future challenges are anticipated, and a plan is in place to address them through innovation and new technology. • Processes are in place to ensure review and incorporation of relevant innovation.

The D2AC scale is made up of five domains, with 17 corresponding subdomains (Table 2).

Table 2. The five D2AC domains and 17 D2AC subdomains

Domains	Subdomains
1. Data Collection and Reporting	1. Data collection tools and workflow 2. Reporting 3. Data quality
2. Data Analysis and Use	1. Data integration and exchange 2. Analytics and visualization 3. Dissemination and communication
3. Leadership, Governance, and Accountability	1. Data use guidance 2. Data access and sharing 3. Organizational structure and function 4. Leadership and coordination 5. Monitoring, evaluation, and learning (MEL) 6. Financial resources
4. Capacity Building	1. Data interpretation 2. Skill and knowledge development
5. Information and Communications Technology (ICT)	1. Hardware 2. Network and connectivity 3. ICT business infrastructure

Workshop Design

The D2AC Toolkit is designed to be implemented as a facilitator-guided workshop with stakeholders from different aspects of the NTP (e.g., screening, diagnosis, and treatment) and from different levels of the health system. Participants discuss and achieve consensus on where the elements of NTP capacity fall on the continuum. The Toolkit then yields suggested interventions—called priority actions—tailored to stakeholders' assessments of NTP capacities. These priority actions help the NTP improve capacity to translate data into action, targeted to the current continuum level at different levels of the health system.

D2AC in the Context of TB DIAH Resources

The D2AC Toolkit can be used on its own, or as a complement to other TB DIAH tools and products as part of an assessment of a country's TB M&E and surveillance systems. When used alongside other TB DIAH tools and assessments, such as the PBMEF, ARC, or Quality of TB Services Assessment,[2] the D2AC activity contributes to a holistic view of a country's TB M&E and surveillance systems, and its capacity to collect, analyze, and use key indicator data for TB service delivery, performance improvement, and data-based decision making.

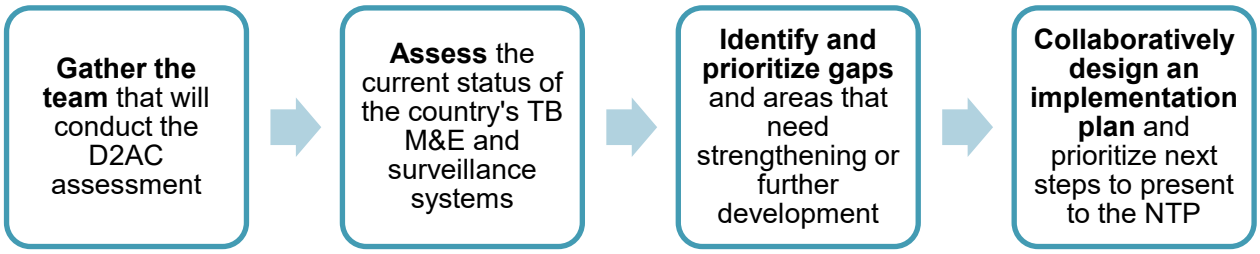
[2] Available at https://www.tbdiah.org/assessments/quality-of-tuberculosis-services-assessments/

Methods

Summary of Workshop Process

Planning for the D2AC workshop began in the fall 2021 with the formation of the leadership team (described in the next section). USAID played a key role in working with the NTP and the D2AC team to secure support, identify the assessment scope, discuss the planning process, and identify participants. Although COVID-19 caused a delay in the original assessment timeline, the team was able to eventually conduct the assessment in Ghana a few months later. During the workshop, participants assessed the current status of the TB M&E and surveillance systems, identified gaps, and prioritized actions in areas that needed strengthening or further development. Once this was completed, the participants designed an implementation plan to present to the NTP for further discussion (Figure 2).

Figure 2. The D2AC workshop approach and process



Identification of Ghana as a Field Test Location

The D2AC team had several criteria in mind when considering what countries to partner with for the D2AC Toolkit field tests. First, the team wanted to field test the D2AC Toolkit in two Anglophone countries, before the original English version of the Toolkit was published, after which it would be translated into other languages. Second, the team wanted to conduct field tests in countries where a member of the D2AC Advisory Group was already working closely with a NTP, and where there would be strong support from the USAID Mission to have more NTP buy-in and support for workshop facilitation and an increased chance of later use of the assessment recommendations and findings. Third, for health safety reasons, the team wanted to target a country with a low COVID-19 incidence at the time of the workshop.

Ghana is not one of USAID's 23 priority countries that TB DIAH usually works with closely as part of its portfolio of technical assistance activities. Moreover, Ghana recently transitioned out of the list of the 30 high TB/HIV burden countries (WHO, 2021), thereby providing the opportunity of testing the tool in a context where the findings would be of particular interest. Strong and established support from the NTP was another valuable consideration. Moreover, the nature of Ghana's integrated TB program was an opportunity to test how the tool responded in such a health system structure and context. The D2AC core team approached Ghana as a possible first field test location in July 2021, contacting the USAID Mission on July 15, followed by the Mission introducing the D2AC team to the Ghana NTP on July 19.

Formation of the Leadership Team

The leadership team consisted of two senior NTP staff taking on the role of hosts; one D2AC advisory group member as co-facilitator; three D2AC team members as workshop co-facilitators; and one D2AC team member supporting the event from headquarters. USAID was represented at the workshop on both days. The leadership team had the appropriate knowledge of the D2AC Toolkit and assessment process, and the expertise to oversee the assessment process (Table 3). The leadership team met over Zoom calls on November 15 and December 6, 2021, and on February 1 and February 3, 2022.

Table 3. Ghana D2AC leadership team

Name	Position	Institution
Yaw Adusi-Poku	Manager	Ghana NTP
Rita Frimpong-Mansoh	Deputy Manager	Ghana NTP
Zeleke Alebachew Wagaw	STAR Advisor	USAID
Jeanne Chauffour	D2AC Team Lead/M&E Advisor	TB DIAH
David Boone	Epidemiologist	TB DIAH
Meredith Silver	Data Systems and Use Technical Advisor	TB DIAH
Manish Kumar	Principal Investigator and Senior Technical Specialist-Health Systems Strengthening (formerly)	TB DIAH (formerly)
Yanira Garcia-Mendoza	M&E Officer	TB DIAH

Invitation of Participants

The leadership team used purposive sampling to identify and select participants. Criteria for selection included participants from the national level (e.g., NTP, national reference laboratory, health management information system [HMIS] department); provincial level (e.g., provincial TB program unit); district level (e.g., district health/TB program unit); and health facility level (TB clinic/health unit). Emphasis was placed on diversifying participants working on TB case outreach, treatment, prevention, and TB program sustainability (USAID TB pillars of reach, cure, prevent, sustain). Twenty-five people were invited by the NTP, of which 19 attended, and another seven were in attendance, either as substitutes for the original invitees or as additional invitees from the Policy, Planning, Monitoring and Evaluation (PPME) of the Ministry of Health and Ghana Health Service (GHS), for a total of 26 participants. This total did not include the USAID Strengthening the Care Continuum Project (SCCP) in Ghana, which is implemented by John Snow, Inc. (JSI), and TB DIAH staff.

Workshop Process

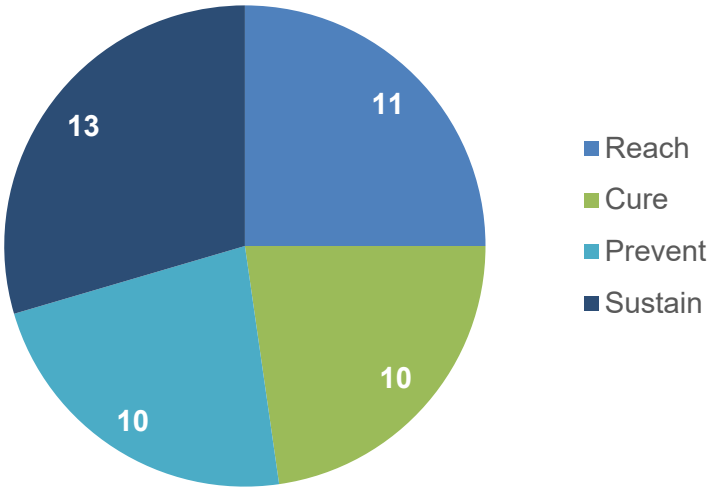
The D2AC assessment can be implemented using a variety of approaches, including individual assessment, group assessment, or a hybrid approach. In Ghana, a hybrid approach was implemented. The original plan was to conduct the assessment in-person; however, the D2AC team had to pivot based on unforeseen circumstances to implement a blended assessment approach. The D2AC core team members facilitated the workshop remotely, while the in-country team gathered in-person. The workshop was conducted over a two-day period and included 26 key personnel identified and invited by the NTP.

The assessment took place on March 16–17, 2022 at the Movenpick Hotel in Accra, Ghana. The workshop was facilitated by Jeanne Chauffour, D2AC Team Lead and M&E Technical Advisor, and David Boone, Epidemiologist, of TB DIAH, JSI; Meredith Silver, Data Systems and Use Technical Advisor, of TB DIAH, University of North Carolina at Chapel Hill; and Zeleke Alebachew Wagaw, USAID Sustaining Technical and Analytical Resources (STAR) Advisor posted at the Ghana NTP and D2AC advisory group member. The workshop was supported by Emmanual Nuworzah, Senior Program Specialist, and Juliana Akpalu, Administrative Assistant, of SCCP in Ghana. The workshop agenda can be found in Appendix A.

Workshop Participants

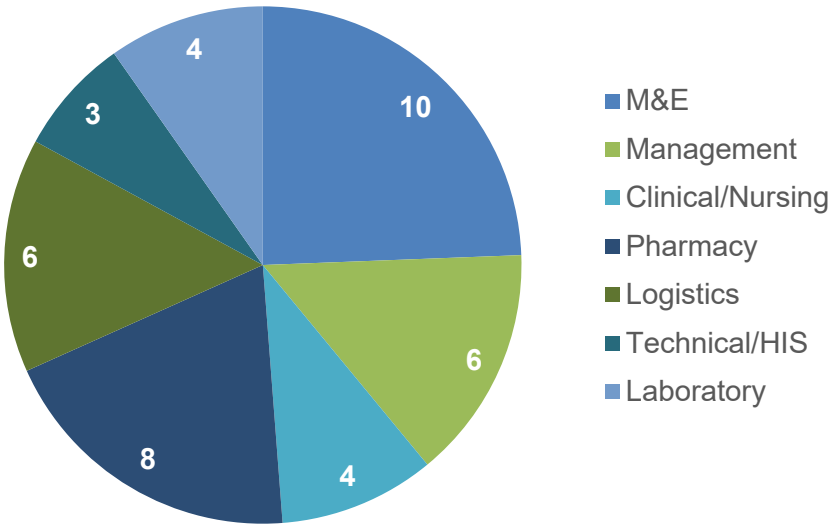
Of the 26 participants, 65 percent were men (17 participants), and 35 percent were women (9 participants). More than half of the participants came from the national level (53% – 14 participants), about one-quarter represented the regional level (23% – 6 participants), and the lower levels were equally represented by two participants each, including the district level (8%), the facility level (8%), and the community level (8%). The four USAID TB pillars of reach (11 participants identified with this pillar), cure (10 participants), prevent (10 participants), and sustain (13 participants), were evenly represented by the participants' areas of work and focus (Figure 3 and Appendix B, Table B1). The split was also relatively even when examining secondary responsibilities, falling into the four USAID TB pillars of reach (10 participants), cure (9 participants), prevent (11 participants), and sustain (11 participants).

Figure 3. Participant composition, by TB work area



Although most participants were in M&E roles (10%), other managerial (6%), clinical (4%), pharmacy (8%), and logistics (6%) representatives also attended (Figure 4).

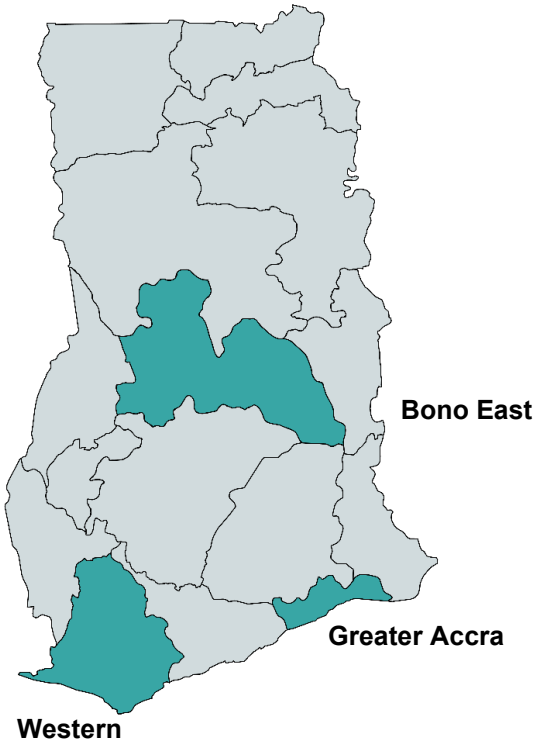
Figure 4. Participant composition, by TB program sector or specialty



Ten participants represented the NTP from the following units: management, M&E, lab, pharmacy, technical, and logistics. Twelve participants represented the GHS—at the regional level: Bono East (1 participant), Western (1 participant), and Greater Accra (4 participants) regions were represented; five participants came from hospitals, including four participants from Mamprobi Hospital in Accra and one from the Ablekuma Central District Hospital; and one GHS representative from the National Public Health and Reference Lab (Figure 5). The four partner organizations represented were the Stop TB Partnership Ghana (1 participant), the Aurum Institute Ghana (1 participant), the Christian Health Association of Ghana (1

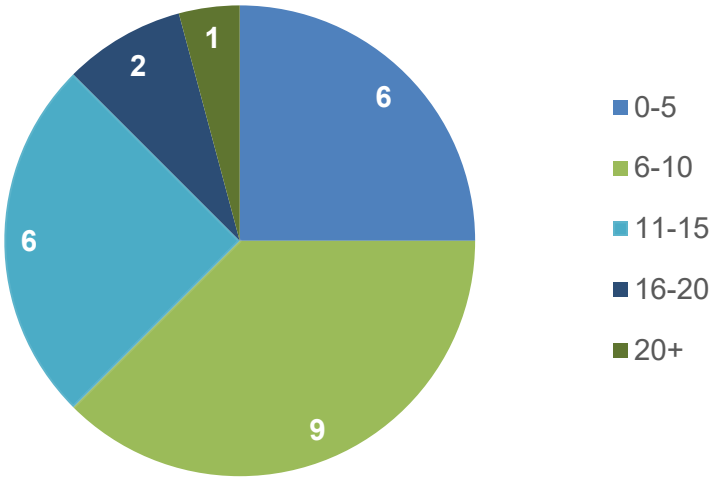
participant), and the Ghana National TB Voice Network (1 participant). Appendix B provides the full list of participants (Table B1).

Figure 5. Regions represented at the D2AC workshop in Accra



Nearly one-quarter of the attendees had less than five years work experience (23% – 6 participants), 35 percent had 5–10 years of experience (9 participants), another one-quarter had 11–15 years of experience (23% – 6 participants), and 11 percent had more than 15 years of work experience (2 participants had 16–20 years of work experience and one participant had more than 20 years of work experience). Two participants did not provide a response (Figure 6 and Appendix B, Table B2).

Figure 6. Years of experience in TB work among workshop participants



Workshop Proceedings

Workshop Opening

The opening address was given by Dr. Yaw Adusi-Poku, NTP Manager; followed by Heather Robinson, HIV/AIDS Team Lead, USAID/Ghana; and Henry Nagai, Chief of Party, SCCP—Ghana, JSI. The D2AC team concluded the opening words of welcome.

The assessment leadership team presented the workshop overview, including its purpose and how the findings would be used, and the D2AC assessment approach and Toolkit.

The D2AC team applied a mixed methods approach conducted in three parts: (1) participants completed the D2AC Toolkit's data collection instrument first individually and then in groups; (2) individually and then in groups, participants provided evidence and justification in the data collection instrument for the response options selected; and (3) in groups, participants identified priority actions for post-workshop implementation. A semi-structured questionnaire and focus group discussion method were implemented during the assessment.

The D2AC team facilitated the workshop with the use of slides and handouts. There were also several break-out group activities and report-backs. The D2AC team introduced the objectives of the workshop, the background of the Toolkit's development and method, the workshop approach, and the Toolkit in detail, tab-by-tab.

The Ghana country profile was developed by a D2AC core team member, Yanira Garcia-Mendoza, M&E Officer for TB DIAH, JSI (who was not facilitating the workshop) in parallel to the workshop taking place. The country profile is provided in Appendix C.

Individual Instrument Completion

The 26 participants were invited to fill out the D2AC data collection instrument individually with the help of the D2AC Glossary (Appendix D). This gave each participant the chance to

explore the tool, become familiar with the instrument questions and their answer options (Appendix E), and to indicate their views on the Ghana TB program and information system's current status for each of the 44 capability questions associated with the five domains and 17 subdomains (Table 4). The 26 filled-out instruments were aggregated in the D2AC Data Analysis Tool. The findings from the aggregated individual responses were shared in plenary using data visualizations generated by the D2AC Data Analysis Tool. The floor was then opened for comments and questions.

Table 4. Data collection instrument questions, by domain and subdomain

Domain	Subdomain	Questions by subdomain	Questions by domain
Data Collection and Reporting	Data collection tools and workflow	6	11
	Reporting	3	
	Data quality	2	
Data Analysis and Use	Data integration and exchange	4	10
	Analytics and visualization	4	
	Dissemination and communication	2	
Leadership, Governance, and Accountability	Data use guidance	1	11
	Data access and sharing	1	
	Organizational structure and function	1	
	Leadership and coordination	2	
	Monitoring, evaluation, and learning	4	
	Financial resources	2	
Capacity Building	Data interpretation	3	8
	Skill and knowledge development	5	
Information and Communications Technology (ICT)	Hardware	2	4
	Network and connectivity	1	
	ICT business infrastructure	1	
Total number of questions		44	

Group Instrument Completion

The 26 participants were divided into six groups. Each group had at least one representative from the national level, with groups 1 and 2 gathering participants from the regional level; group 3 gathering the district level; groups 4 and 5 gathering participants from the health facility level and nongovernmental organization/civil society sector; and group 6 gathering central-level

pharmacy and laboratory personnel. Participants were invited to fill out the D2AC data collection instrument (Appendix E) as a group. Each group discussed and built consensus on all 44 capability questions before submitting their completed instrument. The six group instrument responses were aggregated in the D2AC Data Analysis Tool. Each group presented the scores, findings, and discussion points raised during this group exercise. The findings from the aggregated group responses were then shared in plenary using data visualizations generated by the D2AC Data Analysis Tool, and the floor was then opened for comments and questions.

Co-Created Priority Actions

Following the groups' completion of the data collection instrument and plenary presentation of results, which was a moment for consensus building around the aggregate group score, the D2AC team facilitated an activity where participants individually identified the five subdomains (out of a total of 17 in the D2AC Toolkit) that were of highest priority for action, according to their experience and results (personal opinion).

Once the five priority subdomains were identified by tallying the individual votes (five votes per person, to assign to five subdomains of their choice among the 17), the D2AC facilitators asked participants to divide themselves equally across five groups (with each group assigned one of the five priority subdomains) based on their interests and votes. Participants chose what subdomain to work on and created groups of four to six people. The five groups each filled out an implementation plan worksheet. Once submitted, the five worksheets were compiled into a combined implementation plan. The combined implementation plan was projected on the screen, with each group presenting their suggested priority actions and rationale. The combined implementation plan was approved and validated by all attendees in plenary.

Toolkit Field Test Feedback

The field test objectives were presented to participants, and all participants were given a feedback rubric to fill out over the two days of the workshop with any comments or observations useful to the team. Feedback was also provided during the workshop (verbally) and presented in some of the group PowerPoint slides. All feedback given (written or oral) was collected, transcribed, and organized.

Workshop Closing

The D2AC team and Dr. Adusi-Poku and Dr. Frimpong-Mansoh, Deputy Manager of the NTP, gave closing remarks. Both speakers expressed high satisfaction with the workshop organization, content, and proceedings. They described a valuable learning opportunity that stressed reflection and enabled the meeting of and discussions with colleagues from different levels of the TB health system. Ms. Chauffour gave closing words on behalf of TB DIAH and the D2AC team.

At the end of the workshop, all participants received a certificate of completion. The D2AC team collected all feedback rubrics about the D2AC Toolkit and the workshop and aggregated the results.

Data Analysis

Quantitative Data

The quantitative data from the 32 (26 individual and six group) data collection instruments were automatically generated using the D2AC Analysis Tool; these data included the scores by domain, subdomain, user level, etc. The scores were automatically generated and displayed in summary data tables and bar charts. Responses were averaged across subdomain, domain, and overall to derive scores for each. Although subdomains are given an equal weight in the calculation of domain aggregates, domains are weighted by the number of subdomains they include to derive the overall score. The aggregate score generation was done by David Boone of the D2AC core team, using the D2AC Data Analysis Tool.

Qualitative Data

The qualitative data from the assessment workshop consisted of the observations, comments, and questions presented and posed in plenary and in groups; the comments entered in the individual and group data collection instruments; the work entered on the implementation plan worksheets; and the group presentations and report-backs. The group presentation takeaways and the plenary observations, comments, and questions were carefully noted in real time during the workshop. All 32 (26 individual and six group) data collection instruments were reviewed manually one-by-one and all comments were noted. Last, all five group implementation plan worksheets were transcribed and analyzed.

Limitations

There are limitations to the generalizability and applicability of the findings in other contexts, given that all participants were from and were responding to questions about the context of the Ghana TB system. The purposive sampling strategy could have led to some biases, with the most engaged or involved actors in the Ghana TB system being invited, agreeing to attend, and participating in the two-day workshop, as opposed to other actors perhaps less engaged or involved.

It is also possible that some courtesy bias may have been introduced, meaning that participants wished to convey an image of quality that was better than reality. This may have occurred for several reasons, including the fact that they were invited by the NTP's leadership and were participating in the workshop in the presence of their hierarchical superiors, and even potentially assigned to the same groups. Participants may have felt inclined to say positive things about the TB program to please superiors or to avoid receiving negative feedback. To minimize this bias, the D2AC team first asked each participant to individually share their responses, without discussing or sharing those with anyone else in the room. Subsequently, the group work was organized so that no one person could sway a group's answers or potentially, even unintentionally, inhibit other group members from freely expressing their opinions.

Ultimately, the value of the output of the workshop depended heavily on the expertise and experience of the participants. A potential limitation arises if insufficient knowledge and experience of the local system are not brought to bear when completing the tool.

Post hoc comparison of group scores is one quality assurance approach to assess the consistency and coherence of the workshop output. Divergent group scores can indicate imbalances in knowledge or experience, or of overly influential group members.

A second quality assurance technique is comparing the individual scores to the group scores. Consistency across individual and group scores provides reassurance that the output is unbiased, whereas inconsistencies reveal areas that should be examined more thoroughly.

Quality is challenging to guarantee, especially when it comes to the individual tool completion exercises. All participants completed the same data collection instrument, and while it took the fastest participant just 90 minutes, it took others 2.5 hours (without interruptions), excluding those who submitted their instruments in the evening after having gotten home or the following day.

Challenges

Logistical Challenges

The three D2AC core team members (Jeanne Chauffour, Meredith Silver, and David Boone) facilitated the two-day workshop virtually (Figure 7), with all participants in the room, and with in-person facilitation from Mr. Alebachew Wagaw and support from the JSI/Accra office team (Figure 8). The virtual nature of the workshop made it difficult at times to properly hear the discussions occurring in the venue space, and the distance between the computer connected to Zoom and the participants made it difficult to gauge the progress of activities, level of understanding of certain instructions, among other elements that are easier to evaluate when in the room. This challenge was mitigated as much as possible by the in-person presence and facilitation of Mr. Alebachew Wagaw and with support from the JSI/Accra office team. Mr. Alebachew Wagaw was charged with facilitating most of the group activities, and the virtually-present D2AC team altered the slides to include written instructions for each activity that could be projected on the screen, and to repeat the instructions to ensure comprehension from participants.

Figure 7. Screen capture of the live broadcast of the workshop room and virtual facilitation

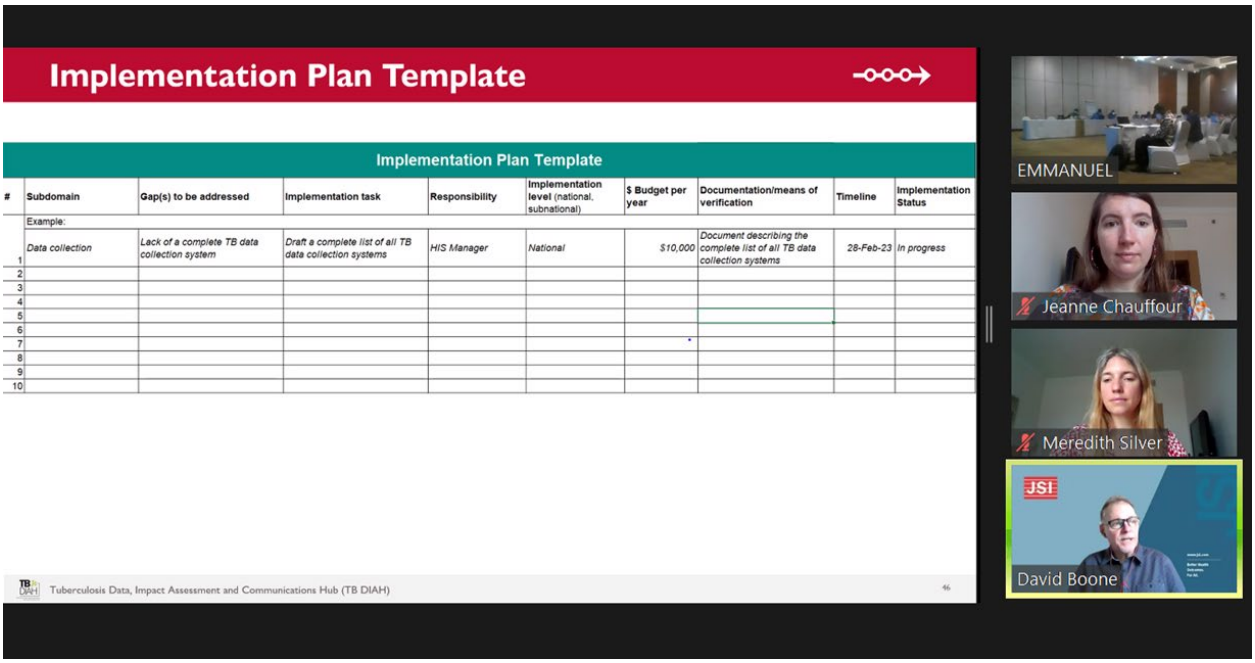


Figure 8. Workshop participants in the room following the presentation on the conference room screen

Photo credit: Emmanuel Owusu

Although the workshop was successful in many respects, despite the difficulties, another weakness was the inability of the D2AC team to work with the groups to ensure complete and uniform understanding of how different components of the Toolkit were to be used or completed, and to clarify misunderstood instructions or the distribution of tasks among the groups. For example, during the priority actions implementation plan group activity, two groups were—unknowingly to each other—both working on identifying priority actions for domain 5 subdomain 1 (Hardware), whereas one of those two groups had been assigned to work on domain 4 subdomain 2 (Skill and Knowledge Development). As a result, activities to address domain 4, subdomain 2 issues are not included in the combined implementation plan.

Technical Challenges

Some of the technical challenges with the data collection instrument were the fact that the questions were not always well adapted to integrated TB systems, like is the case in Ghana. Moreover, participants who were clinical staff for the GHS and were not responsible for data management or M&E at their facilities, had more difficulty responding to the data collection instrument's questions.

Ethics

The D2AC team explored the need for institutional review board approval, but it was deemed not necessary by the University of North Carolina and JSI institutional review board committees.

Risks

There were no major risks associated with participating in this workshop. The non-physical risks included personal information about participants being shared with the D2AC team. This was considered of minimal risk because little or no information of a confidential nature was collected and all personal information collected during the assessment was treated as confidential; all responses aggregated in the D2AC Data Analysis Tool were anonymized before being shared back with the participants. The primary research burden for participants was the time spent providing information to the D2AC facilitators team.

All necessary precautionary measures pertaining to COVID-19 were taken, including mandatory mask wearing during the workshop, and readily available hand sanitizer in the workshop hall and on tables. Meals were served outdoors and the facilitation was remote to avoid any risk due to COVID-19 exposure.

Advantages

No direct benefits accrued to participants from attending this workshop. Participants were each given a transportation per diem for the two workshop days, and the three participants coming from outside Accra had their flights and accommodation paid for by TB DIAH. Each participant was awarded a certificate of attendance.

At the national level, there were several important societal benefits from this assessment, namely that the NTP and its partners will receive feedback on the quality of data use and evidence-based decision making in the TB program, and that useful policy and program implications, and targeted funding allocation, may result from the findings.

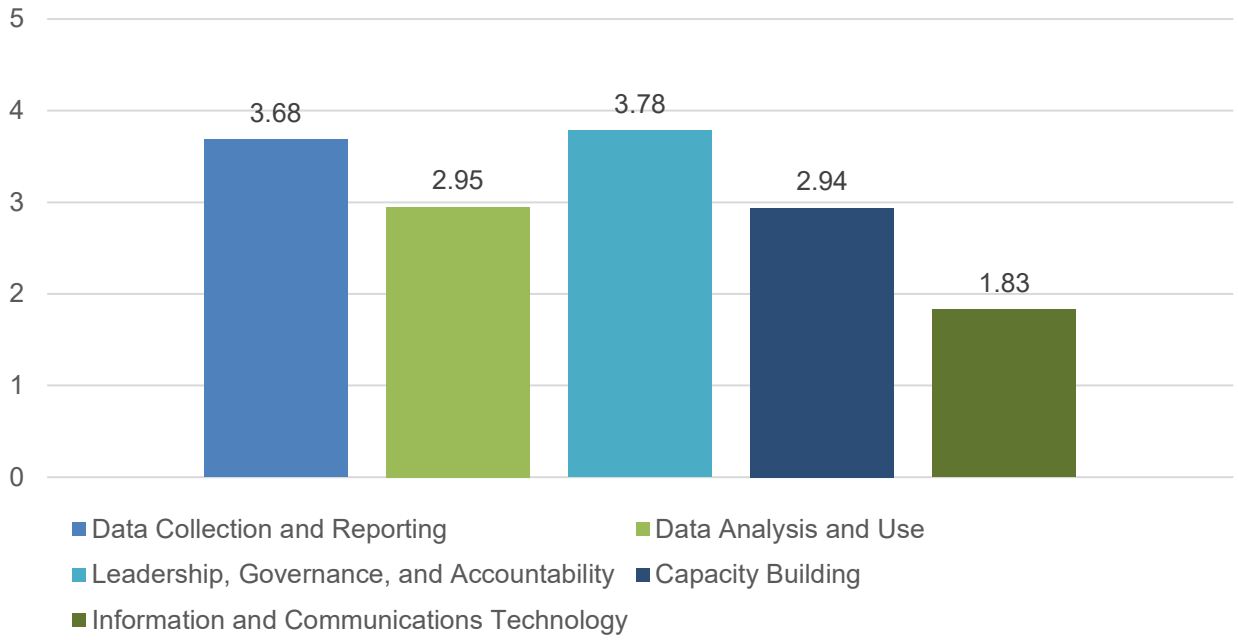
Results

Overall Results

The overall D2AC assessment score from aggregate group responses was 3.18 (out of 5), putting Ghana at an "established" level according to the D2AC. The country performed best in domain 1 (Data Collection and Reporting, score of 3.68) and domain 3 (Leadership, Governance, and Accountability, score of 3.78), and worst in domain 5 (ICT, score of 1.83). Domain 2 (Data Analysis and Use) and domain 4 (Capacity Building) received scores of 2.95 and 2.94, respectively (Figure 9). Summary tables of results are provided in Appendix F. The answer equivalents to the aggregate group score for each of the 44 questions are highlighted in yellow in Appendix E.

Although the results presented below were only extracted from the group aggregate scores, it should be noted that the overall score from aggregated individual responses was very similar, albeit slightly inferior, to the group aggregate score, with a score of 3.16 (out of 5).

Figure 9. Overall domain scores (aggregate of group responses)

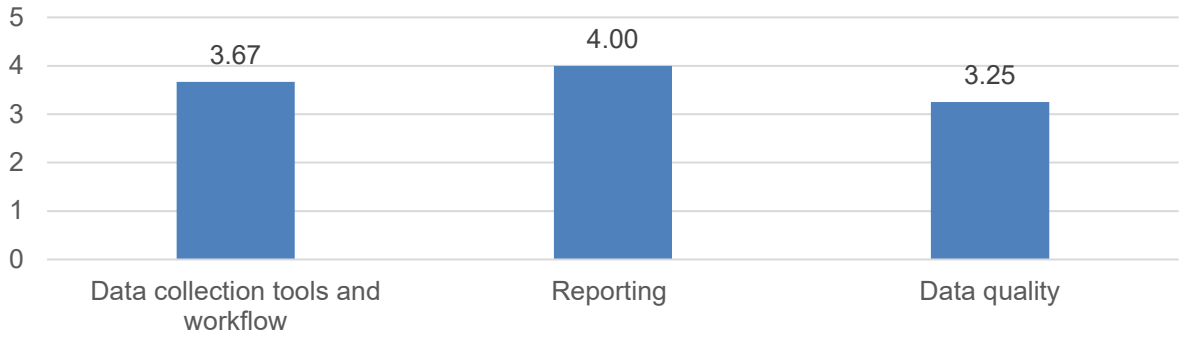


Results by Domain

Domain 1: Data Collection and Reporting

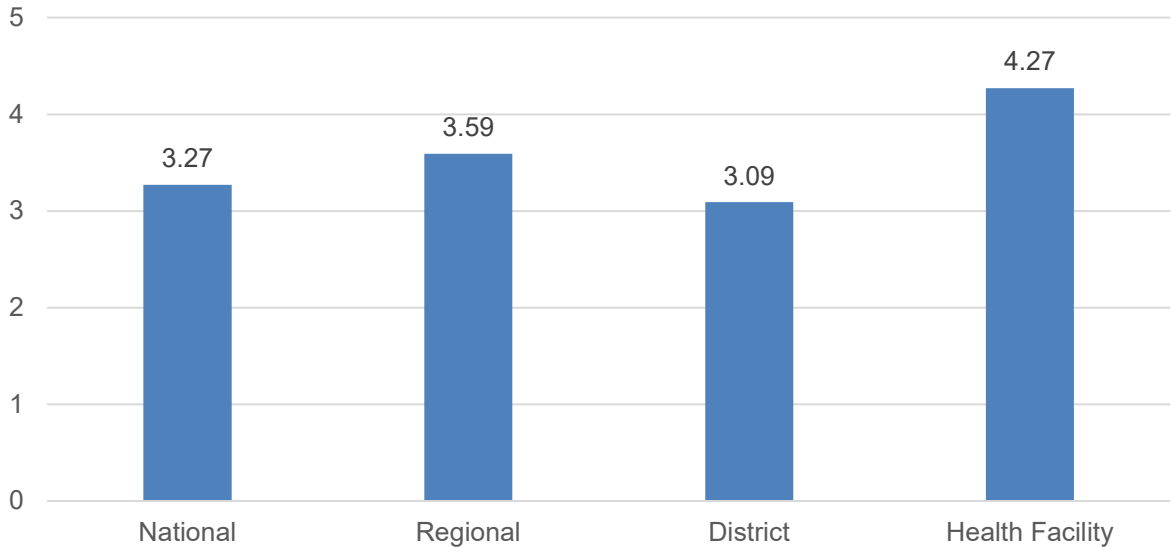
Domain 1, subdomain 1 (Data collection tools and workflow) received an aggregate score of 3.67; subdomain 2 (Reporting) received an aggregate score of 4.00; and subdomain 3 (Data quality) received an aggregate score of 3.25 (Figure 10).

Figure 10. Overall domain 1 subdomain scores (aggregate of group responses)



For domain 1, facility-level participants gave higher scores, on average (4.27), whereas the district level was the most conservative (3.09). The national-level score was 3.27 and the regional-level score was 3.59 (Figure 11).

Figure 11. Domain 1 scores, by health system level (aggregate of group responses)



The qualitative findings for domain 1 (11 questions) were that the TB01–TB10 registers (TB data collection tools, including for TB screening) and the laboratory request forms were the standardized data collection tools used (**question 1**). Some of these standardized data collection tools were in electronic format and were available at some levels; however, in most cases, the data were collected on paper-based forms due to a dearth of laptops or tablets and poor Internet connectivity, and the register data were then copied into an electronic database. The electronic databases were the District Health Information Management System[3] (DHIMS2), used to capture aggregated data; the e-Tracker (a District Health Information Software [DHIS2]

[3] Available at https://chimgh.org/dhims/

app), used to capture individual/case-based data, which was available at all hospitals and some health centers but not fully deployed in all DHIMS2 reporting sites; and the APOMUDEN Research Data Management System.[4] Both the e-Tracker and the aggregate summary report in DHIMS2 were managed by the Ghana Centre for Health Information Management (CHIM),[5] which runs a national web-based database for all diseases/conditions where all GHS data can be found. Data aggregation was performed on the DHIMS2 and e-Tracker databases. The e-Tracker is expected to replace the aggregate summary report after it is fully deployed.

The inventory of TB data collection systems (**question 2**) was usually captured on paper-based tools before being entered in an electronic system. There was an inventory at the PPME for routine updates of information about new TB data collection systems. They included patient folders (hard copies and electronic copies in some facilities) and laboratory results (hard and electronic copies). Monthly consumption and stocks levels of TB commodities were available. Data collection tools were "reviewed periodically in the fourth quarter of each year and the changes are reflected in the DHIMS2 for use in the ensuing year." Some regional-level data collection on training was limited to that level.

The data collection processes (**question 3**) for the quarterly M&E field reports and joint TB/HIV annual review reports were aligned with TB service delivery guidance. The TB service delivery guidance had instructions for data processing at the facility, district, and regional levels. Data quality was reviewed at the district, regional, and national levels. Monitoring was conducted by technical officers. Performance reviews also happened at these levels. In addition, the Ghana NTP had a "TB Situation Room" with its international partners, a gathering whose objective was to identify (and work to remedy) gaps and set targets.[6] Data quality assessments were periodically undertaken by the PPME division in collaboration with the NTP, sometimes as a response to a situation encountered on the ground. The findings guided revisions.

Unique identification (**question 4**) was used for TB cases. Each presumed TB case had a unique presumed TB number during his or her outpatient department visit. Once the person was confirmed to have TB, s/he was assigned a unique district TB number by the directly observed treatment facility. These numbers were found in the presumptive TB register and the district TB register. Adherence to unique identifiers was especially important "with the sputum sample transportation." Sites or facilities using e-Tracker used the national unique identifier that was the National Health Insurance Number. Patients' folders (hard copies and electronic on e-Tracker) were associated with the unique identifier at some facilities, as were patient laboratory and treatment card numbers, but they were not yet linked to the national identification system.

An Excel-based list of facilities (**question 5**) existed, and facilities that offer TB services were on the facility list available in the DHIMS2. Facilities providing TB services were "updated

[4] Available at https://rdms.geocemslab.com/redcap/
[5] Available at https://chimgh.org/
[6] This joint weekly virtual meeting gathered the NTP and its international stakeholders (USAID, WHO, Global Fund to Fight AIDS, Tuberculosis and Malaria [Global Fund]) for the purpose of monitoring grant implementation, identifying any challenges and to suggest solutions. WHO, NTP, and USAID regularly attended the meeting whereas the Global Fund's attendance was demand-based, when the meeting agenda touched on issues related to the Global Fund.

periodically to reflect new designated sites in the DHIMS2 to "ensure completeness of the site list."

All TB data collection and reporting (TB 07–08 forms) tools allowed for data disaggregation (**questions 6 and 8**) by age and sex for new and relapse TB cases, as did DHIMS2 aggregate summary data. It should be noted that age and sex disaggregation were not possible for TB retreatment cases on the paper tools and in the DHIMS2. However, the e-Tracker, which compiles case-based data, could disaggregate by age and sex for all TB cases. In terms of data use, data disaggregation occurred more based on periodic data needs. Private sector participants mentioned that "data collection and reporting is [sic] done in alignment with the requirements of the NTP."

Electronic data reporting (**question 7**) was done (in the DHIMS2 and e-Tracker) only after paper-based data were copied to the electronic tools and databases (usually by health workers), precluding any real-time reporting, as was intended. The e-Tracker was not integrated with the DHMIS2.[7] Data were directly entered at the facility level. Only assigned facilities had write, edit, and read access to the DHIMS2. However, staff at different levels of the health system could have log-in access to view reported data, with a limited data entry role.

Alignment between data reporting processes and TB service delivery guidance (**question 9**) was ensured through the TB registers (TB01–14), e-Tracker, and facility, district, and regional reports. New indicators introduced in the TB service delivery guidance were regularly updated in the national reporting data platform (DHIMS2). Decisions were based on the monthly, quarterly, and semi-annual real-time e-Tracker and DHIMS2 data.

Data quality parameters (**question 10**) were defined in the TB guidelines and DHIMS2/e-Tracker ("this application and online software helps a lot in this direction"). Data were validated, data quality was reviewed, and data quality parameters applied at and to all levels of the health system for specific timeframes to achieve data quality (timeliness, accuracy, completeness). Data supervision and monitoring for all levels were conducted by the national level in the DHIMS2.

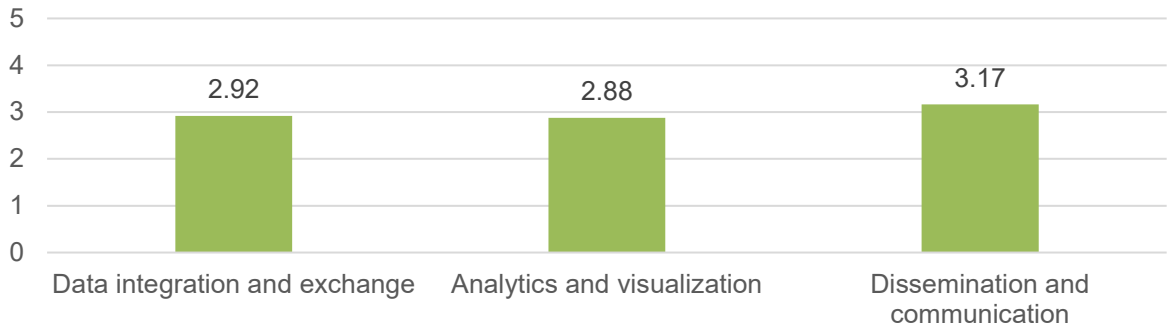
Data quality reviews (**question 11**) occurred monthly (for monthly reports). Supportive supervision was conducted quarterly by the NTP and monthly data feedback for data validation reviews was sent to facilities through the district for data quality purposes. At the regional level, data quality reviews were conducted monthly and feedback was given to the district level. The central level NTP also reviewed data quality and gave feedback to regions on a quarterly basis. Every six months, the NTP staff organized a data review meeting that included "cohort analysis, case notifications, treatment monitoring, etc."

[7] By design, the e-Tracker data were mapped to generate the summary report from individual data. However, because the cases in the e-Tracker were also reported in the DHIMS2 summary report form, the auto-generation of the e-Tracker report was not active. Ghana plans to fully migrate the reporting system to the e-Tracker.

Domain 2: Data Analysis and Use

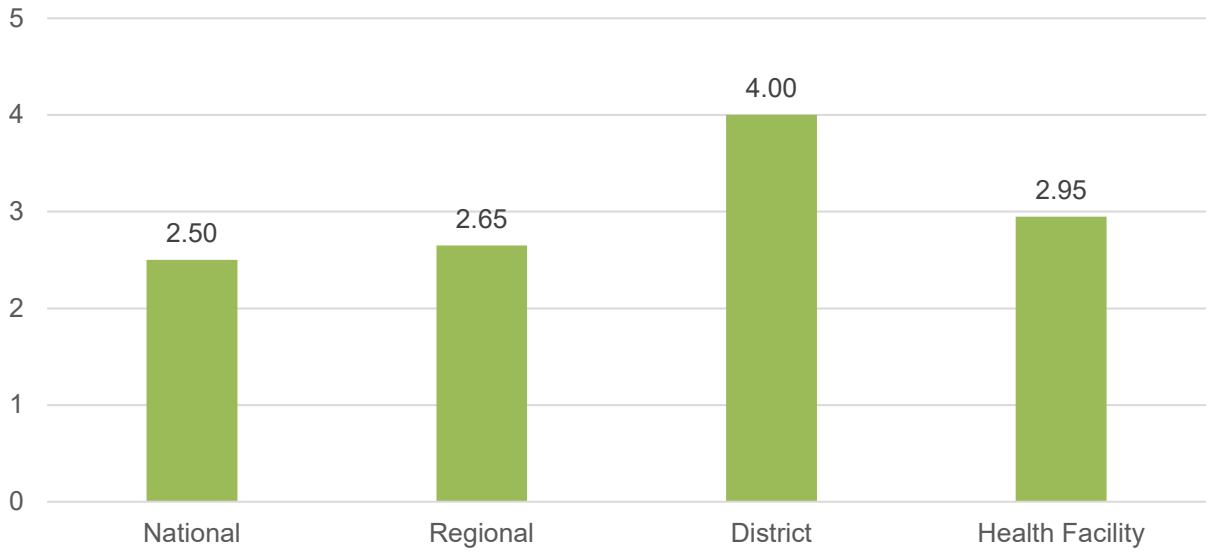
Domain 2, subdomain 1 (Data integration and exchange) received an aggregate score of 2.92; subdomain 2 (Analytics and visualization) received an aggregate score of 2.88; and subdomain 3 (Dissemination and communication) received an aggregate score of 3.17 (Figure 12).

Figure 12. Overall domain 2 subdomain scores (aggregate of group responses)



For domain 2, district-level participants gave higher scores, on average (4.00), whereas the national level was the most conservative (2.50). The regional-level score was 2.65 and the facility-level score was 2.95 (Figure 13).

Figure 13. Domain 2 scores, by health system level (aggregate of group responses)



The qualitative findings for domain 2 (10 questions) were that a central data repository (**question 12**) was in place and used, namely the DHIMS2 and the e-Tracker. This software has embedded data analysis and visualization functions.

Data exchange between systems at points of service and central repositories (**question 13**) was mostly done through TB reports in the DHIMS2 and e-Tracker; data were entered in the e-Tracker at the facility level and could be seen at the national level. However, "the system does

not allow for data exchange processes" and "there is no existing process or system for different levels of the NTP to exchange data with the regional or facility level." All data entered in the DHIMS2 could be accessed by the NTP.

Data were reported by participants to only flow (**question 14**) from facilities to the national level; there was no data flow or exchange going in the other direction. GxAlert[8] was used and it was "automated and in real time." The TB lab registers and reporting forms were the means by which data flowed from the bottom up, and the "MDR [multidrug-resistant TB] laboratory diagnostic data are exchanged more often in real time with the central NTP team."

The PPME division of the GHS had appointed staff in charge of integrating data exchange standards in the TB manual and data exchange implementation activities (**question 15**).

Users' ability to conduct analyses and to develop visualizations (**question 16**) for commodities management (including laboratory and medicine supplies) was aided by the use of the Ghana Integrated Logistics Management Information System (GhiLMIS). Ghana also used the QuanTB[9] software for forecasting, planning supplies, and early warning of TB medicine stockouts. Some visualizations also appeared in the annual TB program report. "The degree of competence for analysis differs from one level of care to another—the higher levels of care (regional and national) have higher competence."

Data analytics and visualization requirements (**question 17**) were documented in the TB reports and registers, the annual TB report, and the DHIMS2.

Data sources, such as "patient pathway analyses and epidemiological reviews" and the "action plan for the year and the descriptive analysis from the quarterly reports" were used (**question 18**) for the national strategic plan (NSP), decision making, annual reports, and for reprogramming.

Decision support tools (**question 19**) were used during the last TB Situation Room, which resulted in the revision of the TB facility, community, and people living with HIV/AIDS screening algorithms and laboratory algorithms. Other tools existed to help make decisions "in terms of logistics (QuanTB), program implementation, and patient management."

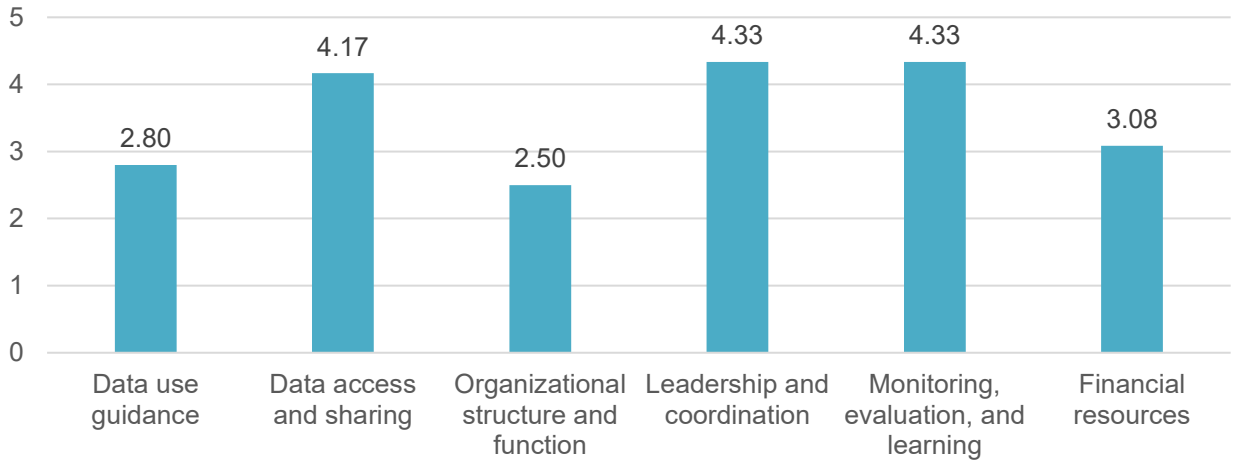
The NTP's communication strategy was the quarterly M&E report, which was also considered to be the information product developed and subsequently disseminated in the Ghana TB program. A communication strategy (**question 20**) was in place at the "subdistrict, district, regional, and national levels as well as for international performance reviews." Analyses were often "disseminated from the district level through the regional and national levels based on need and the forum created." Other communication channels included the quarterly M&E report and the NTP guidelines. Information products (**question 21**) were developed following technical supportive supervision and from the electronic data systems (DHIMS2 and e-Tracker). They included the quarterly M&E reports and supervisory reporting feedback.

[8] GxAlert is an automatic electronic notification service that provides immediate Xpert® MTB/RIF testing results.
[9] Available at https://siapsprogram.org/tools-and-guidance/quantb/

Domain 3: Leadership, Governance, and Accountability

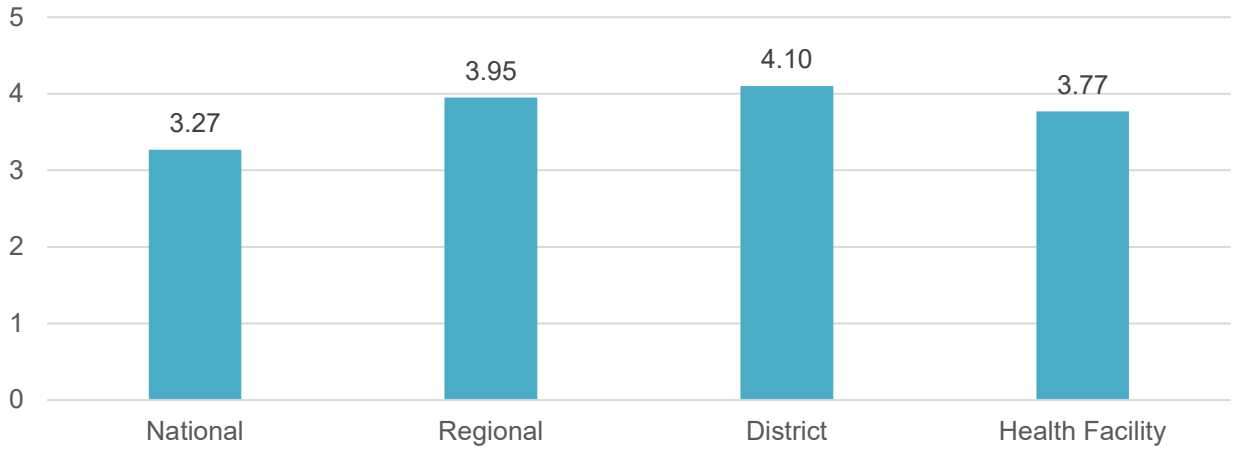
Domain 3, subdomain 1 (Data use guidance) received an aggregate score of 2.80; subdomain 2 (Data access and sharing) received an aggregate score of 4.17; subdomain 3 (Organizational structure and function) received an aggregate score of 2.50; subdomain 4 (Leadership and coordination) received an aggregate score of 4.33; subdomain 5 (MEL) received an aggregate score of 4.33; and subdomain 6 (Financial resources) received an aggregate score of 3.08 (Figure 14). Domain 3 subdomains 4 and 5 were the highest performing subdomains. Domain 3 was the highest performing domain.

Figure 14. Overall domain 3 subdomain scores (aggregate of group responses)



For domain 3, district-level participants gave higher scores, on average (4.10), whereas the national level was the most conservative (3.27). The regional-level score was 3.95 and the facility-level score was 3.77 (Figure 15).

Figure 15. Domain 3 scores, by health system level (aggregate of group responses)



The qualitative findings for domain 3 (11 questions) were that data use guidance existed at the national level, but it was not disseminated to the peripheral levels (**question 22**). National-

level guidance was developed "through yearly performance reviews whose participants are subdistrict, regional, and national officers, and from reviews at the senior managers' meetings whose participants are districts, regional, and national officers." Data use guidance was included in the evaluation reports and NSPs, and the NTP also used its program data for the NTP guidelines. Data use was "at the discretion of district, regional, and national levels in accordance with national guiding principles."

In terms of data sharing, the Ghana NTP regularly shared its data with WHO and the Global Fund Country Coordinating Mechanism (CCM) via online portals (**question 23**). The WHO and CCM had access-based control of NTP data. "The use of these data is quarterly, half-yearly, and yearly with our external partners."

Job descriptions existed and roles were well defined but they did not include specific data use responsibilities when relevant to the position (**question 24**). Data use responsibilities were "implied in the roles of the health worker at various levels of care" and written roles and responsibilities were not clearly documented at the district and facility levels. The NTP staff at all levels had access to their written roles but not their responsibilities related to data use. This being said, the data use responsibilities chain of command was well structured: "At the national level, it begins with the M&E officers, [then the] regional M&E officers, [and finally the] district and subdistrict officers."

The interagency leadership and coordination team (**question 25**) coordinated at all levels of the health system and also collaborated to develop the annual program reports.

Standard operating procedures for the annual TB data review or data quality review meetings did not exist (**question 26**) and could increase the efficacy of the coordination team. Participants remarked that the leadership and coordination team were effective through capacity building (e.g., for MDR-TB teams), at regular meetings hosted by the CCM and the GHS senior managers meetings.

Although monitored and reviewed, the MEL implementation plan did not include any budget allocations (**question 27**). However, at the national level, there was a budget line for M&E. The MEL plan (part of the Global Fund grant) was implemented in quarterly central TB level monitoring, supervision, mentoring, and coaching, regional and district review reports, and the DHIMS2.

MEL's contributions to improved health outcomes (**question 28**) was "evidenced from field reports data and DHIMS2 data." MEL processes (**question 29**) were developed in performance review reports.

MEL support to program improvement (**question 30**) was evidenced from field reports data, DHIMS2 data, and "discussions with international partners and incorporating [the outcome of these discussions] in the NTP's strategic plans." MEL "serves both for program review and towards goal achievement."

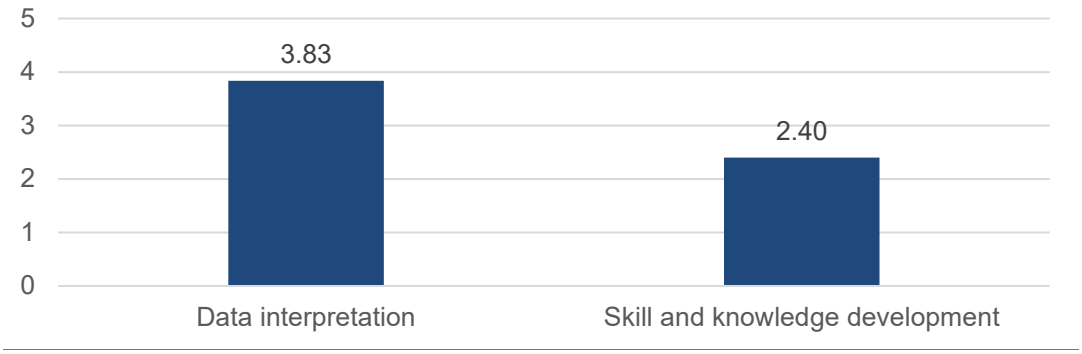
Funding for data use activities (**question 31**) came from "using review findings, writing concept notes for the New Funding Models with Global Fund." For example, there was funding for MDR-TB cases, which was outlined in the annual NTP financial and budget report.

Financial resources were mobilized (**question 32**) through the NSPs and the Ghana National Health Sector Strategic Plans. Most NTP finances were primarily funded by the Global Fund.

Domain 4: Capacity Building

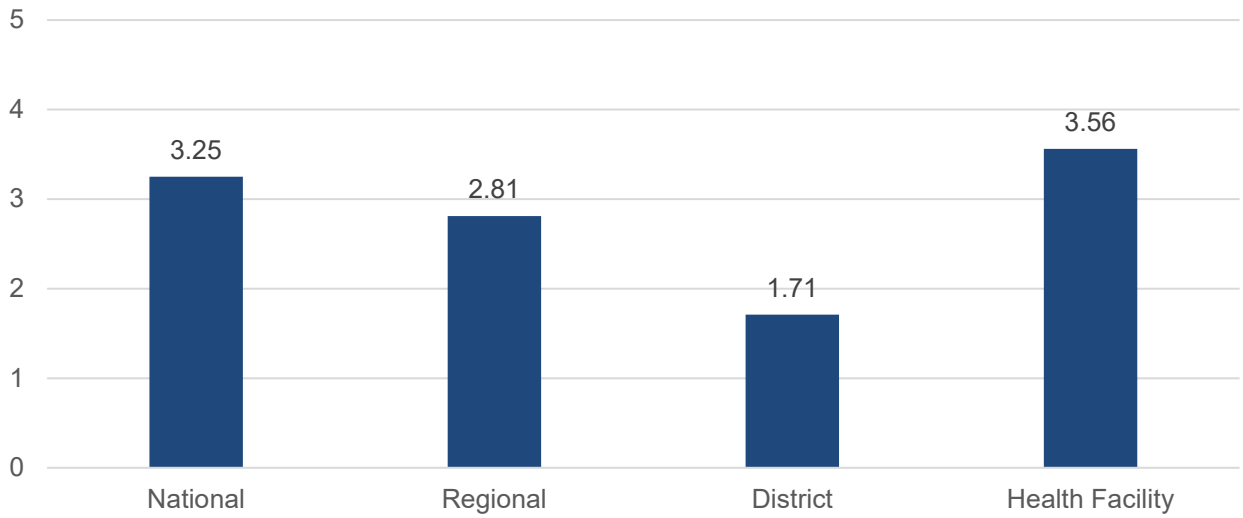
Domain 4, subdomain 1 (Data interpretation) received an aggregate score of 3.83 and subdomain 2 (Skill and knowledge development) received an aggregate score of 2.40 (Figure 16).

Figure 16. Overall domain 4 subdomain scores (aggregate of group responses)



For domain 4, facility-level participants gave higher scores, on average (3.56), whereas the district level was the most conservative (1.71). The national-level score was 3.25 and the regional-level score was 2.81 (Figure 17).

Figure 17. Domain 4 scores, by health system level (aggregate of group responses)



The qualitative findings for domain 4 (8 questions) were that data use forums (**question 33**) were mostly limited to the context of the NTP annual report or to other performance review meetings that could also include other divisions, such as the PPME. The data reviewed (**question 34**) were "annual reports, workplans, and national strategic plans."

The NTP staff conducted periodic (quarterly) supportive supervision and mentoring visits when it came to data use (**question 35**), using older data. Pre-service training programs for skill and knowledge development were done by the NTP (**question 36**) "in collaboration with the training colleges" and were conducted at graduate-level training institutions "such as medical schools or nursing training schools." They featured "training manuals that are written for students and other health professionals" and an internship. The pre-service training was followed up by in-service training at facilities when staff were assigned TB-related jobs and, for the most part, it was on-the-job training and onsite coaching. Training for staff was provided by the respective regional/district health directorate. Regional and district health directorate staff were assigned TB-related duties and were expected to provide training and staff orientation, including on-the-job training. Pre-service training was a core component of the NTP's NSP (**question 37**).

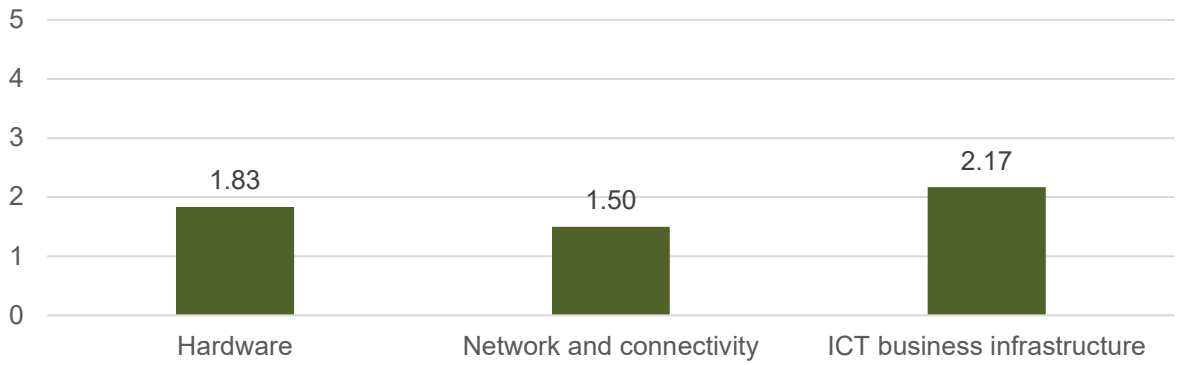
The NTP's in-service training program for skill and knowledge development (**question 38**) and for building staff capacity was developed through onsite coaching based around NTP monitoring visits. In-service training as part of guidance outlined by the NTP (**question 39**) was performed by both the NTP—with national office staff going on periodic supportive supervision visits to service providers in the field and conducting on-site coaching where needed—and other authorities, at all levels of the health system, as designated by the NTP to oversee and supervise the training programs.

In-service training programs (**question 40**) and on-site coaching were periodic—"limited but not ad-hoc," as one participant commented. A participant from the national level reported that on a quarterly basis, officers from the national level provided on-the-job coaching as part of monitoring activities at the regional level. The effectiveness of these programs was not expanded upon.

Domain 5: ICT

Domain 5, subdomain 1 (Hardware) received an aggregate score of 1.83; subdomain 2 (Network and connectivity) received an aggregate score of 1.50; and subdomain 3 (ICT business infrastructure) received an aggregate score of 2.17 (Figure 18). Domain 5 was the lowest performing domain, and domain 5 subdomain 2 was the lowest performing subdomain.

Figure 18. Overall domain 5 subdomain scores (aggregate of group responses)



For domain 5, health facility-level participants gave higher scores, on average (2.25), whereas the district level was the most conservative (1.00). The national-level score was 1.50 and the regional-level score was 2.00 (Figure 19).

Figure 19. Domain 5 scores, by health system level (aggregate of group responses)

The qualitative findings for domain 5 (4 questions) were that hardware (**question 41**) was missing at the peripheral level. Computers were limited to the central level. At the regional level, hardware (computers) was missing, with "many staff using their own personal computers at work." Hardware was even less available at more subnational (district) levels, and although "districts have a computer and hardware equipment, these computers are not necessarily used for TB-related activities." Hardware was sparsest at the facility level.

Regularity of hardware specification (**question 42**) updates was done to "suit the evolution" in software and technology.

Internet connectivity (**question 43**) at the subnational level was very limited, if it existed at all. Subnational staff mostly relied on personal cell phone hotspots or personal modems for connectivity. In some places, where connectivity was provided, the unavailability of computers did not render connectivity as useful.

No comments were provided by participants for **question 44**.

Comparing Individual and Group Results

A comparison of the individual and group responses revealed significant disparities in scoring for domain 5 (ICT). The average scores for domain 5 for both the group and individual responses, plus the percentage difference between them, by domain and subdomain, are presented in Table 5. The overall difference for domain 5 was 30 percent, indicating a significant discrepancy (Figure 20). At the subdomain level, subdomain 2 (Network and connectivity) was rated 1.15 points (43%) lower in the group responses than in the individual responses, whereas

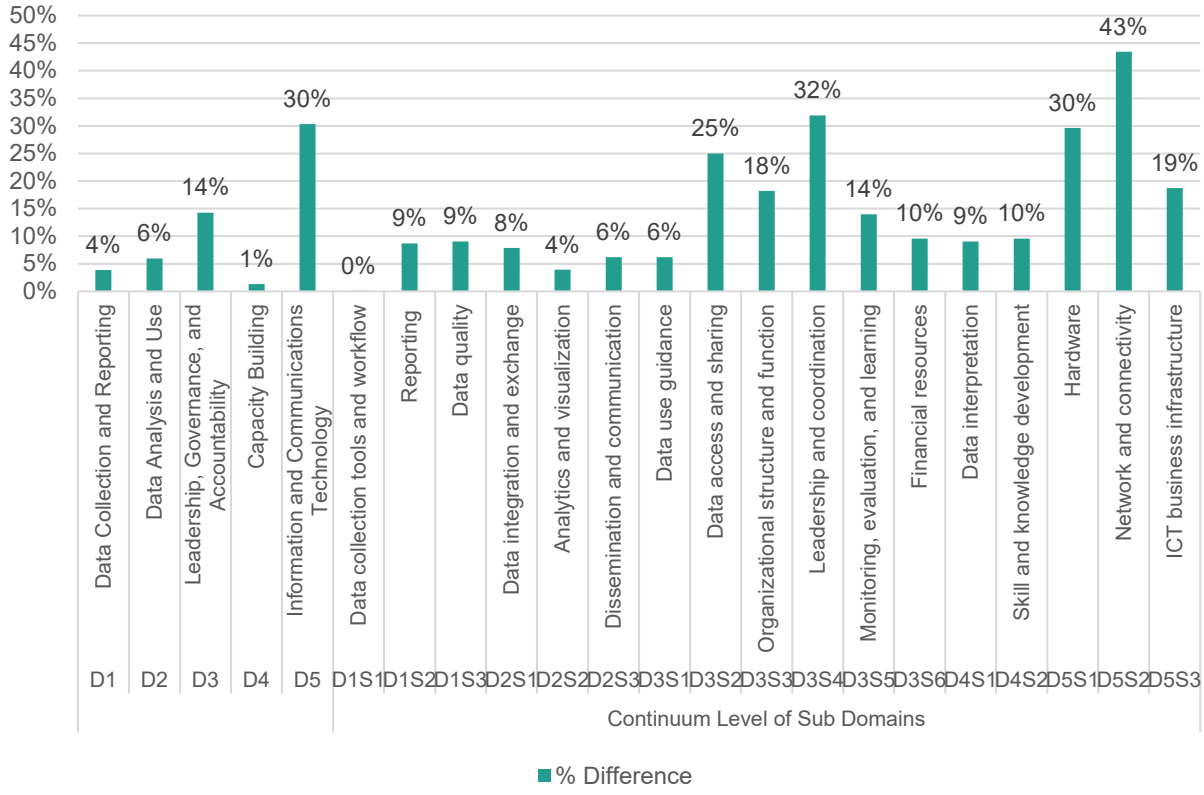
subdomain 1 (Hardware) was rated 30 percent lower, and subdomain 3 (ICT business infrastructure) was rated 19 percent lower.

Table 5. Average scores for domain 5 in group and individual responses and percentage difference between them, by domain and subdomain

Domain/Subdomain		Average of group scores	Average of individual scores	Percentage difference
D5	ICT	1.83	2.63	0.30
D5S1	Hardware	1.83	2.60	0.30
D5S2	Network and connectivity	1.50	2.65	0.43
D5S3	ICT business infrastructure	2.17	2.67	0.19

Looking more closely at the individual responses that made up the averages for both the group and individual responses, it is evident that some members of certain groups had substantial influence on the discussions, with a large divergence of scoring between individuals in the group for individual scoring and the group response (Figure 20). For example, the group with the largest disparity had an average individual response of 2.81, whereas the group instrument submitted a score of 1.00. The individual members scored the domain as 4.25, 1.75, 3.75, and 1.5. It would appear that the discussion in the group not only led the two individuals with the higher scores to agree to drop their scores from significant capacity to nascent capacity, and the two individuals who gave the lower scores on individual responses to reduce their scores even further.

Figure 20. Difference between individual and group results, by domain and subdomain



Co-Created Priority Actions

The count of individual votes resulted in five subdomains being identified as priority subdomains (receiving between 13 and 19 votes each). Five other subdomains received between 10 and 12 votes each, another five received between 6 and 9 votes each, and finally, two subdomains received 3 votes or fewer (Table 6). The five priority subdomains were D1S3 (Data quality), D2S2 (Analytics and visualization), D2S1 (Data integration and exchange), D4S2 (Skill and knowledge development), and D5S1 (Hardware).

Table 6. Number of votes by subdomain

Subdomain		Votes
D1S3	Data quality	19
D2S2	Analytics and visualization	14
D2S1	Data integration and exchange	13
D4S2	Skill and knowledge development	13
D5S1	Hardware	13
D1S1	Data collection tools and workflow	12

Subdomain		Votes
D3S5	Monitoring, evaluation, and learning	12
D5S3	ICT business infrastructure	12
D3S6	Financial resources	10
D5S2	Network and connectivity	10
D3S1	Data use guidance	9
D2S3	Dissemination and communication	7
D4S1	Data interpretation	7
D1S2	Reporting	6
D3S2	Data access and sharing	6
D3S4	Leadership and coordination	3
D3S3	Organizational structure and function	1

For the four subdomains evaluated, the groups came up with 11 priority actions in a combined implementation plan (Appendix G).

For D1S3 (Data quality), five participants suggested that the priority actions should be to ensure that data were generally complete, consistent, and accurate for priority data elements for at least the past 12 months, and to integrate data quality metrics in program review and as a routine feature of program management.

For D2S1 (Data integration and exchange), six participants suggested that the priority actions should be to develop and approve standards for TB data management and exchange that require certification of new exchange partners for compliance.

For D2S2 (Analytics and visualization), five participants suggested that the priority actions should be to provide training on advanced data analytics, resolve e-Tracker synchronization issues with the DHIMS2, and organize regular updates and orientations on new tools/forms.

Due to a mix-up in the room, the group assigned to D4S2 (Skill and knowledge development) instead worked on D5S1 (Hardware). Therefore, two groups ended up working on D5S1 and no recommendations were provided for D4S2.

For D5S1 (Hardware), 10 participants (in two groups of four and six participants, respectively) suggested that the priority actions should be to conduct a hardware needs assessment to identify gaps and specifications; procure hardware based on the needs assessment conducted (computers, printers, scanners, external drives, etc.) to achieve a coverage of at least 60 percent of subnational staff; develop nationally documented specifications and requirements for all hardware needed; and allocate funds for hardware procurement.

Field Test

The field test component findings will be the object of a series of meetings among the D2AC team members to update the Toolkit before its publication. The Ghana field test was followed by a second field test in Nigeria in April 2022. The findings from these field tests will be published in the Journal of Global Health in 2022 and will be made available at https://www.tbdiah.org/assessments/d2ac. The Nigeria field test report is also available at this link.

Discussion

The March 2022 D2AC assessment in Ghana shed light on the perceived weaknesses of the Ghana TB information system, namely in the domain of ICT, where hardware, network and connectivity, and ICT business infrastructure received the lowest scores across the groups, on average. Hardware shortages were one of the most important stated concerns when examining the reasons for the lack of data use or lack of strong data use practices. Many facilities lacked essential hardware for data reporting, analysis, visualization, and communication. Significant hardware needs existed at the facility, district, and regional levels.

The conversation around hardware brought up other concerns about TB diagnostic and screening equipment, with participants sharing that GeneXpert and digital x-ray machines should be considered an essential part of the physical equipment inventory that TB health facilities should have (which many lacked), not only to enhance TB elimination efforts, but in the context of the current ongoing COVID-19 pandemic, in particular. Indeed, the inability to conduct onsite bidirectional screening and testing for TB and COVID-19 at facilities and for TB contacts was an important hurdle in the quality of care for TB patients.

Network and connectivity are essential to send information. Important data challenges existed for weekly, monthly, or other reporting. In the context of COVID-19, Internet accessibility is also instrumental for conducting virtual meetings and training in the era of democratization of remote work.

In addition to the challenges of physical resources, equipment, and infrastructure, other challenges revealed concerned human resources, such as organizational structure and function, and skill and knowledge development. Again, in terms of the ongoing COVID-19 pandemic, capacity building of health workers on bidirectional screening and testing for COVID-19 was of priority concern for the Ghana NTP.

Last, a third broad category in which improvements could be made were around data management and use practices, functionalities, and capabilities, specifically: data integration; data exchange and interoperability; data use guidance; analytics; and data visualizations. These areas received scores lower than 3 out of 5, meaning that they were identified as being at a “nascent” or “defined” stage on the continuum.

The D2AC assessment in Ghana shed light on the areas that were performing the best. They included aspects of data availability practices, such as data reporting, data access, and data sharing. Other strong areas were MEL and leadership and coordination. These areas received scores superior to 4 out of 5, meaning that they were identified as being at an “institutionalized” stage on the continuum.

The D2AC records data in two ways: individual and group responses. The individual responses provided an opportunity for workshop participants to orient themselves to the content of the Data Collection Tool and engage in forethought on the maturity of the various capabilities, subdomains, and domains. The group-level exercise provided an opportunity for participants to derive a consensus view following discussion among themselves. The group-level results should be considered the more reasoned responses, given that a post hoc analysis of group constitution

yielded reassurance that the appropriate background and experience were present in the groups. The individual responses could be used to validate the group responses if they were not substantially different (that is, if they were similar, it could be reasonably assumed that the group responses reflected the actual maturity of the system). If individual and group responses differed significantly, a comparison of individual and group responses at the capability and subdomain level could provide insight on the disparity. For example, the comparison may reveal that individual respondents lacked significant background or experience, or it could bring to light an overly influential group member. Differences in individual versus group responses do not indicate bias in the responses per se, rather, the potential for such that should be evaluated further and rectified, if possible.

The disparity in responses observed for domain 5 can be attributed to many factors, such as lack of knowledge and/or experience with the domain, or an influential or dominant group member. More knowledge of the relative familiarity of group members with the domain needs to be sought to know with certainty. The NTP could take these results as an indication of a lack of maturity in the domain and seek out a more informed response from more targeted respondents.

Recommendations

The recommendations are presented in two parts. The first part discusses recommendations developed in plenary and by consensus by all workshop participants. They are described in detail in the implementation plan (Appendix G). The second part presents, in greater breadth, recommendations that apply to the Ghana context. They are based on the average scores in the D2AC data collection instrument, and were both generated from the priority actions for implementation tab in the D2AC Data Analysis Tool and inspired by the group discussions during the workshop.

Priority Recommendations from Combined and Validated Implementation Plan

As previously mentioned, the priority recommendations were developed in small groups, combined in a joint implementation plan in plenary, and validated by the workshop participants. The priority recommendations are:

1. Ensure that data are generally complete, consistent, and accurate for priority data elements for at least the past 12 months to address gaps created by poor data quality, inadequate human resources, and skill gaps.
2. Integrate data quality metrics in program review and as a routine feature of program management.
3. Develop and approve standards for TB data management and exchange that require certification of new exchange partners for compliance to address gaps created by the lack of standard guidelines for TB-related data exchange, poor integration of existing electronic formats (e-Tracker and DHIMS2) making data exchange and sharing impossible, and poor security and confidentiality of data exchanges.
4. Develop and provide training on advanced data analytics to address skill and knowledge gaps with respect to data analysis and visualization.
5. Resolve e-Tracker synchronization issues with the DHIMS2 until the e-Tracker becomes the source for all data reports.
6. Organize regular updates and orientations on new tools/forms for staff.
7. Implement a hardware needs assessment to identify gaps and specifications to identify and support districts with no or inadequate hardware.
8. Procure hardware based on the needs assessment to address gaps created by the lack of high-grade recording and reporting equipment (computers, printers, scanners, external drivers), the need for upgraded and multi-functional GeneXpert and digital x-ray machines to help in second-line TB testing, and GxAlert for data transmission.
9. Procure hardware to achieve a coverage of at least 60 percent of subnational staff to improve the current situation where less than half of NTP staff have hardware at the subnational level.
10. Develop nationally documented specifications and requirements for all hardware needs, especially at the subnational level.
11. Allocate funds for hardware procurement in annual workplans, including at the subnational level.

Other Recommendations, by Domain and Subdomain from the D2AC Toolkit and Group Feedback

This section lists the benchmarks and recommendations generated by the D2AC Toolkit's Priority Actions for Implementation function based on the subdomain scores, combined with the recommendations shared by the groups in small group discussions and in plenary.

Domain 1: Data Collection and Reporting

For **D1S1 (Data collection tools and workflow, score of 3.67)**, the requirements to go from an established to an institutionalized level on the D2AC are the following:

1. Standardized electronic data collection tools are used at all levels and integrated with the national HMIS data collection system.
2. The inventory information is used to inform the need for a new TB data collection system.
3. Data collection processes are monitored and assessed to check alignment with the service delivery guidance.
4. Unique identifiers for TB cases are aligned with the national unique (person or patient) identifiers.
5. The NTP web-based site list is integrated in the master facility list.
6. NTP monitoring and review assesses quality of disaggregated data collection.

To reach an institutionalized level, the specific recommendations are to:

1. Routinely update TB data collection system inventory to add information about a new TB data collection system.
2. Use data collection process monitoring and assessment findings to guide revisions and updates.
3. Continue ongoing efforts to ensure that unique identifiers for TB cases are aligned with the national unique (person or patient) identifiers.
4. Routinely review and update disaggregated data collection requirements in the M&E plan.
5. Increase data quality review activities at the facility level (recommendation from a group).

For **D1S2 (Reporting, score of 4.00)**, the requirements to go from an institutionalized to an optimized level on the D2AC are the following:

1. Standardized real time case-based electronic data reporting tools are used.
2. The NTP routinely reviews and updates disaggregated data reporting requirements in the M&E plan.
3. Routine NTP guidance revision/update guides the revision of data reporting processes.

To reach an optimized level, the specific recommendations are to:

1. Use standardized real time case-based electronic data reporting tools/e-Tracker at all health care levels.
2. Ensure that the NTP routinely reviews and updates disaggregated data reporting

requirements in the M&E plan.
3. Ensure that data reporting processes are monitored and assessed to check alignment with TB service delivery guidance.

For **D1S3 (Data quality, score of 3.25)**, the requirements to go from an established to an institutionalized level on the D2AC are the following:

1. Data quality problems are documented and factored in data analysis to be comparable across sources and time.
2. Data quality parameters are integrated in program review and management.

To reach an institutionalized level, the specific recommendations are to:

1. Ensure that data are generally complete, consistent, and accurate for priority data elements for at least the past 12 months.
2. Integrate data quality metrics in program review and are a routine feature of program management.

Domain 2: Data Analysis and Use

For **D2S1 (Data integration and exchange, score of 2.92)**, the requirements to go from a defined to an established level on the D2AC are the following:

1. An electronic central data repository collates aggregate program data only at the national level.
2. Data exchange between systems at points of service for TB cases and reporting and/or central repositories occurs extensively on a national level and is mostly automated.
3. Data exchange between systems at points of service for laboratory testing and reporting and/or central repositories occurs extensively on a national level and is mostly automated.
4. Standards for TB data management and exchange are approved and require certification of new exchange partners for compliance.

To reach an established level, the specific recommendations are to:

1. Routinely use the central data repository to address program data analytics and visualization needs at the NTP. The use of a standard dashboard is recommended, similar to those used by the WHO[10] or TB DIAH.[11]
2. Exchange data extensively on a national level and the exchange is mostly automated.
3. Develop mechanisms for data flow down from the national to the peripheral levels to allow for further data exchange than just the unidirectional bottom up data flow (recommendation from a group).
4. Develop guidelines for data sharing (recommendation from a group).

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[10] WHO dashboard available at https://worldhealthorg.shinyapps.io/tb_profiles/?_inputs_&entity_type=%22country%22&lan=%22EN%22&iso2=%22GH%22

[11] TB DIAH Hub available at https://hub.tbdiah.org/dashboards/aggregate and https://hub.tbdiah.org/dashboards/countries

5. Build capacity and plan for regular refresher training to upgrade staff on data management and security-related issues (recommendation from a group).
6. Approve standards for TB data management and exchange that require certification of new exchange partners for compliance.

For **D2S2 (Analytics and visualization, score of 2.88)**, the requirements to go from a defined to an established level on the D2AC are the following:

1. NTP staff are able to conduct advanced analysis (e.g., cascade analysis) and develop visualization in real time mostly at the national level.
2. The NTP has identified and documented a minimum set of standard data analyses and visualization requirements/needs at all levels.
3. Decision making is focused only on program resources and/or patient data reports and summaries. Some decision support tools exist locally or for specific implementations.
4. Decision support tools are automated to use the knowledge base for contextually-relevant reference information.

To reach an established level, the specific recommendations are to:

1. NTP staff at national, subnational, and facility levels should conduct advanced analysis (e.g., cascade analysis) and develop visualizations in real time (e.g., for identifying causes of poor performance, implementation problems, and monitor and forecast services/commodities demand) as part of their M&E activities.
2. The NTP should identify and document a minimum set of standard data analyses and visualization requirements/needs at all levels.
3. Ensure that program staff routinely make decisions that require combining data from multiple sources (e.g., to provide scenario-based, health-system level specific decision-making support and to predict the impact of decisions and policy).
4. Make certain that decision support tools are automated to use the knowledge base for contextually-relevant reference information.

For **D2S3 (Dissemination and communication, score of 3.17)**, the requirements to go from an established to an institutionalized level on the D2AC are the following:

1. Implementation monitoring and assessment are routinely conducted to gauge the effectiveness of the communication strategy as part of the NTP review.
2. Information products are routinely produced and distributed to stakeholders at all levels of the health system and are monitored and evaluated.

To reach an institutionalized level, the specific recommendations are to:

1. Conduct routine "implementation monitoring and assessment" to gauge the effectiveness of the communication strategy as part of the NTP review.
2. Routinely produce/distribute information products to stakeholders at all levels of the health system.

Domain 3: Leadership, Governance, and Accountability

For **D3S1 (Data use guidance, score of 2.80)**, the requirement to go from a defined to an established level on the D2AC is the following:

1. The NTP has an approved and comprehensive data use guidance implemented at all health system levels to support data use for decision making.

To reach an established level, the specific recommendations are to:

1. Make sure that the national data use guidance is disseminated to all levels of the health system (recommendation from a group).
2. Make sure that the NTP has an approved and comprehensive data use guidance implemented at all health system levels to support data use for decision making.

For **D3S2 (Data access and sharing, score of 4.17)**, the requirement to go from an institutionalized to an optimized level on the D2AC is the following:

1. The NTP uses monitoring data to support access to and sharing of data with all relevant stakeholders (e.g., NTP, external stakeholders).

To reach an optimized level, the specific recommendation is to:

1. Ensure that the NTP uses monitoring data to support access to and sharing of data with all relevant stakeholders (e.g., NTP, external stakeholders).

For **D3S3 (Organizational structure and function, score of 2.50)**, the requirements to go from a defined to an established level on the D2AC are the following:

1. NTP staff at all levels have access to their written roles and responsibilities related to data use.
2. Ensure that all job descriptions include specific and explicit data use responsibilities, when applicable to the role or position, at all levels, but especially at the district and facility levels (recommendation from a group).

To reach an established level, the specific recommendation is to:

1. Ensure that NTP staff at all levels have access to their written roles and responsibilities related to data use.

For **D3S4 (Leadership and coordination, score of 4.33)**, the requirements to go from an institutionalized to an optimized level on the D2AC are the following:

1. The formal leadership and coordination team facilitates an annual review of TB data use activities at all levels of the health system and decisions are evident in the updated program/guidance documents.
2. Assessment findings are used to improve leadership and coordination team meeting outcomes.

To reach an optimized level, the specific recommendations are to:

1. Facilitate an annual review of TB data use activities at all levels of the health system and decisions are evident in the updated program/guidance documents led by the formal leadership and coordination team.
2. Develop a standard operating procedure for the annual review meeting management that could also be applied to other important gatherings of key TB program actors (recommendation from a group).

3. Ensure that the MEL team evaluates and monitors the ability of the leadership and coordination team to lead and coordinate regularly scheduled meetings.

For **D3S5 (MEL, score of 4.33)**, the requirements to go from an institutionalized to an optimized level on the D2AC are the following:

1. Monitoring data are used to inform the annual review/update of the MEL plan.
2. Health outcome measurement data are used to revise and prioritize program interventions.
3. Program performance review findings are used to routinely revise/update MEL processes.
4. The MEL data are used to continuously improve the MEL plan for achieving better program goals.

To reach an optimized level, the specific recommendations are to:

1. Strengthen the use of monitoring data to inform the annual review/update of the MEL plan.
2. Strengthen the use of health outcome measurement data to revise and prioritize program interventions.
3. Use program performance review findings to routinely revise/update MEL processes.
4. Use the MEL data to continuously improve the MEL plan for achieving better program goals.
5. Include a budgetary allocation when developing and reviewing the MEL plan (recommendation from a group).

For **D3S6 (Financial resources, score of 3.08)**, the requirements to go from an established to an institutionalized level on the D2AC are the following:

1. Budget for data use activities is monitored and reviewed during the program review process.
2. Availability and utilization of financial resources is monitored and measured by the MEL team.

To reach an institutionalized level, the specific recommendations are to:

1. Secure operations of data use activities with annual budgets.
2. The MEL team monitors and measures the availability and utilization of financial resources.

Domain 4: Capacity Building

For **D4S1 (Data interpretation, score of 3.83)**, the requirements to go from an established to an institutionalized level on the D2AC are the following:

1. Performance of data use forums is monitored and assessed as part of the program performance review.
2. MEL staff routinely monitor and assess implementation of actions identified in the data review.
3. Supportive supervision is monitored to help identify technical resources NTP staff can access to meet supportive supervision needs.

To reach an institutionalized level, the specific recommendations are to:

1. Use monitoring and assessment findings to improve the performance of data use forums.
2. Use monitoring and assessment data to continuously improve the implementation of actions identified in the data review.
3. Monitor supportive supervision to help identify technical resources that NTP staff can access to meet supportive supervision needs.

For **D4S2 (Skill and knowledge development, score of 2.40)**, the requirements to go from a defined to an established level on the D2AC are the following:

1. A national pre-service training program for all cadres of the NTP is being implemented.
2. A designated NTP authority oversees pre-service training programs.
3. A national in-service training program for all cadres of the NTP is being implemented.
4. A designated NTP authority oversees in-service training programs.
5. Training needs assessment data are used for identification and recommendation of appropriate training.

To reach an established level, the specific recommendations are to:

1. Establish a national pre-service training program for imparting knowledge and skills, even if only for clinical staff.
2. Ensure that a designated NTP authority oversees pre-service training programs.
3. Implement a national in-service training program for all cadres of the NTP.
4. Ensure that a designated NTP authority oversees in-service training programs.
5. Routinely assess the training programs as part of the MEL activities to gauge skill and knowledge of trainees.
6. Develop post-training evaluation strategies to assess trainees' skills and competencies as a way to assess training effectiveness.

Domain 5: ICT

For **D5S1 (Hardware, score of 1.83)**, the requirements to go from a nascent to a defined level on the D2AC are the following:

1. Less than half of the NTP's central and subnational offices have adequate hardware.
2. Hardware specifications are documented at the national and subnational levels.

Furthermore, the requirements to go from a defined to an established level on the D2AC are the following:

1. Hardware needs are documented and national offices have adequate hardware, including backup services.
2. Hardware specifications are documented and followed in procurement at all levels.

To reach a defined level, the specific recommendations are to:

1. Guarantee that national and subnational offices have adequate hardware, including backup services. In the longer term, making computers and tablets available to facility-level staff is essential to allow electronic data collection and reporting, and real-time data availability on the e-Tracker.
2. Document hardware specifications at national and subnational levels.

Furthermore, to reach an established level, the specific recommendations are to:

1. Document and follow hardware specifications in procurement at all levels.

2. Develop an inbuilt standard dashboard at different health system levels in the DHIMS2 to facilitate data use for action.

It should also be noted that, although not directly related to hardware for data use purposes nor a direct response to one of the 44 prompts in the D2AC instrument—rather, as a result of group discussions on facility-level equipment that contributes to more timely and reliable TB data—participants stressed the importance of facilities having adequate TB detection and screening equipment, including GeneXpert and digital x-ray machines.

For **D5S2 (Network and connectivity, score of 1.50)**, the requirement to go from a nascent to a defined level on the D2AC is the following:

1. Network and Internet connection exist at the national level and about half of subnational offices have a reliable network and Internet connection.

Furthermore, the requirement to go from a defined to an established level on the D2AC is the following:

1. Adequate dedicated network and Internet connectivity exist at national- and subnational-level sites.

To reach a defined level, the specific recommendation is to:

1. Ensure that the NTP national office has a network and Internet connection and about half of subnational offices have a reliable network and Internet connection. In the longer term, Internet connectivity is a crucial aspect of ICT to which to dedicate resources to allow electronic data collection and reporting, and real-time data availability on the e-Tracker.

Furthermore, to reach an established level, the specific recommendation is to:

1. Establish an adequate dedicated network and Internet connectivity at national and subnational levels to operate the TB HIS.

For **D5S3 (ICT business infrastructure, score of 2.17)**, the requirement to go from a defined to an established level on the D2AC is the following:

1. An ICT operations and maintenance plan is being implemented at the national level.

To reach an established level, the specific recommendation is to:

1. Implement an ICT operations and maintenance plan at the national level.

Conclusion

Despite progress toward ending TB worldwide, combating TB remains a high priority in Ghana, especially in the COVID-19 era where TB case notification, screening, and contact tracing—all three imperative to contain the epidemic and strive to eliminate TB—are being severely impacted. The D2AC assessment in Ghana highlighted both the high-performing elements of the NTP's data use capabilities and the challenges that should be addressed to improve evidence-based decision making. The assessment revealed good performance in certain dimensions of the D2AC, such as leadership and coordination, MEL, and data reporting, access, and sharing. However, it also revealed important gaps, such as the availability of hardware at subnational levels, the reliability of network and connectivity, and ICT business infrastructure. These findings provide evidence of the areas needing programmatic interventions, and can also inform policymakers, donors, and program managers who want to design and implement responsive programs and interventions to strengthen and improve data use capabilities for evidence-based decision making to provide targeted and informed high-quality services for all TB patients and their families.

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Appendix A. D2AC Ghana Workshop Agenda

Wednesday, March 16, 2022 D2AC Assessment Workshop Day 1 Location: Movenpick Hotel, Accra		
Time	**Description**	**Participants**
8:15–8:45	Registration and morning tea	
8:45–9:30	Welcome and introductions Opening address	TB DIAH D2AC team* Zeleke Alebachew Wagaw Dr. Yaw Adusi-Poku
9:30–10:00	Workshop Overview	TB DIAH D2AC team
10:00–10:15	Break	
10:15–11:15	Introducing the D2AC assessment approach and toolkit	TB DIAH D2AC team
11:15–1:00	Step 1: Individual review of D2AC Toolkit	All (individually)
1:00–1:45	Lunch	
1:45–2:30	Step 2: Group work (building on individual review information)	All (in groups)
2:30–2:45	Tea break	
2:45–4:00	Step 2: Group work (building on individual review information)	All
4:00–5:00	Step 3: Plenary discussion on group work	All
Thursday, March 17, 2022 D2AC Assessment Workshop Day 2 Location: Movenpick Hotel, Accra		
Time	**Description**	**Participants**
8:15–8:45	Morning tea	
8:45–9:00	Step 4: Welcome, day one recap and overview of day two	TB DIAH D2AC team*
9:00–10:30	Step 5: Presentation of aggregate assessment data	Group leads
10:30–10:45	Break	
10:45–1:00	Step 6: Plenary discussion and finalization of findings	All
1:00–1:45	Lunch	
1:45–2:30	Step 7: Identify priority action items	All (individually)
2:30–2:45	Tea break	
2:45–4:45	Step 8: Draft implementation plan for priority action items	All (in groups)
4:45–5:00	Step 9: Discuss implementation plan and next steps	All

***TB DIAH D2AC team**: David Boone, Jeanne Chauffour, Meredith Silver

Appendix B. D2AC Ghana Workshop Participants

Table B1. Workshop participant list

Names of participants appear in alphabetical order by last name.

Name	Affiliation	Role
Farida Njelba Abdulai	Ghana Health Service, Greater Accra Region	Regional TB Coordinator
Yaw Adusi-Poku	National TB Control Programme	Programme Manager
Richard Socrate Adzesi	Ghana National TB Voice Network	M&E Officer
Felix Kwami Afutu	National TB Control Programme	Head, M&E Unit
Gifty Amugi	Ghana Health Service, Western Region	Deputy Director, Public Health
Emmanuel Rex Annan	Ghana Health Service, Mamprobi Hospital	Medical Officer
Paulina Clara Appiah	Ghana Health Service, Bono East Region	Deputy Director, Public Health
Jemima Appiah-Pippim	Ghana Health Service, Mamprobi Hospital	Pharmacist
Isaac Opoku Asamoah	Ghana Health Service, Greater Accra Regional Health Directorate	Disease Control Officer
Solomon Awah	National TB Control Programme	Pharmacist
Dziedzom Awalime	Aurum Institute Ghana	M&E Manager
Akosua Sika Ayisi	Ghana Health Service, Greater Accra Region	Deputy Director, Public Health
Susuana Bruce	National TB Control Programme	Logistics Focal Person
Reuben Dzotefe	Ghana Health Service, Mamprobi Hospital	Technical Officer (Biostatistics)
Uriah Scott Essilfie	National TB Control Programme	Pharmacist
Rita Patricia Frimpong Amenyo	National TB Control Programme	Deputy Programme Manager
Raymond Gockah	National TB Control Programme	M&E Specialist
Prince Kwadwo Gyasi	National TB Control Programme	M&E Technical Officer
Richard Kutame	Ghana Health Service, National Public Health and Reference Lab	Deputy Head/Quality Manager

Name	Affiliation	Role
Seth Makario	Ghana Health Service, Mamprobi Hospital	Health Information Officer
Eric Mensah	Christian Health Association of Ghana	Project M&E Officer
Emmanuel Owusu	Stop TB Partnership Ghana	M&E Officer
Stella Quarshie	Ghana Health Service, Ablekuma Central District Hospital	Nursing/TB Coordinator
Grace Phyllis Quaye	National TB Control Programme	Pharmacy Resident
Razak Sarkodie	Ghana Health Service, Greater Accra Regional Health Directorate	Regional M&E Officer
Felix Sorvor	National TB Control Programme	Lab Focal Person

Table B2. Workshop participant characteristics

Participant information			Percentage and count
Gender		Men	65% (n=17)
		Women	35% (n=9)
Level	Central	NTP	38% (n=10)
		Other government	-
		Partners	15% (n=4)
		All (subtotal)	53% (n=14)
	Regional		23% (n=6)
	District		8% (n=2)
	Health facility		8% (n=2)
	Community		8% (n=2)
Roles affiliated with USAID TB pillars		Reach	25% *
		Cure	22.5% *
		Prevent	22.5% *
		Sustain	30% *
Years of work experience		0–5	23% (n=6)
		5–10	35% (n=9)
		10–15	23% (n=6)
		15–20	8% (n=2)
		20+	4% (n=1)
		Unknown	8% (n=2)
Individual instrument responses			100% (n=26)
Participated in group instrument			100% (n=26)

* No *n* is provided here because participants were able to identify with more than one pillar (and up to all four pillars), so the percentages illustrate representativeness of each pillar.

Appendix C. D2AC Toolkit Ghana Country Profile

Demographic, Geographic, and Socioeconomic Features		Response	Year	Source
Demographic				
Area/size of the country (km^2)		227,540 sq. km	N/A	
Notable borders		Togo, Côte d'Ivoire, Burkina Faso	N/A	
Estimation of population size		31 million	2020	World Bank Data[1]
Administrative structure				
Regions/provinces/states (#)		16 regions	2018	N/A
Districts/councils/counties (#)		216 districts	2018	N/A
Service delivery sites	Facility-based (#)			
	Community-based (#)			
Socioeconomic features				
United Nations classification		Lower-middle income	N/A	
Population below the poverty line		25.50%	2020	World Bank[2]
	Rural (%)	64.60%	2020	Ghana United Nations Development Programme (UNDP)[3]
	Urban (%)	27%	2020	Ghana UNDP[3]
Major revenue sources		gold, cocoa, sawn wood	2020	Britannica[4]
TB Epidemiologic Burden and Trends		**Response**	**Year**	**Source**
TB mortality rate		34 per 100,000	2019	CDC Ghana Country Profile[5]
TB incidence		44,000 (143 per 100,000)	2020	WHO Ghana TB Profile[6]
TB case notification rate		12,922	2020	WHO Ghana TB Profile[6]
TB treatment coverage		29%	2020	WHO Ghana TB Profile[6]
TB treatment success rate		84%	2019	World Bank Data[7]
MDR/RR-TB incidence		211	2020	WHO Ghana TB Profile[6]
MDR/RR-TB treatment enrollment rate		200	2020	WHO Ghana TB Profile[6]
XDR-TB incidence		1	2020	WHO Ghana TB Profile[6]
HIV coinfection rate		8,100 (26 per 100,000)	2020	WHO Ghana TB Profile[6]
TPT coverage		38,826	2021	WHO Global TB Report Data[8]
WHO impact indicators				
Reduction in TB incidence rate (compared with 2015)		160 (2015); 143 (2020) 17 per 100,000 reduction	2020	World Bank Data[9]

	Reduction in TB deaths (compared with 2015)	16,000 (2015), 15,000 (2020) 1,000 reduction	2021	WHO Global TB Report Data[8]
	TB-affected families facing catastrophic costs dues to TB (%)	64%	2021	Global Fund CCM Ghana Profile[10]
NTP Laboratory and Workforce Capacity		**Response**	**Year**	**Source**
Laboratory centers (#)				
	Total number of laboratories conducting TB diagnosis (#)	44	2020	Journal Article: Trends of tuberculosis case detection, mortality and co-infection with HIV in Ghana: A retrospective cohort study[11]
	Microscopy centers	300	2014	WHO Global TB Report Data[8]
	GeneXpert sites	13	2014	WHO Global TB Report Data[8]
	Culture laboratories	5	2020	WHO Global TB Report Data[8]
	Reference laboratories	163	2006	USAID Assessment of the Ghana Laboratory Logistics System and Services[12]
	Does a lab referral network exist? (Yes/No)	Yes	2021	WHO Global TB Report Data[8]
Human resources				
	NTP staff supported by government (#)			
	NTP M&E staff supported by government (#)			
	Resources allocated toward M&E or TB M&E ($)	3,955,000	2020	MOH, National Tuberculosis Health Sector Strategic Plan for Ghana 2015–2020[13]
	TB/HIV officers recruited under partner's support absorbed into payroll (%)			
TB Health Financing		**Response**	**Year**	**Source**
WHO recommended level for the country		20.2 million USD needed as of 2020 to fill the gap in TB funding	2020	STOP TB Partnership Ghana Dashboard[14]
TB treatment is free (Yes/No)		Yes	N/A	
People eligible for exemptions who receive those exemptions (%)		N/A		
Proportion of population with TB who received social protection under the national health insurance scheme (%)		29%	2020	WHO Ghana TB Profile[6]
Health budget allocated to TB services		8 million	2020	WHO Ghana TB Profile[6]
Proportion of annual TB budget funded by donors (%)		67%	2020	WHO Ghana TB Profile[6]

Proportion of domestic TB financing (%)	13%	2020	WHO Ghana TB Profile[6]
Proportion of cases that led to catastrophic costs due to TB (%)	64%	2020	WHO Ghana TB Profile[10]
Research and Development	**Response**	**Year**	**Source**
National TB budget allocated to research	24,000 USD	2020	MOH, National Tuberculosis Health Sector Strategic Plan for Ghana 2015–2020[13]
Surveys and research being conducted (e.g., prevalence surveys). Please provide name, year, and implementing/financing entity.			

[1] https://data.worldbank.org/indicator/SP.POP.TOTL?locations=GH

[2] https://www.worldbank.org/en/country/ghana/overview#1

[3] https://www.gh.undp.org/content/ghana/en/home/presscenter/pressreleases/2020/new-data-looking-at-poverty-in-different-dimensions-in-ghana-sho.html

[4] https://www.britannica.com/place/Ghana/Economy

[5] https://www.cdc.gov/globalhivtb/where-we-work/region/westafrica/ghana/ghana.html#:~:text=Country%20Overview&text=CDC%20continues%20to%20work%20with,treatment%20to%20viral%20load%20suppression.

[6] https://worldhealthorg.shinyapps.io/tb_profiles/?_inputs_&entity_type=%22country%22&lan=%22EN%22&iso2=%22GH%22

[7] https://data.worldbank.org/indicator/SH.TBS.CURE.ZS?locations=GH

[8] https://www.who.int/teams/global-tuberculosis-programme/data

[9] https://data.worldbank.org/indicator/SH.TBS.INCD?locations=GH

[10] https://www.ccmghana.net/index.php/9-content/91-catastrophic-cost-faced-by-tb-patients

[11] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7313972/

[12] https://pdf.usaid.gov/pdf_docs/Pnadi974.pdf

[13] https://www.ccmghana.net/images/PRs/NTP/TB-health-sector-plan-2015-2020.compressed.pdf

[14] https://www.stoptb.org/static_pages/GHA_Dashboard.html

Appendix D. D2AC Toolkit Glossary

Term	Definition
ad hoc	Arranged or happening when necessary and not planned in advance.
aggregate data	Compilation of individual data systems and data that could result in the totality of the information being classified and stratified at a higher level.
algorithm	A process or a set of rules to be followed in calculations or other problem-solving operations, especially by a computer; a common term used to show decision trees for diagnostic or treatment procedures (e.g., treatment algorithm; diagnostic algorithm).
aligned	The fit between the data flow and data collection or program goals and data analysis and data collection.
analytics	The process of discovering, interpreting, and communicating significant patterns in data.
capacity building	Capacity building focuses on strengthening the skills and knowledge of personnel, the management and governance of a program or project, and organizational infrastructure.
cascade analysis	Cascades are frameworks for monitoring gaps in program services needed to achieve goals and health outcomes.
case-based data	Patient-level data for a series of key or sentinel (reportable) events, used to measure and monitor the incidence, progression, and outcome of a disease.
central data repository	A centralized place to store and maintain data.
client	An individual who is a potential or current user of health services; may also be referred to as a patient or beneficiary.
commodities	A raw material that can be bought and sold.
communication strategy	An outlined method used for exchanging information that can be visual, verbal, or in written form. A plan to achieve communications objectives internal or external.
data	A reinterpretable representation of information in a formalized manner suitable for communication, interpretation, or processing (e.g., a sequence of bits, a table of numbers, the characters on a page, and the recording of sounds made by a person speaking).
data analysis	The examination of acquired data for its significance and probative value to the case.
data audit	A guided inspection of an organization's health data registries and forms, typically by an independent body.
data collection system	A computer application that facilitates the process of data collection, allowing specific, structured information to be gathered in a systematic fashion, subsequently enabling data analysis to be performed on the information.
data element	A basic unit of information that has a unique meaning and subcategories (data items) of distinct value (e.g., gender, race, and geographic location).
data exchange	The process of taking data structured under a source schema and transforming it into a target schema, so that the target data are an accurate representation of the source data. Data exchange allows data to be shared between different computer programs.
data governance	A set of processes that ensures that data assets are formally managed throughout the healthcare system. A data governance model establishes authority, management, and decision-making parameters related to the data produced or managed by the healthcare system.

Term	Definition
data quality parameters	Dimensions used to examine, evaluate, and improve data quality— they include accuracy (are the data collected and reported in a manner by which the data are to be trusted because they are a reflection of the reality, [i.e., there are no omissions or duplicates]?), timeliness (are the data collected, cleaned, reviewed, or reported according to issued protocol and guidance?), completeness (are the data submitted complete, and are all the variables and indicator data fields properly filled out?), among others.
data quality reviews	A process whereby data and associated data files are assessed and required actions are taken to ensure that files are independently understandable for informed reuse. This is an active process involving a review of the files, documentation, the data, and the code.
data reporting tools	The paper and electronic tools used to transfer collected or received data to a higher level in an organized, streamlined, and consistent manner.
data source	The location from which the data being used originates and can include primary, secondary, and tertiary data sources.
data use	Instances where data are currently reviewed, updated, processed, erased, accessed, or ready to inform a recommendation for action in strategic planning, policymaking, program planning and management, advocacy, or delivering services.
decision making	The selection of a course of action from among two or more possible alternatives to arrive at a solution for a given problem.
decision support tools	Electronic applications to assist decision makers (e.g., clinicians, policymakers) by providing evidence-based knowledge in the context of clinical decision making (e.g., drug interaction alerts at the time a medication is prescribed and reminders for specific guideline-based interventions during the care of patients with chronic disease) or policy/program decision making (e.g., providing alternative policy decisions based on resource efficiency and health outcomes).
descriptive analysis	Statistical techniques used to summarize and describe a data set, and also the statistics measures used in such summaries.
disaggregate data	Breaking down of data into smaller groupings, often based on such characteristics as sex, income, or racial/ethnic group.
exchange standards	Refers to the exchange of information according to a set of standards. Standards are agreed on methods for connecting systems together and may pertain to security, data transport, data format or structure, or the meaning of codes or terms.
evaluation	The systematic assessment of an ongoing or completed intervention to determine whether the intervention is fulfilling its objectives and to demonstrate an effect on health outcomes.
function	The functionality of a system is how well the system works when examining it against relevant documents that describe the conceptual design of the system(s).
guideline	A general rule, principal, or piece of advice.
health information system (HIS)	The HIS provides the underpinnings for decision making and has four key functions: data generation, compilation, analysis and synthesis, and communication and use. The HIS collects data from the health sector and other relevant sectors, analyzes the data, ensures their overall quality, relevance, and timeliness, and converts data into information for health-related decision making.
indicator	A quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement.
information and communications technology (ICT)	The means employed to provide access to information through Internet, wireless networks, cell phones, and other communication media.

Term	Definition
information products	Data that has been compiled, managed, and analyzed becoming evidence that can be used by decision makers.
in-service training program	Training concurrent to official responsibilities for improving professional qualifications or skills. Can be compulsory related to official professional development activities to maintain or upgrade professional qualifications or it can be optional for the sole purpose of improving skills.
in source documents	Documents from which data were originally collected (i.e., facility registers and tally sheets).
integration	The inter-connectivity requirements needed for two applications to securely communicate data to and receive data from another.
inventory	An itemized list of current information system/digital assets.
master facility list	A standard mechanism for uniquely identifying health facilities, which allows for information to be compared across time and across data sources for individual facilities.
mandate	An official order or commission to do something.
monitoring	The process of collecting and analyzing routinely collected data to compare how well an intervention is being implemented against expected results and measure changes in performance over time.
monitoring and evaluation plan	Describes and manages the process of assessing and reporting progress toward achieving project outputs and outcomes, and to identify what evaluation questions will be addressed through evaluation.
national health management system (HMIS)	A system whereby health data are recorded, stored, retrieved, and processed to improve decision making.
operational/ operationalized	In use or ready for use/put into use.
points of service	Of, relating to, or being a healthcare insurance plan that allows enrollees to seek care from a physician affiliated with the service provider at a fixed co-payment or to choose a nonaffiliated physician and pay more.
policy	A course or principal of action adopted or proposed by a government, party, business, or individual/a definite course or method of action selected from among alternatives and in light of given conditions to guide and determine present and future decisions.
pre-service training program	Recognized and organized programs designed to train future professionals to formally enter the profession at a specified level of education.
procedures	An established or official way of doing something.
process	Services that the program provides to accomplish its objectives, such as outreach activities, curriculum development, materials developed, counseling sessions, workshops, and training events.
real-time data entry	Data that are not kept or stored, but are passed along/delivered to the end user immediately after being collected.
requirements (for data analysis and visualization)	Necessary components for bringing order and structure to collected data and putting data into a chart, graph, or other visual format that helps inform analysis and interpretation.
retrospective (data entry)	Data recorded, or the process of recording data, later than the period or moment at which they should have been recorded (e.g., updating patient charts or registers days after the patient visit,

Term	Definition
	when guidance instructs to update the charts and registers immediately following the patient visit).
scenario	A set of simple statements that summarize what the end-user needs the digital health intervention to do.
standard operating procedures (SOPs)	A set of descriptive directions that ensure the correct development of specific activities and processes.
stakeholder	Any person or party with an interest in the financing, implementation, or outcome of a service, practice, process, or decision made by another (e.g., healthcare, health policies).
standardize	Standardized measures are nationally recognized criteria for evaluating the quality of healthcare provided to patients. These measures are endorsed or developed by organizations, specialty medical boards, national accreditors, or government agencies.
standardized electronic data collection tools	A streamlined ensemble of digital data collection tools meant to be used in a consistent manner across a territory or system, as opposed to ad hoc or misaligned systems that make data difficult to compare or combine.
standards	Accepted methods or models of practice; they may be formally approved or de facto standards.
supportive supervision	A process of helping staff improve their own work performance continuously, carried out in a respectful and non-authoritarian way with a focus on using supervisory visits as an opportunity to improve knowledge and skills of health staff and provide feedback.
synthesize (data)	A process of combining data into a coherent whole with the aim of drawing conclusions.
TB service delivery workflows (or just workflows)	A repeatable pattern of activity that can be organized with adequate resources, defined roles, and information and feed into a process that can be documented and learned.
unique identification	An identifier that is guaranteed to be unique among all identifiers; a long-lasting reference that allows for continued access to a digital object for a specific purpose.
visualization (data)	The representation of data in charts, infographics, video graphics, and dashboards or other images.

Appendix E. D2AC Field Test Data Collection Instrument

The highlighted sentences correspond to the average group response.

Domain 1	Data collection and reporting
Subdomain (D1S1)	**Data collection tools and workflows**
Definition	The tools/devices/instruments and processes used for the ongoing systematic data collection to support analysis, interpretation, and sharing of data according to the National TB Program (NTP) guidelines for TB treatment, prevention, and control.
1. To what extent are standardized electronic data collection tools used?	
1	Non-standardized paper-based tools are the primary tools for data collection at all levels.
2	Standardized paper-based data collection tools are the primary tools for data collection at all levels.
3	Standalone standardized electronic data collection tools are often used, including for retrospective data entry, at higher levels.
4	Standardized electronic data collection tools are used at all levels and integrated with the national health management information system (HMIS) data collection system.
5	National HMIS data collection system is used for real-time data entry.
2. Do you have an inventory of TB data collection systems (clinical, lab, commodities, training)?	
1	There is an ad hoc list of TB data collection system.
2	A list of all the TB data collection systems exists but information about its data and users is limited to the national level.
3	A complete inventory of all the TB data collection systems, its data, and target users is available with the NTP.
4	The inventory information is used to inform the need for a new TB data collection system.
5	TB data collection system inventory is routinely updated to add information about a new TB data collection system.
3. To what extent are data collection processes aligned with TB service delivery guidance?	
1	Data collection is ad hoc or mainly driven by donor or external stakeholder mandate for data collection.
2	Some data collection processes align with service delivery guidance.
3	Data collection processes are aligned with the TB service delivery guidance.
4	Data collection processes are monitored and assessed to check alignment with the service delivery guidance.
5	Data collection process monitoring and assessment findings guide revisions and updates.
4. To what extent is unique identification used for TB cases?	
1	Unique identification is absent or rarely used to identify TB cases.
2	Some TB program sites use their own unique identifiers to identify TB cases.
3	The NTP uses unique identifiers for TB cases across program sites.
4	Unique identifiers for TB cases are aligned with the national unique (person or patient) identifiers.
5	The NTP ensures use of unique identifiers to track and treat TB cases across all TB sites (program, testing, pharmacy).

5. To what extent is the NTP site list standardized and in what format is it?	
1	The NTP site list is absent or only includes site names.
2	The NTP has an electronic site list but it is incomplete.
3	The NTP has a web-based site list (similar to a master facility list) that is complete.
4	The NTP web-based site list is integrated into the master facility list.
5	The NTP web-based site list is routinely reviewed and updated together with the national master facility list.
6. How is data disaggregation (e.g., by sex or age, treatment/retreatment, drug-resistant/drug susceptible) addressed in data collection?	
1	Data are rarely or inadequately disaggregated in the site level data collection.
2	Data collection tools (paper or digital) and processes allow disaggregation of data but disaggregate data are not collected.
3	NTP guidance require collection of disaggregate data.
4	NTP monitoring and review assesses quality of disaggregated data collection.
5	The NTP routinely reviews and updates disaggregate data collection requirement in the monitoring and evaluation (M&E) plan.

Domain 1	**Data collection and reporting**
Subdomain (D1S2)	**Reporting**
Definition	The tools/devices/instruments and processes used for the ongoing systematic data reporting to support analysis, interpretation, and sharing of data according to the NTP guidelines for TB treatment, prevention, and control.
7. To what extent are standardized electronic data reporting tools used?	
1	Non-standardized paper-based tools are the primary tools for reporting at all levels.
2	Standardized paper-based reporting tools are used at all levels.
3	Standalone standardized electronic data reporting tools are used at national and district levels for aggregate data reporting, at higher levels.
4	Standardized electronic data reporting tools are used at all levels and integrated into the national HMIS.
5	Standardized real time case-based electronic data reporting tools are used.
8. How is data disaggregation (e.g., by sex or age, treatment/retreatment, drug-resistant/drug susceptible) addressed in reporting?	
1	Data are rarely or inadequately disaggregated in the site level reporting.
2	Data reporting tools (paper or digital) and processes allow disaggregation of data but data are incomplete or rarely collected.
3	NTP guidance require reporting of disaggregate data.
4	NTP monitoring and review assesses quality of disaggregated data reporting.
5	The NTP routinely reviews and updates disaggregate data reporting requirement in the M&E plan.

9. To what extent are data reporting processes aligned with TB service delivery guidance?	
1	Data reporting is ad hoc or mainly driven by donor or external stakeholder mandate for reporting.
2	Some data reporting processes align with TB service delivery guidance.
3	Data reporting processes are aligned with the TB service delivery guidance.
4	Data reporting processes are monitored and assessed to check alignment with TB service delivery guidance.
5	Routine NTP guidance revision/update guides revision of data reporting processes.

Domain 1	**Data collection and reporting**
Subdomain (D1S3)	**Data quality**
Definition	The accuracy, completeness, timeliness, consistency, reliability, and integrity of data.
10. To what extent are data quality parameters (e.g., accuracy, completeness, etc.) defined and applied?	
1	Data quality is defined and measured in an ad hoc manner.
2	Data quality parameters are clearly defined and documented by NTP.
3	Data are generally complete, consistent, and accurate for priority data elements for at least the last 12 months.
4	Data quality problems are documented and factored in data analysis to be comparable across sources and time.
5	High quality data is available for at least the priority data elements for at least the last 5 years.
11. For what reason and how frequently are data quality reviews and audits conducted?	
1	Data quality is not checked or ad hoc and non-standardized data quality assessments are conducted.
2	Application of standard data quality tool is limited to donor-funded programs.
3	The NTP conducts routine data quality reviews both in source documents at the facility and for the reported data.
4	Data quality parameters are integrated into program review and management.
5	The NTP uses data quality assessment findings to improve the data and capacity to collect and report good quality data.

Domain 2	Data analysis and use
Subdomain (D2S1)	**Data integration and exchange**
Definition	The mechanism for transforming and integrating data from multiple sources into a target destination environment; can also refer to the activities of matching, merging, and deleting records within a single data store.
12. To what extent has a central data repository been developed?	
1	The NTP lacks central data repository(ies) (e.g., a national reporting system, a TB case report repository) where TB case report data are analyzed/reported to (at case or aggregate level).
2	The system requirements for a central data repository are documented but not implemented.
3	An electronic central data repository collates aggregate program data only at national level.
4	A standard-based central data repository collates data from all the TB data collection systems.
5	The central data repository is routinely used by NTP stakeholders to address program data analytics and visualization needs.
13. To what extent are there data exchange processes between systems at points of service for TB cases and reporting and/or central repositories currently in place?	
1	Data exchange processes are missing or are limited and require manual intervention.
2	There is some data exchange at the national level but limited automated exchange.
3	Data exchange occurs extensively on a national level and is mostly automated.
4	All data exchange is automated with adequate budgetary resources in the program to meet custom requirements.
5	All data exchanges are automated, resourced, and no specialized engineering efforts or expertise is needed to meet new requirements.
14. To what extent are there data exchange processes between systems at points of service for laboratory testing and reporting and/or central repositories currently in place?	
1	Data exchange processes are missing or are limited and require manual intervention.
2	There is some data exchange at the national level but limited automated exchange.
3	Data exchange occurs extensively on a national level and is mostly automated.
4	All data exchange is automated and integrated with the national health data exchange (if it exists).
5	All data exchanges are automated, integrated, and no specialized engineering efforts or expertise are needed to meet new requirements.
15. To what extent are exchange standards (interoperability and/or health data standards, e.g., XML, JSON, LOINC, FHIR) integrated into the data exchange implementation?	
1	No defined technical standards exist for use in the TB data management and exchange but may exist for other diseases or HIS activities.
2	The country has adopted and/or developed standards for TB data management and exchange, but standards may be localized to specific projects.
3	Standards for TB data management and exchange are approved and require certification of new exchange partners for compliance.
4	The national TB data management and exchange standards are integrated in the national HIS and/or health plan.
5	TB data management and exchange standards are tracked, monitored, and reviewed through a standardized process.

Domain 2	Data analysis and use
Subdomain (D2S2)	**Analytics and visualization**
Definition	The use of analytics and visualization techniques/tools to provide new insights and patterns from data analysis to stakeholders at different levels to enhance health and healthcare decision making.
16. To what extent are users able to conduct analysis and develop visualization?	
1	Basic or no knowledge/skill exists to conduct analysis and develop visualization.
2	NTP staff can conduct descriptive analysis and generate some visualization (tables, graphs, charts, etc.) to make comparisons and evaluate trends.
3	NTP staff are able to conduct advanced analysis (e.g., cascade analysis) and develop visualization in real-time mostly at the national level.
4	NTP staff at national, subnational, and facility levels are able to conduct advanced analysis (e.g., cascade analysis) and develop visualization in real-time (e.g., for identifying causes of poor performance, implementation problems, and monitor and forecast services/commodities demand) as part of the M&E activities.
5	NTP staff can develop customized analytics and visualization using the central data repository (e.g., to monitor stock availability and forecast demand at all levels).
17. To what extent are analytics and visualization requirements documented?	
1	Data analysis and visualization requirements/needs are missing or ad hoc.
2	Data analysis and visualization requirements/needs are documented to support NTP decision making.
3	The NTP has identified and documented a minimum set of standard data analyses and visualizations requirements/needs at all levels.
4	The NTP's analytics and visualization requirements are monitored and budgeted in the NTP plan.
5	The NTP routinely updates analytic and visualization needs using monitoring data.
18. To what extent are data sources used?	
1	Decision making is informal or only one data source is used for decision making.
2	Some guidance is available that explains how multiple data sources support decision making.
3	Decision making is focused only on program resources and/or patient data reports and summaries. Some decision support tools exist locally or for specific implementations.
4	Program staff routinely make decisions with data incorporated from multiple sources (e.g., to provide scenario-based, health-system level specific decision making support, and predict the impact of decisions and policy).
5	Advanced models, used for decision making, incorporate multiple data sources (including the central data repository) to optimize and influence TB health outcomes.
19. To what extent are decision support tools used?	
1	The need for decision support tools has yet to be identified.
2	Decision support tools need is documented and exist locally or for specific implementations.
3	Decision support tools are automated to use the knowledge base for contextually-relevant reference information.
4	Assessments to ensure the knowledge relevance, value, and accuracy of decision support algorithms are conducted on a regular schedule.
5	Assessment findings are used for continuous improvement of decision support algorithms (in terms of relevance of information and accuracy).

Domain 2	Data analysis and use
Subdomain (D2S3)	**Dissemination and communication**
Definition	The analyzed data are synthesized and can be shared in appropriate visualizations, understood, and used by the target audience.
20. To what extent is a communication strategy in place?	
1	Communication is informal and lacks documented communication strategy.
2	A documented national communications strategy is in place but not operationalized.
3	An approved communication strategy is being implemented but confined to the national level.
4	Implementation monitoring and assessment are routinely conducted to gauge the effectiveness of the communication strategy as part of the NTP review.
5	A communication strategy and its implementation are adjusted based on the assessment findings.
21. To what extent are information products developed and subsequently disseminated?	
1	Development and sharing of information products are ad hoc or driven by specific program needs.
2	Dissemination of information products is typically limited to senior-level decision makers.
3	Targeted information products are disseminated in multiple formats (print, digital) using electronic and web-based platforms at higher levels.
4	Information products are routinely produced and distributed to stakeholders at all levels of the health system is monitored and evaluated.
5	Information product dissemination is improved using monitoring and evaluation data.

Domain 3	Leadership, Governance, and Accountability
Subdomain (D3S1)	**Data use guidance**
Definition	The process, procedures, and actions of an organization associated with collection and sharing of their data.
22. Does the NTP have a data use guidance?	
1	The need for policies that govern data use at health system levels has been identified but no such guidance exists.
2	The NTP uses data use guidance to manage its data use activities at various levels.
3	The NTP has an approved and comprehensive data use guidance implemented at all health system levels to support data use for decision making.
4	Implementation of data use guidance is monitored and assessed by the national governing/leadership body.
5	The NTP's data use guidance is annually reviewed and updated using the monitoring data.

Domain 3	Leadership, Governance, and Accountability
Subdomain (D3S2)	**Data access and sharing**
Definition	The disclosure of data from one or more organizations to another organization(s), or the sending of data between different parts of a single organization. This can take the form of routine data sharing, where the same data sets are shared between the same organizations for an on-going established purpose and exceptional, one-off decisions to share data for a specific purpose or shared with external stakeholders.
23. What is the data access and sharing status within NTP and with external stakeholders?	
1	The NTP lacks a data sharing mechanism.
2	Data access and sharing processes and methods are mostly documented but data are shared mainly through email.
3	Access-based control and data sharing agreements are established to allow access to and sharing of NTP data within and outside the NTP.
4	Access-based control and data sharing agreement implementation is monitored to ensure compliance with data use guidance/policy.
5	The NTP uses monitoring data to support access to and sharing of data with all relevant stakeholders (e.g., NTP, external stakeholders).

Domain 3	Leadership, Governance, and Accountability
Subdomain (D3S3)	**Organizational structure and function**
Definition	The organizational structures and processes, including job titles and clear descriptions of duties and responsibilities with a focus on data management, data quality, data governance, data analytics, data integration, and exchange.
24. To what extent are data use roles and responsibilities documented for NTP staff?	
1	Job descriptions are absent or lack data use roles and responsibilities.
2	Job descriptions clearly document data use roles and responsibilities but only at the national level.
3	NTP staff at all levels have access to their written role and responsibilities related to data use.
4	Supervisor(s) regularly review staff data use roles using the job description to offer constructive feedback.
5	Supervisor(s) follow NTP guidelines to review and update data use roles and responsibilities of staff.

Domain 3	Leadership, Governance, and Accountability
Subdomain (D3S4)	**Leadership and coordination**
Definition	The exercise of technical, political, and administrative authority to manage the NTP at all levels of a country's health system. The leadership and coordination structure consists of the mechanisms, processes, and institutions through which actors and stakeholders (both internal and external) articulate their interests, exercise their rights, meet their obligations, mediate their differences, and oversee the performance of the NTP.
25. To what extent is the interagency leadership and coordination team (including internal and external stakeholders) structure developed?	
1	The leadership and coordination team structure is informal or ad hoc.
2	Some formal leadership and coordination team structure with a clearly defined scope of work exists.
3	A formal leadership and coordination team is managing implementation of the data use policy and data access and sharing guidance with attention to gender and equity.
4	A formal leadership and coordination team is an integral part of the NTP review and assessment process.
5	The formal leadership and coordination team facilitates an annual review of TB data use activities at all levels of the health system and decisions are evident in the updated program/guidance documents.
26. To what extent is the leadership and coordination team effective?	
1	An informal leadership and coordination team meets at the national level.
2	Meetings are held periodically among individual health system levels, but there is no standard operating procedure (SOP) related to meeting management.
3	Leadership and coordination team meetings occur on a periodic, regular schedule across the health system levels with SOPs to follow related to meeting management.
4	The monitoring, evaluation, and learning (MEL) team monitors and assesses ability of leadership and coordination team to lead and coordinate regularly scheduled meetings.
5	Assessment findings are used to improve leadership and coordination team meeting outcomes.

Domain 3	Leadership, Governance, and Accountability
Subdomain (D3S5)	**Monitoring, evaluation, and learning (MEL)**
Definition	A plan supporting management of program activities and informing the organization about what activities to implement, timeline, resources, responsible party, and whether and how an activity is contributing toward stated NTP goals including equity and inclusion.
27. To what extent is the MEL plan implemented?	
1	MEL activities are informal or ad hoc.
2	An MEL guidance document exists but is only accessible at the national level.
3	An approved MEL plan with adequate budget allocation is being implemented at the national level.
4	The MEL plan implementation is monitored and reviewed as part of the program/strategy review.
5	Monitoring data are used to inform the annual review/update of the MEL plan.

28. To what extent does MEL contribute to improved health outcomes?	
1	Health outcomes are yet to be defined or lack standardized outcome parameters.
2	Some health outcomes are defined and monitored at the national level.
3	Health outcome parameters are documented and monitored at all the levels.
4	Routine health outcome assessment and evaluation is conducted to measure improvement in individual and population level health outcomes.
5	Health outcome measurement data are used to revise and prioritize program interventions.
29. To what extent are MEL processes developed?	
1	MEL processes are ad hoc.
2	MEL processes are documented but project- or intervention-focused.
3	MEL processes are documented and aligned with the data collection and reporting at all levels.
4	MEL processes are routinely reviewed as part of the NTP performance review.
5	Program performance review findings are used to routinely revise/update MEL processes.
30. To what extent does MEL support program improvement?	
1	MEL is informal and relies on individual experiences.
2	MEL data are sometimes used to monitor implementation and program performance.
3	Leadership and coordination team(s) uses MEL data at the national level for program review and course correction.
4	The MEL data are used to monitor, measure, and improve program data use at all levels.
5	The MEL data are used to continuously improve the MEL plan for achieving better program goals.

Domain 3	Leadership, Governance, and Accountability
Subdomain (D3S6)	**Financial resources**
Definition	The legal and administrative systems and procedures in place that permit a government ministry and its agencies and organizations to conduct activities that ensure the correct use of public funds and that meet defined standards of probity and regularity. Activities include management and control of public expenditures, financial accounting, reporting, and asset management (in some cases).
31. To what extent are data use activities funded in the NTP budget?	
1	Budget for data use activities is absent or ad hoc.
2	Budget for data use activities is allocated but tied with specific interventions/projects.
3	Operations of data use activities have been secured with annual budgets.
4	Budget for data use activities is monitored and reviewed during the program review process.
5	Monitoring and review findings are used to revise/update the budget allocated to data use activities.
32. How are financial resources mobilized?	
1	Availability of financial resources is ad hoc or specific to interventions.
2	Financial resource needs are documented for national level data use activities.
3	The NTP has a comprehensive financial plan that diversifies funding (resources from NTP, donors, and private sector) in place.
4	Availability and utilization of financial resources is monitored and measured by the MEL team.
5	The leadership and coordination team revises financial plan using the monitoring data to align with the national TB goals.

Domain 4	Capacity building
Subdomain (D4S1)	**Data interpretation**
Definition	The organizational structure and individual ability that enables reading, writing, and communicating data in context, including an understanding of data sources and constructs, analytical methods, and techniques applied — and the ability to describe the use case, application, and resulting value.
33. To what extent are data use forums (e.g., monthly or quarterly program review meetings) developed?	
1	Data use forums are missing or ad hoc.
2	Data use forums with terms of reference are convened, but only at the national level.
3	Data use forums with approved terms of reference are operational at all levels.
4	Performance of data use forums is monitored and assessed as part of the program performance review.
5	Monitoring and assessment findings are used to improve performance of data use forums.

34. How often are data reviewed and by whom?	
1	Data review by program staff are rare or ad hoc.
2	Program staff review data at the national level for specific program implementation.
3	Program staff routinely conduct data review at all levels using the data use forums to identify corrective action.
4	MEL staff routinely monitor and assess implementation of actions identified in the data review.
5	Monitoring and assessment data are used to continuously improve implementation of actions identified in the data review.
35. Is NTP staff receiving supportive supervision for practicing data use?	
1	NTP staff receive ad hoc supervision support for data use.
2	NTP staff receive program specific supervision and mentoring to take action on reported findings from indicators.
3	NTP staff receive supportive supervision for data use at the national level.
4	Supportive supervision is monitored to help identify technical resources NTP staff can access to meet supportive supervision needs.
5	NTP staff can mentor/coach peers on data use.

Domain 4	**Capacity building**
Subdomain (D4S2)	**Skill and knowledge development**
Definition	The availability of adequate personnel with characteristics, attributes, and capabilities to perform a task(s) pertaining to data system, data quality, data analytics, and data use to achieve clearly defined results.
36. To what extent has the NTP developed a national pre-service training program for skill and knowledge development?	
1	A national pre-service training program to impart knowledge and skills is absent or ad hoc.
2	A national pre-service training program for imparting knowledge and skills exist but only for clinical staff.
3	A national pre-service training program for all cadres of the NTP is being implemented.
4	Pre-service training programs are monitored and assessed for their effectiveness and relevance.
5	The pre-service training program is routinely updated using the monitoring and assessment data.
[IF THE ANSWER TO Q36 IS "STATEMENT 1," SKIP THIS QUESTION] **37. To what extent are institutions offering pre-service training established in the NTP guidance?**	
1	Institutions offering pre-service training are identified in an ad hoc manner.
2	Pre-service training is conducted by government and/or private training institutions.
3	A designated NTP authority oversees pre-service training programs.
4	The NTP offers opportunities and incentives to promote pre-service training of potential staff.
5	Institutions and their pre-service training offerings are identified based on the NTP strategic goals.

38. To what extent has the NTP developed an in-service training program for skill and knowledge development?	
1	A national in-service training program to impart knowledge and skills is absent or ad hoc.
2	A national in-service training program for imparting knowledge and skills exist but only for clinical staff.
3	A national in-service training program for all cadres of the NTP is being implemented.
4	In-service training programs are monitored and assessed for their effectiveness and relevance.
5	The in-service training program is routinely updated using the monitoring and assessment data.
39. To what extent are institutions (both public and private) offering in-service training established in the NTP guidance?	
1	Institutions offering in-service training are identified in an ad hoc manner.
2	In-service training is conducted by government and/or private training institutions.
3	A designated NTP authority oversees in-service training programs.
4	Training institutions offer opportunities and incentives to promote continuous education of staff at all levels.
5	Institutions and their offerings are identified based on the program review findings.
40. How effective are the in-service training programs?	
1	In-service training offerings are limited or ad hoc.
2	In-service training offerings are aligned with training needs but only at the national level.
3	Training needs assessment data are used for identification and recommending appropriate trainings.
4	Assessment of training programs is routinely conducted as part of the MEL activities to gauge skill and knowledge of trainees.
5	Training assessment data are used to improve design and delivery of targeted in-service training programs.

Domain 5	**Information and communications technology (ICT)**
Subdomain (D5S1)	**Hardware**
Definition	An assembly of tangible physical parts of a system of computers, including servers and virtual private networks (VPN), that provide services to a user in the health information ecosystem. E.g., computers, printers, connecting devices.
41. To what extent does the NTP have adequate hardware?	
1	The NTP has few computers to support it or hardware is dedicated to specific TB HIS activities.
2	Less than half of the NTP's central and subnational offices have adequate hardware.
3	Hardware needs are documented national offices have adequate hardware, including backup services.
4	Hardware needs are monitored and assessed at all levels and is conducted annually as part of the program performance review.
5	Hardware needs for the program are updated and addressed routinely through annual program planning.

42. To what extent are hardware specifications developed and budgeted?	
1	No guidance exists on the minimum hardware specifications for TB data system.
2	Hardware specifications are documented at the national and subnational levels.
3	Hardware specifications are documented and followed in procurement at all levels.
4	Hardware specifications are supported by adequate budget in the program plan.
5	Hardware specifications are routinely updated based on the program data analytics, visualization, and data exchange needs.
Domain 5	**Information and communications technology (ICT)**
Subdomain (D5S2)	**Network and connectivity**
Definition	Network is the disparate elements of a system connected in a way that data and information can be shared among all elements. Connectivity is the ability to access the data in the system.
43. To what extent does Internet and Internet connectivity exist at NTP sites?	
1	No network and Internet connectivity exists or is limited to the national level.
2	Network and Internet connection exist at the national level and about half of subnational offices have a reliable network and Internet connection.
3	Adequate dedicated network and Internet connectivity exist at the national and subnational level sites.
4	Network and Internet connectivity needs are routinely monitored and assessed to identify and address gaps to support programmatic data collection, reporting, and analysis.
5	All or almost all of the NTP national and subnational sites have reliable network and Internet connections supported by a dedicated technology support team.

Domain 5	**Information and communications technology (ICT)**
Subdomain (D5S3)	**ICT business infrastructure**
Definition	Design and planning, operations management, and technical support for information and communications technology (ICT) infrastructure maintenance.
44. To what extent has ICT infrastructure been developed?	
1	There is basic or no support for ICT or electronic systems equipment installation and maintenance related to the TB HIS.
2	There is a recognized need to standardize processes to oversee and support ICT infrastructure, but no established or harmonized process exists specific to HIS needs.
3	An ICT operations and maintenance plan is being implemented at the national level.
4	Data are collected and regularly reviewed on the ICT infrastructure operations and maintenance plan as mandated by the NTP strategic plan.
5	The ICT operations and maintenance plan is continuously reviewed and adapted based on the review data.

Appendix F. D2AC Ghana Summary Findings (Group and Individual Responses Aggregation)

Table F1. Continuum score from aggregate responses, by domain

Domain number	Domain name	Average group score (N=6)	Average individual score (N=26)	D2AC level
D1	Data Collection and Reporting	3.68	3.54	Established
D2	Data Analysis and Use	2.95	3.14	Defined/Established
D3	Leadership, Governance, and Accountability	3.78	3.31	Established
D4	Capacity Building	2.94	2.98	Defined
D5	Information and Communications Technology	1.83	2.63	Nascent/Defined
	Overall	**3.18**	**3.16**	**Established**

Table F2. Continuum score from aggregate responses, by subdomain

Subdomain number	Subdomain name	Average group score (N=6)	Average individual score (N=26)	D2AC level
D1S1	Data collection tools and workflow	3.67	3.66	Established
D1S2	Reporting	4.00	3.68	Institutionalized/Established
D1S3	Data quality	3.25	2.98	Established/Defined
D2S1	Data integration and exchange	2.92	3.17	Defined/Established
D2S2	Analytics and visualization	2.88	2.99	Defined
D2S3	Dissemination and communication	3.17	3.38	Established
D3S1	Data use guidance	2.80	2.64	Defined
D3S2	Data access and sharing	4.17	3.33	Institutionalized/Established

Subdomain number	Subdomain name	Average group score (N=6)	Average individual score (N=26)	D2AC level
D3S3	Organizational structure and function	2.50	3.06	Defined/Established
D3S4	Leadership and coordination	4.33	3.29	Institutionalized/Established
D3S5	Monitoring, evaluation, and learning	4.33	3.80	Institutionalized/Established
D3S6	Financial resources	3.08	2.81	Established/Defined
D4S1	Data interpretation	3.83	3.51	Established
D4S2	Skill and knowledge development	2.40	2.65	Defined
D5S1	Hardware	1.83	2.60	Nascent/Defined
D5S2	Network and connectivity	1.50	2.65	Nascent/Defined
D5S3	ICT business infrastructure	2.17	2.67	Defined

Appendix G. D2AC Toolkit Ghana Implementation Plan

Domain and subdomain	Priority action	Specific gap addressed	Responsible party	Resources needed	Expected deliverable	Timeline
Domain 1 subdomain 3: Data quality	Ensure that data are generally complete, consistent, and accurate for priority data elements for at least the past 12 months	1. Inconsistencies in data collecting 2. Error in data collecting 3. Incomplete data 4. Inadequate human resource 5. Skill gap	1. Data officer 2. M&E 3. NTP	1. Hardware (e.g., desktop, tablets) 2. Data collection tools (software forms) 3. Capacity building in data collecting and validation	1. Consistency in data collecting at all levels 2. Improved accuracy in data collecting 3. Availability of complete collected data 4. Adequate human resources 5. Improved staff skills in data collecting	One year
	Integrate data quality metrics in program review and as a routine feature of program management	1. Absence of data metrics 2. Data quality parameters are not integrated in program management	1. NTP Program Manager 2. Director, PPME	1. Funding2. Training 3. Data quality metrics tools	1. Availability of quality metrics data 2. Quality metrics data integrated in program management	One year
Domain 2 subdomain 1: Data integration and exchange	Develop and approve standards for TB data management and exchange that require certification of new exchange partners for compliance	1. There is no standard guideline for TB-related data exchange 2. Poor integration of existing electronic formats (e-Tracker and DHIMS) making data exchange and sharing impossible 3. Poor security and confidentiality related to data exchanges	1. Director, PPME, GHS 2. Programme Manager, NTP	1. Hardware - computers, servers 2. Capacity building 3. Internet access	1. Improved utilization of data 2. Improved data quality 3. Improved data security 4. Improved data sharing and dissemination	Within 2 years

Domain and subdomain	Priority action	Specific gap addressed	Responsible party	Resources needed	Expected deliverable	Timeline
Domain 2 subdomain 2: Analytics and visualizations	Training on advanced data analytics	Gap in knowledge and skills with respect to analyzing data to generate visuals	NTP	1. Technical expertise 2. Funding 3. Software and hardware/computers	Staff can develop customized analytics and visualizations using the central data repository	3 months
	Resolve e-Tracker synchronization issues with DHIMS2	Synchronization of e-Tracker and DHIMS2	1. PPME 2. NTP	1. Technical expertise 2. Funding 3. Software and hardware/computers/tablets	All e-Tracker data synchronized in DHIMS2	3 months
	Organize regular updates and orientation on new tools/forms	Staff are not oriented on new updates	1. PPME 2. NTP	1. Technical expertise 2. Funding 3. SOPs	Staff knowledge and skills updated	Twice in a year
Domain 4 subdomain 2: Skill and knowledge development	-	-	-	-	-	-
Domain 5 subdomain 1: Hardware	Hardware needs assessment to identify gaps and specifications	Identify and support district with no or inadequate hardware	1. PPME 2. NTP 3. Partners	1. Funding 2. Logistics (fuel, stationary, laptops, tablets, Internet connectivity, etc.) 3. Staff	Hardware needs assessment	By last week of April 2022
	Procurement of hardware based on the needs assessment conducted (computers, printers, scanners, external drives, GeneXpert machines, digital x-ray machines, GxAlert, etc.)	1. Provision of high grade computers, printers, and scanners for recording and reporting purposes 2. Upgraded and multifunctional GeneXpert machine must be provided to help with second-line TB testing and GxAlert for data transmission	1. Government of Ghana 2. Partners	Local and international technical assistance from partners	Procurement of all the required hardware by the end of the year 2022	March–December 2022

Domain and subdomain	Priority action	Specific gap addressed	Responsible party	Resources needed	Expected deliverable	Timeline
	Procure hardware to achieve a coverage of at least 60% of subnational staff	Less than half of NTP staff have hardware at the subnational level	1. Director General 2. Regional Director of Health Services 3. NTP Manager	Funding	Computers and printers made available at the subnational level	Q1 2023
	Develop nationally documented specifications and requirements for all hardware needs	Lack of documented specifications for relevant hardware at the subnational level	1. Head of IT (Ghana Health Service) 2. IT Manager (NTP)	1. Staff 2. Internet	Documented specifications	End of May, 2022
	Allocate funds for hardware procurement	No budgetary allocation for the procurement of hardware	1. Director General 2. Regional Director of Health Services 3. NTP Manager	Funding	Budget allocated for hardware procurement	July, 2022

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REPUBLIC OF GHANA