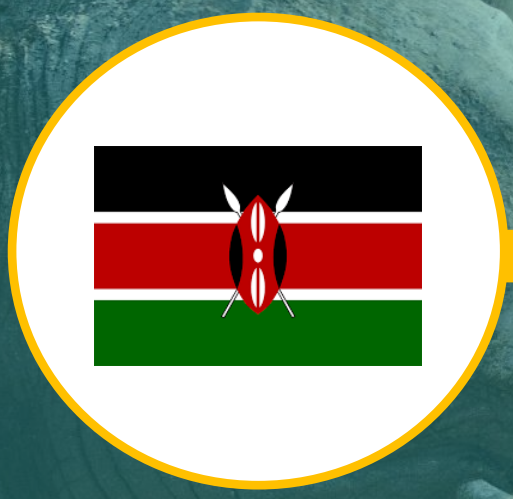


KENYA

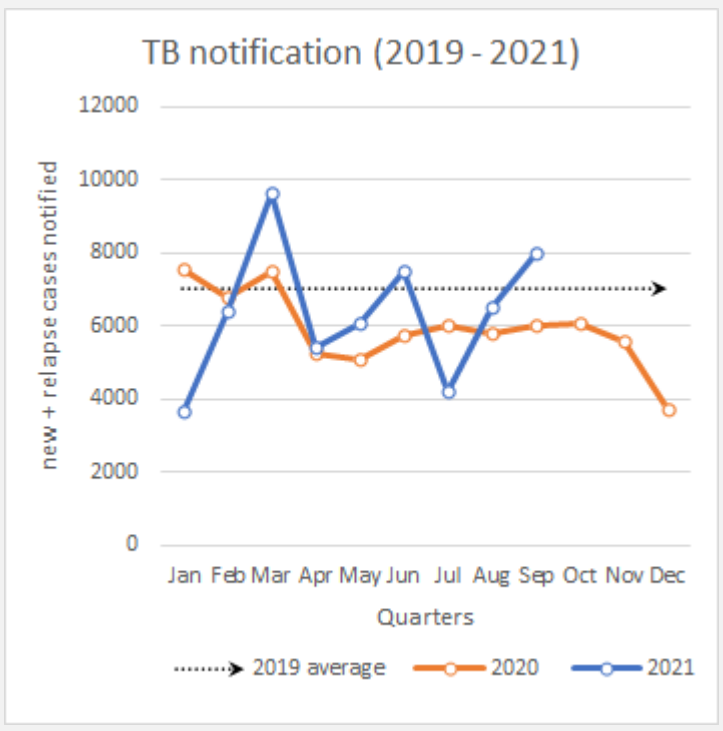
KENYA

BACKGROUND

According to WHO estimates, 139,000 people have newly developed TB in Kenya in 2020, of which 72,943 got notified (Global TB report, 2021) [1] With nearly 35,000 of all people with TB also infected with HIV, Kenya is included in the list for the top 30 TB/HIV high burden countries. [2] Children account for nearly 8% of all cases, and many also suffer from TB-HIV coinfection. [1]

Kenya has achieved a treatment coverage of 51% of all people living with TB in 2020 and the TB case fatality ratio stands at 6% (out of total cases put on treatment). 46% of the children (aged <5 years) that are household contacts of bacteriologically-confirmed TB cases have also been put on preventive treatment. [1]

The COVID19 pandemic has impacted the TB notification rates in Kenya and in 2020, it fell much below the 2019 average monthly notification, however, in 2021, the health system is making efforts to revive its TB surveillance practices rapidly and the case notification has steadily improved to reach back near the 2019 levels.



Source: https://www.who.int/teams/global-tuberculosis-programme/data

In order to achieve the key milestones of reducing TB deaths by 75% and TB incidence rate by 50% by 2025, Kenya's National Strategic Plan (NSP) for TB, leprosy, and lung health 2019-2023 lays emphasis on the need to ensure the provision of quality care and prevention services for all patients suffering from TB, more specifically, by investing in patient-centered care, developing bold policies and building supportive systems, and investing in research and innovation. NTP envisions the closing of gaps along the care continuum to find, treat, and cure all people with TB; differentiate its response by county to address the local TB priorities; optimize the integration of TB services in the universal health coverage (UHC) model; prevent latent TB infection; and implement a patient-centered approach that promotes quality of care, each of which creates an opportunity to exploit technological advances to make the processes more robust and seamless at the same time. [3]

Kenya has a TB reporting platform known as **TIBU**, which captures case-based data. The case-based data is entered in TIBU by the TB coordinators (in the frequency of monthly or quarterly) on behalf of the facilities. Further, the case-based data is aggregated and summarized for further uploading in **KHIS2** (DHIS2-based system) on a quarterly basis, which is used by NTP for program review. Additionally, to complement the existing national HMIS data systems, the TB Data from KHIS2 can easily be analysed with indicators of other programs, which enable comprehensive data review and analysis of TB data nationally.

To strengthen the community-based screening practices of the NTP and improve the frequency of data reporting, a supporting tool called TIBU lite is also being piloted at some facilities.

It is empirical that technology penetration plays a vital role in enabling the evolution of information systems from paper to digital solutions. With the high political commitment of the government in Kenya to improve the country's digital architecture, Kenya has reached one of the highest mobile penetration in Eastern Africa; with nearly 108.9% of the population having a mobile phone, i.e., at least 1 mobile device per person, and the smartphone use of about 99.7%. However, the internet penetration is still improving at a steady pace, i.e., approximately 40%. It is thus a good opportunity for the country to leverage the friendliness of its population with digital tools, which can set a strong ground to implement advanced solutions and ensure adequate uptake.[4]

Based on the multi-stakeholder discussions, interviews and independent research, and guidance from the National TB Program, this assessment report is an attempt to describe the current capacity and identified gaps/ challenges in the digital ecosystem of TB surveillance. The report shares strategic recommendations for developing a comprehensive case-based surveillance system in the country while leveraging the existing infrastructure, in-house capacity, and assets.

STATUS OF CASE BASED TB NOTIFICATION

In 2012, Kenya developed and launched the **TIBU** system with technical support from KNCV, which was later modified in 2014 to match the WHO TB surveillance guidelines. The system was initially developed to address the documentation challenges in the private sector but has further been expanded to cover the public facilities and faith-based organizations. Over the last 5 years, the system has also been enhanced to cover active case finding & TPT modules and is further being customized to cover the entire cascade of care and producing program monitoring dashboards.

The case-based data in TIBU is entered by the TB coordinators. With about 4700 TB sites and 300 TB coordinators, each TB coordinator is assigned 14-15 TB sites for data entry (both DS and DR TB) and supervision. TB coordinators visit once or twice in the month to these sites to upload the data into the TIBU system.

This case-based data from TIBU is aggregated on a quarterly basis and uploaded to the national KHIS2 platform, which helps with the data dissemination for program review from National to district level. Along with it, a Patient Management System (web-based version of TIBU) is another tool to support routine data use.

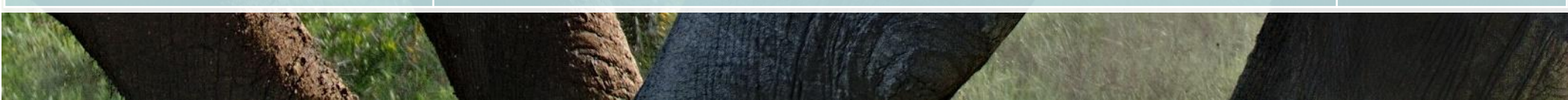
SUCCESS STORIES

As per the old TB notification reports the NTP, there was an 11-day delay on an average in notifying a TB case, while with the introduction of TIBU and its evolution over the last few years, this has now improved to nearly 5 days currently, which is further being planned for case reporting within 24 hours of treatment initiation.

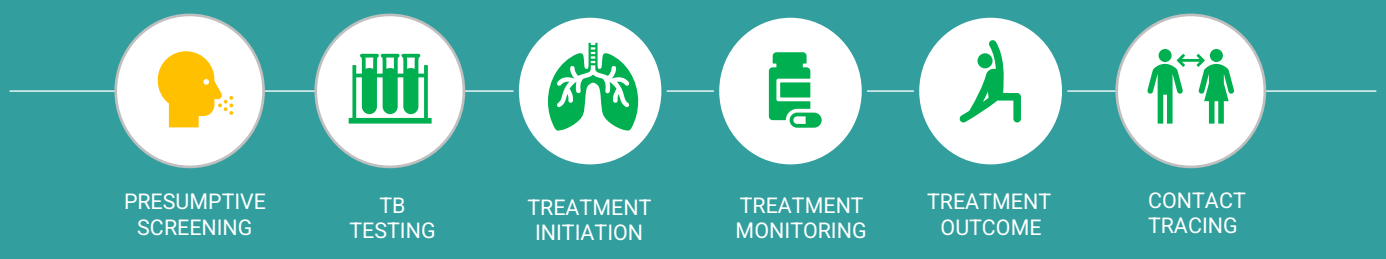
Seeing the gaps in hardware and internet infrastructure at the facilities, Kenya has chosen an alternate arrangement to ensure the capturing of case-based data for TB, and the same is successfully running across the country. The TB coordinators have been given android tablets which they use for patient data entry on behalf of the health facilities under their jurisdiction (as part of their monthly visits) and hence the records are digitized for al TB health centers regularly.

ELECTRONIC TB NOTIFICATION DATA COLLECTION AND USE

	TARGET	CURRENT SCALE	COLLECTION TOOLS	DATA TYPE	DATA USAGE
National level	Data not collected at this level				Patient Management System (TIBU) KHIS2 Dashboard
County level	47	Data not collected at this level			Patient Management System (TIBU) KHIS2 Dashboard
Sub county Level	300	300 (on behalf of facilities)	TIBU KHIS2	Case Based Aggregate	Patient Management System (TIBU) KHIS2 Dashboard
Facility level	4700 - TB treatment units (public, private)	4700	Manual	Case Based	Patient Management System (TIBU)
Community level	Data not collected at this level				No data usage at this level



CASCADE OF CARE MONITORING



KEY DATA VARIABLES

	YES/NO
Demographic details (Age, DOB, Gender)	✓
Address and contact details (Country, Province, District, House address)	✓
Geolocation (GPS coordinates of the household)	
Contact details (Phone number/Mobile number, WhatsApp, Email etc.)	✓
Health Facility address	✓
Type of health facility (Public, Private etc.)	✓
Site of TB (Pulmonary, Extra-pulmonary)	✓
Type of diagnostic test (Microscopy, GeneXpert, TruNaat, CXR, etc.)	✓
Date of test result	✓
Drug susceptibility (DSTB, DRTB)	✓
Treatment Regimen	✓
Treatment start and end date	✓
Co-morbidity (HIV, Diabetes, COVID-19 etc.)	✓
Treatment monitoring/adherence	✓
Treatment outcomes	✓

KEY INDICATORS

	YES/NO
Presumptive screening (proportion)	
Treatment initiation (proportion)	✓
Treatment monitoring/adherence	
Treatment outcome (proportion)	✓
Spatial distribution of TB notification	✓
Age-group & sex wise aggregate numbers and proportions notified	✓
Basis of diagnosis wise aggregate numbers and proportions notified	✓
Type/site/drug resistance wise aggregate numbers and proportions notified	✓
Provider source-wise aggregate numbers and proportions notified	✓
Comorbidity wise aggregate numbers and proportions notified	✓
Key-population wise aggregate numbers and proportions notified	✓
Estimate/Target wise notification/treatment coverage (proportions)	✓
Provider-type disaggregated treatment outcomes (proportions)	✓
Comorbidity disaggregated treatment outcomes (proportions)	✓
Key population disaggregated treatment outcomes (proportions)	✓

✓ Digital (aggregated) ✓ Digital (case based)

STATUS OF ELECTRONIC CASE BASED TB SURVEILLANCE

Electronic system for case based TB Notification	TIBU TB surveillance system
Lowest Unit for TB notification digitisation	Sub county level (on behalf of facilities)
Stage of notification	Treatment initiation
Level of Access and Use of TB Notification data	Facility level (Patient Management System)
Private sector notification	Case based TB notification in TIBU (contributes 20.4% of all TB notification)
Frequency of digitization of TB notification	Quarterly (data uploading and backlog clearing)
Mode of follow-up with notified cases	Phone calls, Physical visits
Scale of implementation	National level (data of all TB facilities)
Contact tracing for TB notified cases	Contact Management register in TIBU (for contacts <5 years)
Multi-channel enablement	Android mobile app for TIBU data entry
Govt. order for mandatory TB notification	Yes

PRIVATE SECTOR NOTIFICATION

Nearly 50-60% of the private providers have an access to the TIBU surveillance system and use it for direct notification of TB cases. NTP is also planning to integrate with the Electronic Health Records systems of bigger private hospitals in the near future, for getting access to the remaining TB cases on treatment. Private sector contributes to nearly 20.4% of the total TB case notification.

COUNTRY IT CAPACITY

Country Server
TIBU platform is hosted by the NTP at the Kenya Country cloud server (certified/commercial Data Center)

Interoperability
Data export from TIBU in JSON/XML and APIs are available and integrated with KHIS2

Country IT team
TIBU is completely owned by the NTP team (have access to source code), and its management is done by outsourcing to a tech partner (Iridium)

ENABLING ENVIRONMENT

108.9%
Mobile penetration (Jan 2021) [4]

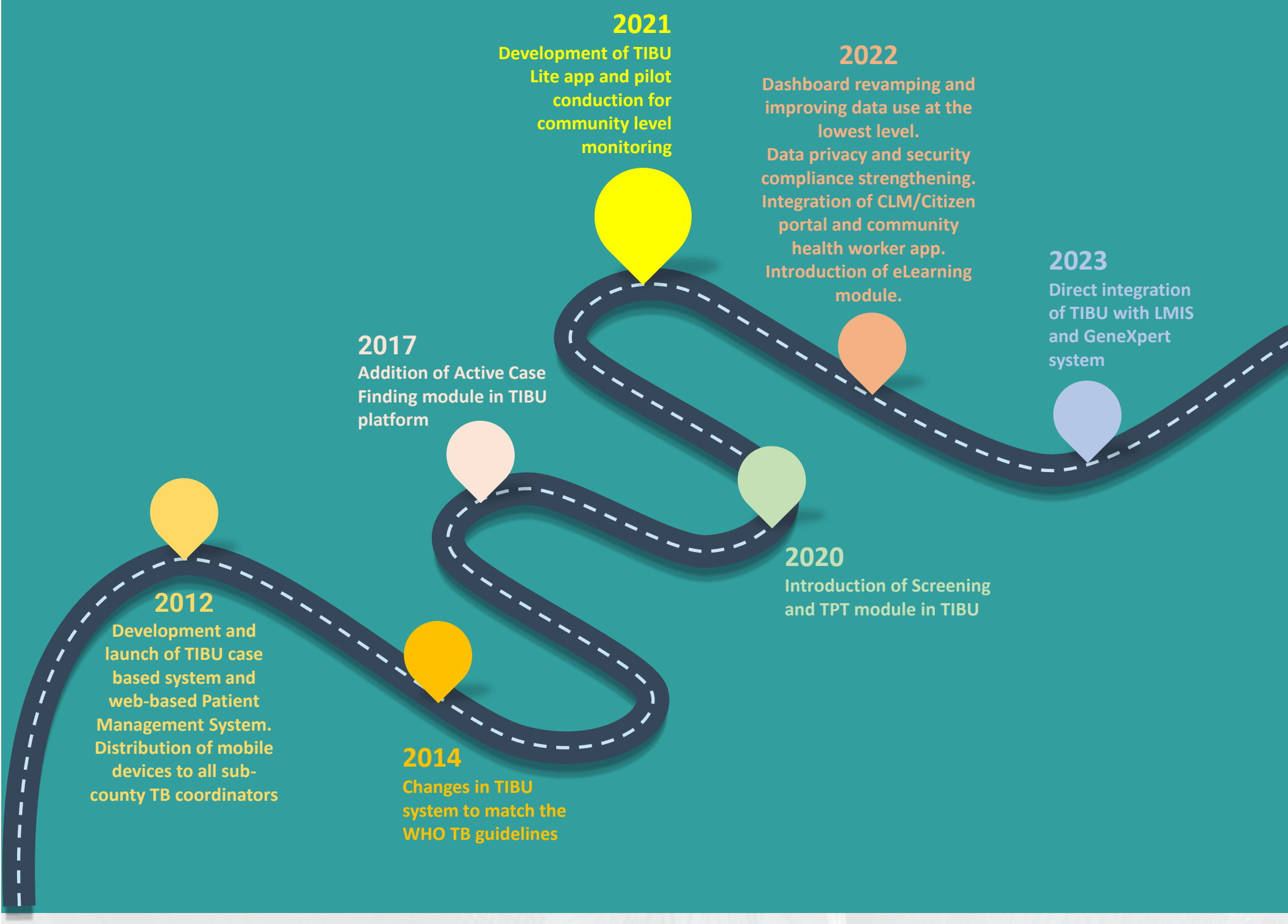
99.7%
Smartphone (2018) [4]

40%
Internet penetration (Jan 2021) [4]

CURRENT RESOURCES AVAILABLE

- Funding of USD 1 million is available from USAID and The Global Fund for supporting the enhancements of the current software to online/offline mobile versions.
- Additional funding of USD 20,000 is present for development of a private sector module.
- Funds of USD 0.3 million from The Global Fund is available for bearing the hardware costs like procurement of mobile phones or laptops, and additionally USD 70,000 is present for rolling out of the system at the lowest level of data reporting.
- USAID grant of USD 20,000 is available for bearing the hosting and deployment costs for the system.

MILESTONES ACHIEVED AND ROAD MAP



OTHER COMPLEMENTING DIGITAL TOOLS

PURPOSE	TOOLS	CHANNEL	DEVELOPED BY	SUPPORTED BY	SCALE
Digital Adherence and Contact Tracing	Nil	NA	NA	NA	NA
Logistics Management Tool - eLMIS	TBMeds, KEMSA LMIS	Web Application	NTP, CHAI	CHAI	National
Laboratory Information Management	GxAlert	Web Application	CHAI	Centre for Health Solution, USAID	180 GeneXpert diagnostic sites
	LabWare	Web Application	South African vendor	AMREF, The Global Fund	National
Community Led Monitoring (CLM)	TIBU Lite Community Module	Mobile App	NTP, AMREF	USAID	To be implemented soon
Pharmacovigilance	Tibu Pharmacovigilence module	Web Application	Iridium	USAID	National

KEY CHALLENGES

- Shortage of personnel (TB coordinators) and High data entry burden poses an acute crunch of trained manpower at the data entry points.
- With the internet conditions being very unreliable, real-time case-based data entry from the facility level with the software remains to be a huge challenge.
- Availability of and lack of maintenance of hardware (desktops/laptops/tablets) for data entry is also inadequate for direct data reporting from facilities, and as a result of this, data is entered from sub county level and that adds to the delays and increases burden on the TB coordinators.
- Gaps in the availability of smartphones with the health workers limits the usage of TIBU app on the ground.
- In the absence of any patient/community centric applications, the access to information at the grassroots remains limited, and crucial information for program monitoring and planning, like TB adherence, gets missed in the data.
- Getting data from the entire private sector requires more system expansion, but funding it is a bottleneck.

NTP VISION

- Expanding the features of TIBU to cover additional module for Screening and Contact Tracing module.
- Extending TIBU usage at the facility level for a real time case notification.
- Development and implementation of a mobile app for enabling the data capture on a real time basis.
- Improvement in data quality (accuracy, validity and precision).
- Encouraging private sector for reporting in TIBU.
- Making the point of diagnosis as the notification trigger and integration with other systems (GeneXpert, LIS, etc).
- Enhancement of dashboards to strengthen data analysis and usage of data by stakeholders.

RESOURCE NEED

Based on multi-stakeholder discussions, country feedbacks and recommendations for fulfilling country's vision, we have put together an estimated investment requirements and areas needing support for provisioning of a comprehensive case based digital TB surveillance system.

- **Hardware and Infrastructure:**
  - Mobile Devices (for data collection): Kenya has 4700 TB facilities and to provision mobile device for every facility for case-based TB surveillance, **USD 705,000** will be needed assuming USD 150 per mobile devices.
  - Tablet (for data use): Kenya has 300 sub-counties and 47 counties. To promote active data use, each sub-county (i.e., the associated TB coordinated) should be given a tablet which would cost roughly around **USD 69,400** assuming USD 200 per Tablet devices.
  - Internet: In case WiFi is not available in each facility, then mobile internet cost of around **USD 1,514,100** should be considered (assuming USD 100 mobile data cost for the entire year per facility, district and regional user)
  - Server: Based on the current volumes of new cases, Kenya would need an investment of **USD 30,000-40,000** for next 3 years for server and server maintenance.

Note: Existing devices available through other health programs can be leveraged. In that case, the above-mentioned costing can be accordingly considered.

- **Software Development:**
  - Based on various multi-stakeholder meetings and given the fact Kenya already have a strong foundation of TIBU case-based notification and DHIS2 aggregate reporting nationally, around **USD 1,500,000-2,000,000** should be budgeted for comprehensive TB surveillance system development and analytical dashboard for data use.
- **Capacity Building and Implementation:**
  - After the software development, a dedicated pool of technical resources will be needed to support platform administration, data management and support. A team of 4-6 skilled resources attributing to a cost of around USD 48,000-72,000 per annum should be budgeted (or **USD 144,000-216,000** for 3 years assuming USD 1,000 per month per resources). Additionally, reskilling of the current IT team should be budgeted.
  - Training: This would involve training material development and onsite and remote training of the trainers. Training sessions should be planned for each 197 districts over a period of 3 years which could cost roughly USD 100 per training amounting to **USD 19,700.** Also, a dedicated trainer should be budgeted in case there is none. E-training options with necessary modules also need to be considered.

TOTAL investment of around **USD 4.5 – 5.0 million for 3 years** will be needed on developing a comprehensive case-based digital TB surveillance system for Kenya.

Disclaimer: The above budget is a function of number of facilities, districts and regions and expected volume of data. This only provides a ballpark figure of what is needed in terms of budget.

Digital TB surveillance system, that is scalable and integrates all services; data, laboratory and commodity management will remain a key pillar in TB control as we work towards ending TB by 2035. The rollout of the TIBU system is a major milestone that promotes the use of data for decision making at all levels. In the near future, this technology will offer real opportunities to improve TB outcomes and enhance efficiency. It will reduce the usage paper-based registers in health facilities, workload, costs and ultimately conserve our environment.

Dr. Waqo Ajersa
Head - National Tuberculosis Leprosy and Lung Disease Programme (NTLP)
Ministry of Health, Kenya

RECOMMENDATIONS

Following are some of the key recommendations suggested based on the findings of this assessment of country's digital ecosystem and infrastructure:

- **Strategic Costing Plan :** As a first step, it is important for the country to create a comprehensive costed action plan for enhancement and scale up for the TB case-based surveillance system.

  Based on NTP's vision and the recommendations for improvements, the plan should clearly define targets with actionable interventions and funding requirements supported with a detailed work plan along with timelines. The plan will help the country to assess and monitor the progress to ensure that any risks can be duly mitigated.

  Tentative timeline: Month 0-1

- **Implementation and scale up of Case Based TB surveillance systems :** The NTP has already established a conducive environment and core infrastructure in terms of database and deployment. It has built the local expertise and capacity which acts as a strong foundation for executing the vision of establishing a comprehensive and integrated real-time case-based TB surveillance and notification system.

  It is recommended that this existing capacity is leveraged for expanding the TIBU platform implementation. While currently, data is getting entered monthly or quarterly by the TB coordinators (sub-county level staff) on behalf of the facilities, the application should further include the monitoring of entire continuum of care including presumptive screening, referral, treatment initiation and adherence, treatment outcome & contact tracing in real-time.

  The solution architecture should support adding all the above components in phases supported with versioning to ensure seamless upgrades and continuity.

  Some of the existing templates already built on DHIS2 tracker systems currently being used by other countries such as WHO's prevent TB tool or other DHIS2 tracker-based systems can be explored for fast-tracking the software development processes [5]

  Tentative timeline: Month 0-12

- **Mobile app :** One of the challenges reported by the NTP during the data collection processes is the lack of availability of real time data for stakeholders and inadequate availability of laptops/ desktops. One effective way to overcome this is to support the current data collection processes by introducing a mobile application at all health facilities, which is in line with the country's efforts of improving the overall digital ecosystem.

  As a recommendation, access to TIBU mobile app version should be expanded to facility level, so that features of security, offline data collection, encryption, version management etc can be leveraged while entering case-based data reporting, even from facilities with limited internet infrastructure.

  This would also ensure that the data structures are consistent. Also, the app should be supported with a configurable set-up module to support any updates/ changes to the program.

  Additionally, the mobile framework is recommended to use open-source technologies like Java, Postgres, React and Android, which are easily supported by country IT teams and are advised to follow the standard best practices of mobile development like version management, data encryption etc which make it a more robust solution. [6]

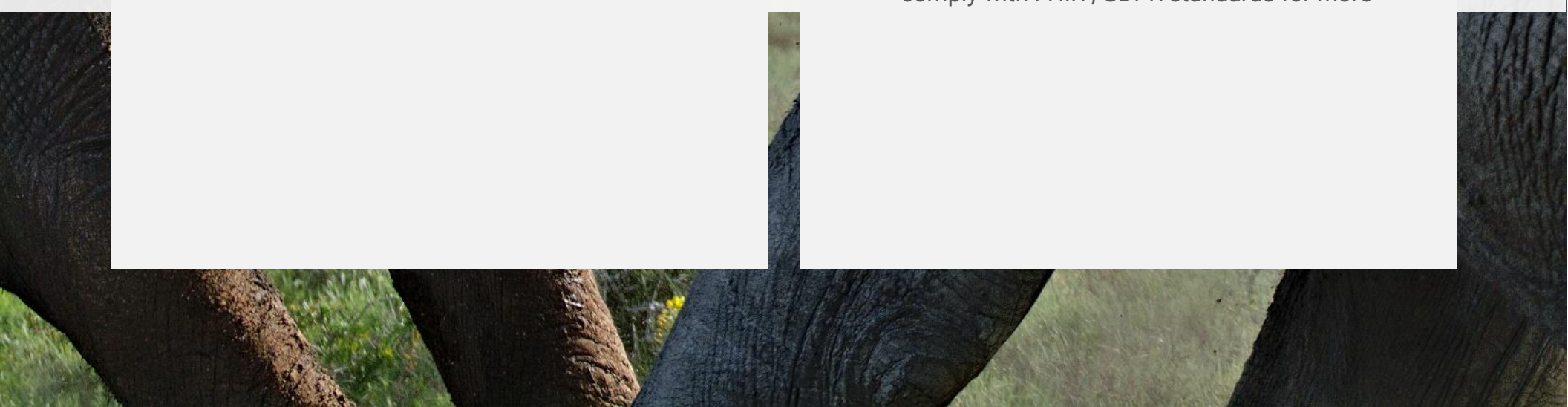
  Tentative timeline: Month 6-12

- **System Integration**: One of the challenges highlighted by NTP is the leveraging the data collected from the multiple sources into the main TIBU/KHIS2 platform as a central system for effective use.

  The current KHIS2 and TIBU platform and infrastructure needs to be extended to support integration with external systems like GeneXpert, TruNat, Digital X-Ray outputs, Pill boxes and other adherence tools which help in using the data effectively for the patient continuum of care as highlighted by the National program.

  Recommended exchange / ETL tools like Talend , Informatica which include these features make the data management task much easier and simultaneously improve data warehousing should be evaluated. [7]

  The data exchange process should follow and comply with FHIR , GDPR standards for more



RECOMMENDATIONS

secured and seamless data exchange supporting standard data taxonomy and meta data management processes.

The KHIS2 platform's architecture is easily compatible with these standard tools and processes making this an effective solution. [8]

Tentative timeline: Month 12-18

- **Data Use :** Country's NTP clearly emphasizes on the importance and need to improve data use. This can be made possible by making case-based TB data and required line listing available at the lowest level health functionary involved in TB care.

  Building on the current DHIS2 visualization module which offers a comprehensive dashboard for reviewing of program and data indicators, additional features of pivot table, event reports which support dimensions, data aggregation reports, individual line lists and job aids with timeline views are extremely useful.

  Once a robust data analytics and data use model has been established with the current KHIS2 and TIBU system then a more advanced analytical dashboard should be designed linked to the new case-based TB surveillance system that is already being planned.

  To achieve this , apart from the standard DHIS2 dashboard features and to strengthen and expand the data visualisation scope and making effective use of data for predictive modelling , data science and for advanced analytics it is also recommended to use best of the breed tools like Tableau , Power BI which offer these features. The current KHIS2 platform offers APIs which can connected for these applications and be used as an extended analytical component of the data analysis framework. [9]

  Tentative timeline: Month 6-18

- **Capacity building for application maintenance:** One of the main challenges identified with the NTP is ongoing maintenance and enhancements of the platform. Since the application requires regular updates and to ensure effective adaptation and scale up, the system support team requires trained staff on DHIS2 & TIBU.

  Strengthening the NTP team with trained system administrators will help in improving and expediting the planned implementations.

  Tentative timeline: Month 0-6

- **Additional data capturing mechanisms :** To make sure the case-based data entry from facilities using a mobile app is convenient, technical solutions like OCR (optical character recognition) should be incorporated in TIBU.

  With the platform supporting this feature, it would also help in data upload of any historical data with less difficulties and will make the daily data entry more seamless.

  Other features like a data transformation API can offer the option of creating standard templates, which can be easily mapped with the data collection tools like TIBU, which can support batch upload large volumes of data.

  Tentative timeline: Month 6-12

- **e-Learning**: To address the challenges with periodic training of facility level staff to orient them on using TIBU system for direct data reporting, the MOH must engage in development of a comprehensive eLearning module for app training.

  While some systems offer standard training modules on the application, training tools like Moodle [10] built on standard LMS framework can be reviewed for application rollouts.

  Additionally, for training and updates on the latest manual of procedure and continued medical education on TB care modules can be developed for TB Health providers, administrators at facility and district level to develop and enhance M&E competencies for ensuring a consistent program oversight, specially for the case-based tracker roll out within the existing applications.

  Guide TB platform developed by WHO Philippines is a good example of eLearning module for health staffs involved in TB care.

  Tentative timeline: Month 0-3

RECOMMENDATIONS

❖ **Device Procurement :** One of the limitation highlighted by NTP is the need to improve the hardware availability at the facility level. To streamline this, procurement, distribution and maintenance of the required data entry equipment like laptops, mobile/tablet devices should be done on an urgent basis. Improving the current infrastructure at the facilities is crucial for a complete transition to digital notification.

Tentative timeline: Month 0-6

❖ **Data Quality :** As part of the standard practice, the application(s) / solutions should follow a set of standard data quality mechanisms or the Data Quality Assurance (DQA) framework which would help in improved data credibility and use.

UIC Code : Having a centralized Unique Patient ID system or leveraging existing national ID supported with an improved search functionality can help drastically reduce the duplication of case-based records.

This should be generated automatically through the case-based TB surveillance system that is already implemented.

Data access control is one such DQA measure that will regulate user's access to only relevant metadata, and hence support data privacy. It will involve the principle of least privilege (POLP), i.e., user's access will be determined based on their role in the project. POLP will define and limit what data they have access to and who has that access.

Tentative timeline: Month 6-18

❖ **Community Monitoring Systems :** As expressed by the NTP, the national TB notification and surveillance system should have necessary mechanism to integrate with ready-to-use open source CLM platforms like One Impact.

Tentative timeline: Month 6-12

❖ **Patient Tracking System:** Tracking lost to follow-up cases and enabling real time notifications for patients is highlighted as one of the main challenges.

Establishing a direct and secured mechanism for engaging with patient has potential for drastic improvements in tracking lost to follow-up patients. Auto generation of notification and messaging by the system through communication channels like Social Media channel, IVRS and SMS outbound messages should be explored. Open-source applications like Open MRS can be used for these activities. [11]

Tentative timeline: Month 12-24

Strategic Technical Recommendations:

❖ Application Upgrades including Server Augmentation & Infrastructure Upgrades : To make sure that systems implementation and scale up of application is supported well, the key need is to have a long-term strategic plan which would cover the technical and operational objectives.

The strategy recommended would cover the following core areas

- **Technical Upgrades**: Based on the architecture, the upgrade would be done with the database, a middleware system, the operating system or the hardware.

  Additionally, the architecture should support the integration layer which would be needed for data exchange with other national / external systems. The technologies that need to be brought in and the areas of inter-connection need special focus.

  Recommended data system architecture would include updating the version of the current DHIS2 to 2.34 which offers better features on data management , encryption & exchange standards.

  Apart from this, 2.34 version also supports compliance to GDPR standards and offers more controlled data encryption practises.[12]

- **Performance Optimisation & Testing :** To support the national scale up and implementation strategies it is very essential to have system(s) and application testing done to enable full proof platform and which also helps in architecture updates and augmentation.

  While core teams from the user community who are involved in the testing learn and automatically get trained, Automated System and Application Testing tools like Selenium and Appium can be used. Load Testing tools which helping in data base sizing and planning need to be adapted for effective planning. [13]

RECOMMENDATIONS

- **Application & System Security Audit:**

  To strengthen the current systems framework and ensuring long term sustenance it is important to have regular evaluation of the security of the information and systems by measuring how well it conforms to an established set of criteria.

  These would also include developing a framework which should outline policies in line with recommended standard policies like HIPAA [14] to cover

  - Patient Data Management
  - Server & Infra guidelines

  Apart from application measures offered by DHIS2 [14] for patient data security , hosting solutions offered from Azure also cover these as part of their deployment options which can be considered as part of systems hosting. [15]

ACKNOWLEDGMENT

We thank the National TB Leprosy and Lung disease Program Manager, ***Dr. Waqo Ajersa*** and the entire team for participating and engaging in the assessment. We would also like to extend our gratitude to ***Dr. Aiban Ronoh*** for providing valuable insights into Kenya's vision for creating an advanced case-based TB surveillance and notification system.

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