OptiDx

OPTIMIZING DIAGNOSTIC NETWORKS

OptiDx: An open-access tool to optimize diagnostic networks to improve access and service efficiency

User Guide

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FIND Diagnosis for all
coupa
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Contents

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Abbreviations

DHIS	District Health Information Software
DNO	Diagnostic Network Optimization
FML	Facility Master List
HF	Health Facility
HMIS	Health Management Information System
HR	Human Resources
LMICs	Low- and middle-income countries
LMIS	Laboratory Management Information System
MAD	Maximum Allowable Distance
MoH	Ministry of Health
RO	Route Optimization
TWG	Technical working group

Executive summary

OptiDx is a web-based, open-access software to conduct diagnostic network optimization and route optimization for any disease. It uses a network analytics approach to better understand the current diagnostic network and recommend the optimal type, number and location of diagnostics and an associated sample referral network, that enable the greatest access to testing and help maximize the impact of investments.

OptiDx was specially designed for low- and middle-income countries seeking to improve their diagnostic networks in the context of limited resources. It has been piloted in several countries across various diseases (e.g. TB, HIV, and SARS-COV-2), and is now being scaled up in additional countries and disease contexts.

This user guide provides an overview of OptiDx and includes a step-by-step process for creating a new country model, reviewing the current state of the network, changing the network, and comparing network outputs. Through this process, OptiDx produces filterable tables, maps, and graphs that help answer granular and large-scale questions about testing sites (location and quantity), testing demand (location and volume), test types (available or required capacity), costs (total and by type), and sample referral (volumes, routes, and modes). OptiDx also enables systematic comparison of access, device utilization, and costs across alternative configurations of potential networks ('compare scenarios') to help identify the 'best-fit' solution.

DNO outputs may be used to shape funding requests and budgets. Interventions recommended by DNO may include procuring new instruments, developing guidelines and operational plans for integrated disease testing or a new sample referral network, and creating micro-plans to relocate devices or reroute sample referrals between selected sites.

OptiDx puts the power of DNO in the hands of countries. It is available free of charge to end users, requires limited prior expertise in network analytics, and comes with a learning resource package. A core project team—led by the Ministry of Health, and including a technical working group and senior leadership across disease programmes, laboratory services departments / divisions, and partner organisations—defines the scope and priority questions of the analysis, and later identifies and implements solutions. Countries can also update their network models periodically for longer-term diagnostic network planning. Ultimately, OptiDx empowers countries to conduct DNO sustainably for improved access to diagnosis and cost-efficiency of the network.

Target audience

This guide provides an overview of how to use OptiDx to conduct DNO, including app functionalities, data requirements, and step-by-step instructions, as well as practical tips.

This guide is made for individuals who will perform DNO with OptiDx. It may be used in conjunction with the guidance document, 'Diagnostic network optimization: A network analytics approach to design patient-centred and cost-efficient diagnostic networks', available at www.optidx.org.

Overview of OptiDx

About OptiDx

OptiDx is a web-based, open-access software application (app) to conduct diagnostic network optimization (DNO) and route optimization (RO) analysis to support the planning and design of diagnostic testing services across multiple diseases. OptiDx was developed by FIND, the global alliance for diagnostics, Coupa Software Inc., and the USAID Global Health Supply Chain Program-Procurement and Supply Management (GHSC-PSM) project with support from the Bill & Melinda Gates Foundation. Hosting and maintenance of OptiDx is supported by the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) via the USAID GHSC-PSM project.

A network analytics tool designed for diagnostic networks in low- and middle-income countries

User-friendly, requiring minimal prior experience in network optimization

Highly visual with pre-populated graphs and charts generated in a click

Models the impact of simultaneous change in multiple parameters in network design and performance

DNO is a network analytics approach to analyse the current diagnostic network and recommend the optimal type, number and location of diagnostics and an associated sample referral network that enable achievement of national health goals, making access to diagnostic services more equitable while maximizing the overall efficiency of the system and achieving the greatest impact with the available resources. RO is an approach to define detailed routings for vehicles within a diagnostic network and consider modes of transport for sample referral, and it may be conducted after a DNO analysis.

OptiDx enables DNO and RO analysis by using national data to create a digital model of the country's diagnostic network. The model includes the location and capacity of diagnostic services, current and projected needs for testing, and referral connections between health facilities and testing sites. It enables the user to run a series of customizable scenarios aimed at improving access and cost-efficiency of services, including the design of an optimal sample transport system. Outputs of the OptiDx analysis can be used to inform strategic planning and to guide investments towards laboratory systems strengthening.

OptiDx is being used across multiple low- and middle-income countries (LMICs) to support DNO analysis for various diseases, including TB, HIV, HPV, and SARS-COV-2. More information and case studies are available at www.optidx.org.

How OptiDx works

OptiDx has four main features, with corresponding sections in the app:

Include New Country	Create a new country model and upload data using standardized data templates.
Review Current State Network	Review preliminary baseline model to understand overall network configuration, and explore associations between testing location and capacity, testing demand, and cost of operating the network, at national and sub-national level.
Change the Network	Create optimized scenarios by making changes to the baseline model. Alter key inputs and assumptions and apply constraints.
Compare Network Outputs	Compare access, costs, and device utilization in depth (by test type, sub-national, and facility level) across scenarios.

OptiDx is a flexible and customizable tool to help answer a variety of network optimization questions based on the local context. Using OptiDx to perform DNO may be particularly useful when: 1) a network assessment shows significant gaps in service delivery; 2) procurement or placement of new devices is being considered; 3) improving access to services is a priority, including through provision of point-of-care testing and / or establishment or enhancement of sample transport systems; and, 4) integration of a new test on existing devices is being considered.

OptiDx can help answer questions related to:

Sites: Locations and quantity

Costs: Total and breakdown by type

Demand: Location and volume

Sample referral: Volumes, routes, and modes

Test types: Available or required capacity

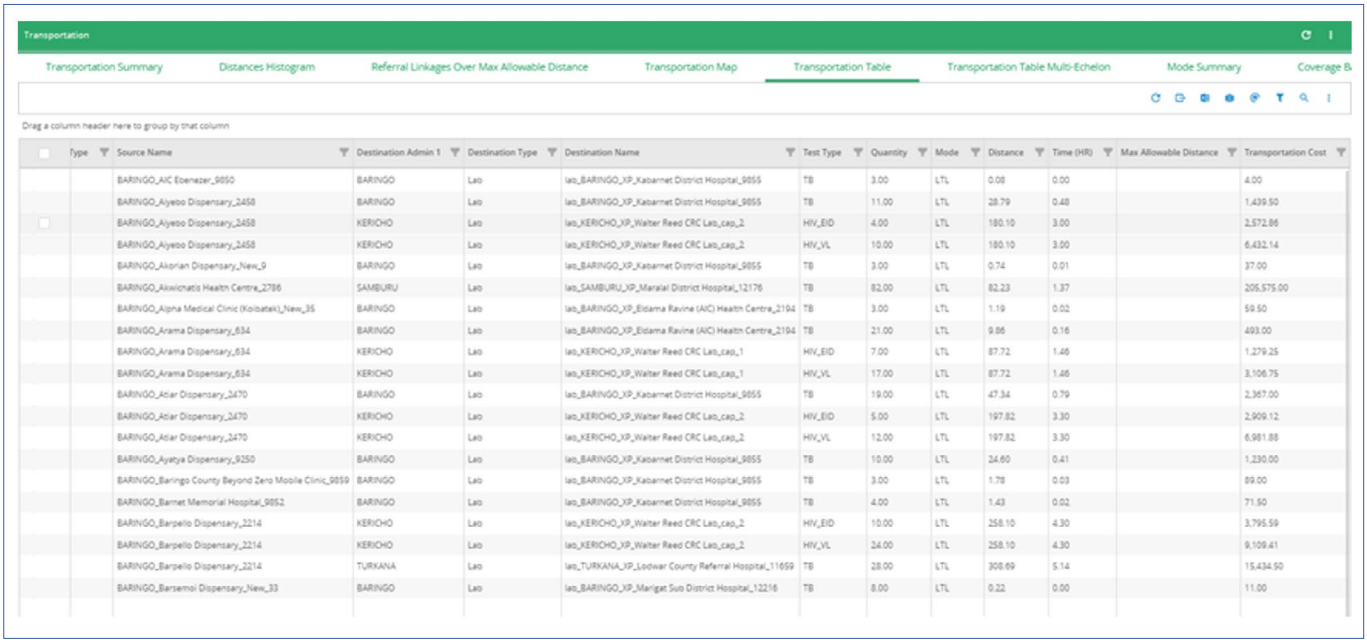
OptiDx utilizes a cost-minimization approach to optimize the overall network design within a given set of constraints. For diagnostic networks, the most commonly applied constraints are service distance or turnaround time (i.e. the maximum distance that a sample should be referred for testing, or the maximum time between sample collection and result reporting). Other examples of constraints include allowing (or not) cross-border sample referral, and considering (or not) integration of testing on devices. OptiDx then identifies the lowest cost option for the overall network that meets these constraints specific to various settings.

Using OptiDx to support evidence-based decision-making

OptiDx helps synthesize and analyse diverse data inputs and enables easy visualization of a wide range of outputs for the actual network as well as for optimized models, based on the priority questions. Some examples of outputs are included below.

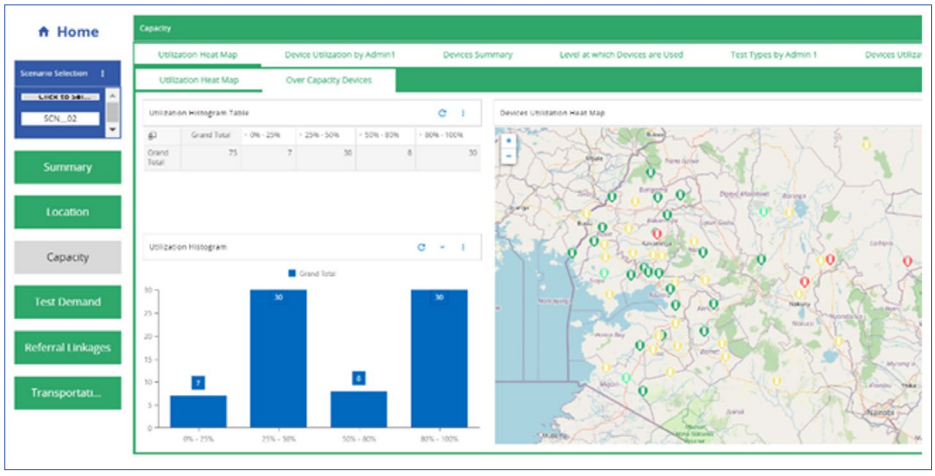
- Detailed data tables for individual sites, providing:
  - Locations and volumes of test-device combinations, actual or possible
  - Structure of the referral network between health facilities, hubs, and labs, including volumes, lanes, transport modes, frequency, etc.

Figure 1: Table from 'Transportation' view, to review or update characteristics of the sample transport network by various test types for each source-destination combination.



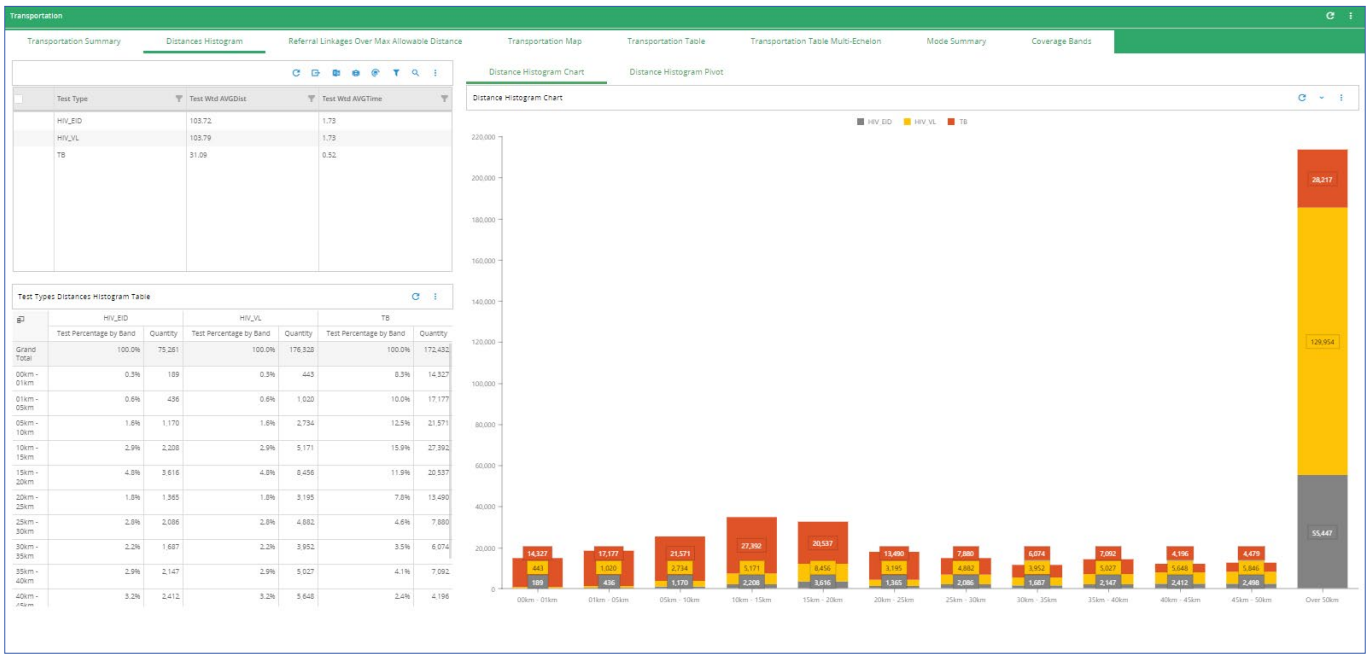
- Maps:
  - Heat maps of testing demand and testing capacity utilization, segregated and colour-coded by percentage bands
  - Referral lanes for transporting samples between Admin 1 areas

Figure 2: 'Capacity' view, to map utilization and distribution of testing devices across the network.



- Graphs:
  - Pie charts and histograms to show disaggregated data for variables such as test volumes, costs, and capacity utilization.

Figure 3: Histogram in 'Transportation' view, displaying volumes of samples being transported by distance bands, ranging from 0-5 kms to 50+ kms.

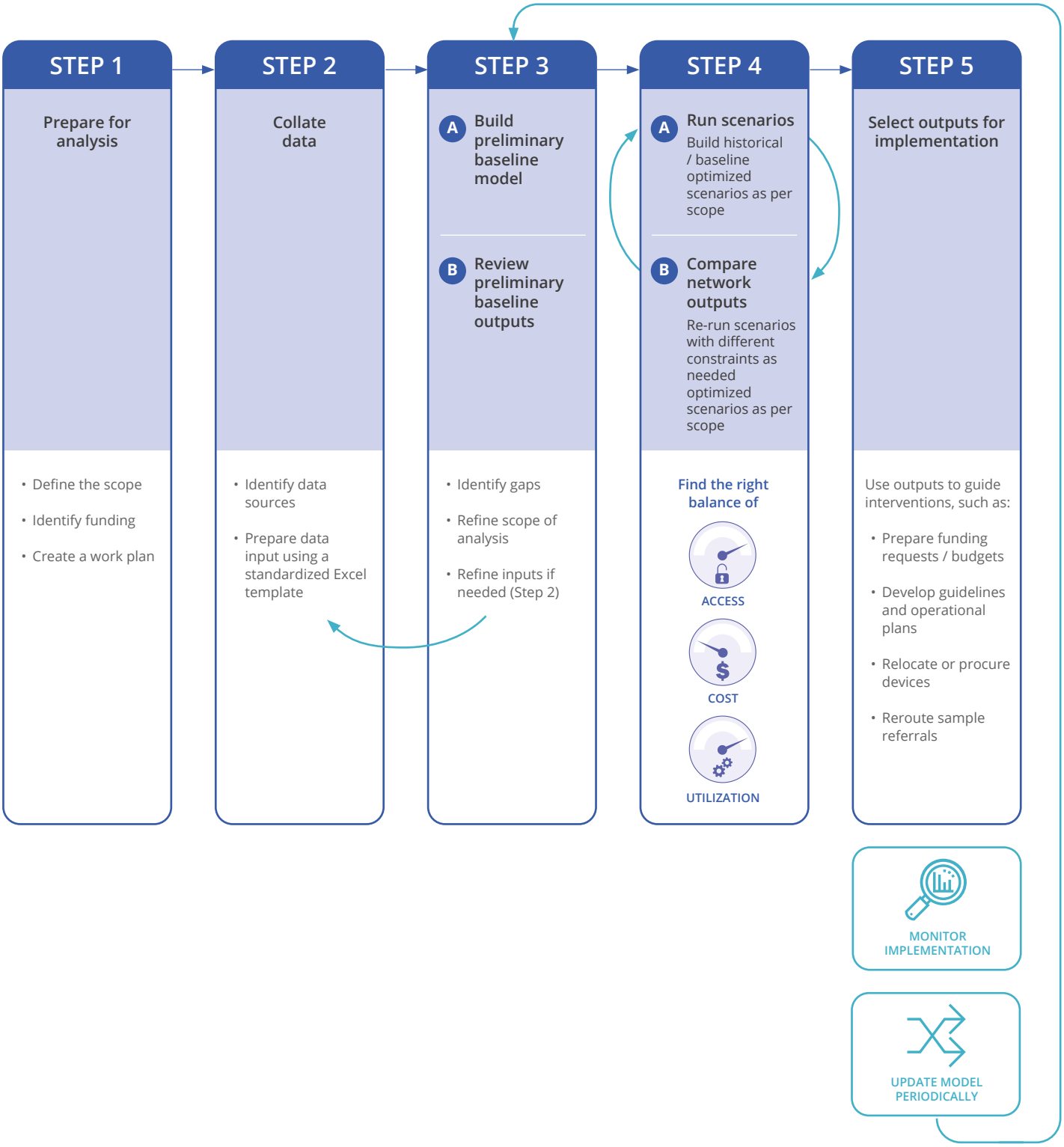


These outputs can be viewed at various levels of administration, national or subnational (Admin 1 area or Admin 2 area, respectively). They can also be easily filtered by various categories and combinations, for example, Admin 1 areas, test types, devices, or capacity utilization status, to enable granular analysis.

Decision-makers can then use these outputs to compare trade-offs between access, device utilization, and costs across alternative approaches to meet the desired goal for the diagnostic network. OptiDx thus provides recommendations for best-fit network design and sample referral route plans to meet the testing demand within a set of defined parameters or constraints, for example:

- the number of devices needed for current demand, and for changes to demand in the future
- the optimal mix of devices to best meet the testing demand
- increasing testing capacity with existing devices by, for example, changing referral networks or adding additional shifts
- optimal locations to consider when placing additional devices or relocating existing devices
- spare capacity available or additional capacity needed on multi-disease platforms for integrated disease testing

Using OptiDx to conduct DNO



Step 1: Prepare for analysis

Check timing

A DNO analysis is best conducted when the results can be used to inform upcoming decisions, e.g. for procurement and allocation of devices, funding requests, or preparing national strategic plans. Ensure adequate time is available to deliver DNO results to inform decision-making, including sufficient time for review, feedback, and iterations of scenarios.

Identify a multi-stakeholder technical working group and a core project team

Formation of a core project team is recommended, ideally led by the Ministry of Health (MoH), with guidance from a technical working group (TWG) and assistance on use of software packages as needed. The engagement of senior leadership across organizations and various disease programmes and laboratory services departments / divisions is critical to shape the DNO scope according to country priorities, address priority questions, and make decisions for implementation including allocating necessary resources.

Composition of core project team:

Project lead

- Officials from MoH / partner organizations with access to required data sources and broad understanding of diagnostics and the health system context.
- Experience in data-driven programming

Data analysts / modelers

- Advanced data analytics skills, including Excel
- Familiarity with broader health systems data (DHS, SPA, HEUS or NHA data sources)

Composition of TWG

Relevant partners, departments, and divisions with insight into specific areas of the DNO scope to guide the analysis.

Access resources

Visit www.optidx.org to review available guidance materials on DNO and OptiDx, and contact the OptiDx team at optidx@finddx.org to indicate your interest in gaining access to the software.

Define scope

To define the scope, you'll need to consider the following:

Baseline model

- The geographical scope: national or a specific region
- Single disease or multi-disease
- Which tests are performed on which devices
- Whether devices are currently being used for integrated testing or for separate diseases
- Data availability
- Budget constraints to be considered in the analysis

Future state scenarios

- Programmatic targets and constraints for access, efficiency, and costs
- Changes in demand and driving factors (population growth, disease trends, testing algorithm)
- Changes in capacity (new devices, tests, integration plans)

Table 1: Steps to conduct a DNO analysis using OptiDx (adapted from the DNO guide).

Step 1	Step 2	Step 3	Step 4		Step 5
Prepare for analysis	**Collate data**	**Build baseline & validate**	**Run and compare scenarios**		**Select outputs for implementation**
		3a: Build preliminary baseline model **3b:** Review preliminary baseline outputs	**4a:** Build historical baseline model / optimized scenarios as per scope	**4b:** Compare network outputs	
Outputs	**Outputs**	**Outputs**	**Outputs**	**Outputs**	**Outputs**
Better understanding of priorities and clarification of overall goals	Routine programmatic and survey data compiled and cleaned using Scenario creation template	Validated preliminary baseline network model	Adjusted model for factors such as site locations, capacity, utilization, sample flow, and overall costs	Customized optimization scenarios for current and future testing demand	Identification of preferred scenarios and operational plans for their implementation
Activities	**Activities**	**Activities**	**Activities**	**Activities**	**Activities**
• Multi-stakeholder project team and TWG members define scope, priority questions, and budgetary constraints • Gather additional information on current network • Identify funding / technical support, and define a work plan for the DNO study	• Identify and collate data inputs, including existing country data, e.g. routine programmatic data, previous geospatial data analysis • Clean, prepare, and validate data for entry	• Build digital representation of current diagnostic system, including performance and costs • Validate baseline and document validation criteria • Identify gaps and refine questions to be examined in future state scenarios	• Adjust data inputs and apply constraints, e.g. turnaround time / service distance, budget constraints	• Run customized optimization scenarios using practical constraints • Assess impact of changing inputs / constraints in different scenarios on diagnostic capacity, cost, and patient access	• Refine and re-run scenarios, taking into consideration stakeholder feedback on priorities and practical feasibility • Prepare implementation plan for selected outputs, including activities, timelines, resources, and responsibilities
Estimated duration of each step					
2–3 weeks	4–6 weeks*	4–6 weeks	4–6 weeks		3–4 weeks

*Depending on availability and quality of data, and the ease of data collation across various sources. Durations mentioned above are indicative and do not include the time required for training on DNO and OptiDx.

Checklist Step 1: Prepare for analysis

1. Assess timing
2. Identify team members
3. Review resources and request access to OptiDx
4. Identify funding for DNO and need for technical assistance
5. Define scope
6. Create a work plan with roles and timelines

Step 2: Collate data

OptiDx requires data inputs related to sites, demand, tests, costs, and policies that define referral linkages and transport. The table below describes these inputs and corresponding potential data sources.

Variable	Data requirement	Data sources
Sites	• Location of health facilities from the Facility Master List (FML) • Testing capacity, including device-test availability	• District Health Information Software (DHIS) data and / or other health facility lists compiled by MoH • Testing capacity computed from site operating hours and device-test procedures
Tests	• List of facilities with diagnostic devices included in the DNO scope • Number of tests currently done at each site	• Laboratory Management Information System (LMIS) data, routine programmatic data on testing or research data
Demand	• Health facility catchment area	• Census or electoral data
	• Disease prevalence at each health facility	• Disease programme reports
	• Number of individuals tested (current state) or projected testing among eligible individuals (future state scenarios)	• Testing volumes from LMIS or testing registers • Estimates based on disease programme guidelines and diagnostic algorithms, and demographic and health system surveys
Referral and transport policies	• Sample volume and referral flows to and from each facility by test type • Modes and frequency of sample transport	• Data sources mentioned under 'tests' • Disease programme partners or regional authorities implementing sample transport
Costs	• Transport costs for sample referral	• Disease programme partners or regional authorities implementing sample transport • Couriers or other third-party providers
	• Equipment: capital costs and operating costs • Test costs: HR, supplies, consumables	• MoH, partners, and manufacturers or authorized service providers

Input data templates

You will need two Excel templates—**Scenario creation template** and **Costing template**—to collate and prepare data for entering into OptiDx. OptiDx requires data to be structured in such a way that it is readable for modelling purposes. Hence, the two templates provide detailed guidance on how to synthesize and populate raw data collected from various sources under various tabs and columns.

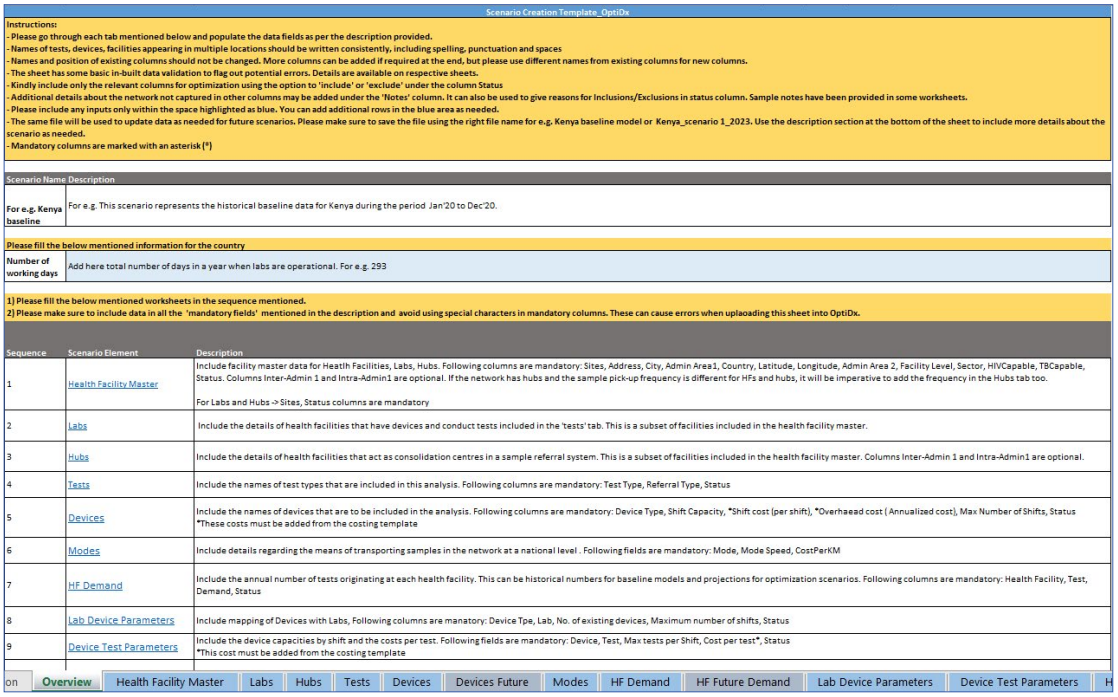
- Costing template: This template (Annexure C) incorporates various input parameters related to costs and calculates a cost per test for each test type. It feeds into the main input template, Scenario creation.

- Scenario creation template: This template is the main data input file to upload data into OptiDx. The template has multiple sheets to store input data for each variable (Annexure D). The first sheet provides instructions on how to use the template and a description of the data to be entered into the subsequent sheets.

Tips:

- Must-have data points include Facility Master List, device and test combinations, number of tests demanded at each health facility, number of tests conducted at each laboratory, and number of working days and hours per day.
- For an accurate baseline model, and to be able to accurately measure the impact of proposed network changes, it is good (but not essential) to have information on the existing sample referral network at the network level and more granular level, e.g. sample mode, frequency, working days / hours.
- Copies of the original Scenario creation template can be created and uploaded, in case of significant change to data inputs in future scenarios. Alternatively, minor data adjustments can be done directly in the app.

Scenario creation template in OptiDx



Scenario Creation Template_OptiDx

Instructions:
- Please go through each tab mentioned below and populate the data fields as per the description provided.
- Names of tests, devices, facilities appearing in multiple locations should be written consistently, including spelling, punctuation and spaces
- Names and position of existing columns should not be changed. More columns can be added if required at the end, but please use different names from existing columns for new columns.
- The sheet has some basic in-built data validation to flag out potential errors. Details are available on respective sheets.
- Kindly include only the relevant columns for optimization using the option to 'include' or 'exclude' under the column Status
- Additional details about the network not captured in other columns may be added under the 'Notes' column. It can also be used to give reasons for Inclusions/Exclusions in status column. Sample notes have been provided in some worksheets.
- Please include any inputs only within the space highlighted as blue. You can add additional rows in the blue area as needed.
- The same file will be used to update data as needed for future scenarios. Please make sure to save the file using the right file name for e.g. Kenya baseline model or Kenya_scenario 1_2023. Use the description section at the bottom of the sheet to include more details about the scenario as needed.
- Mandatory columns are marked with an asterisk (*)

Scenario Name	Description
For e.g. Kenya baseline	For e.g. This scenario represents the historical baseline data for Kenya during the period Jan'20 to Dec'20.

Please fill the below mentioned information for the country

Number of working days	Add here total number of days in a year when labs are operational. For e.g. 293

1) Please fill the below mentioned worksheets in the sequence mentioned.
2) Please make sure to include data in all the 'mandatory fields' mentioned in the description and avoid using special characters in mandatory columns. These can cause errors when uplaoading this sheet into OptiDx.

Sequence	Scenario Element	Description
1	Health Facility Master	Include facility master data for Heatlh Facilities, Labs, Hubs. Following columns are mandatory: Sites, Address, City, Admin Area1, Country, Latitude, Longitude, Admin Area 2, Facility Level, Sector, HIVCapable, TBCapable, Status. Columns Inter-Admin 1 and Intra-Admin1 are optional. If the network has hubs and the sample pick-up frequency is different for HFs and hubs, it will be imperative to add the frequency in the Hubs tab too. For Labs and Hubs -> Sites, Status columns are mandatory
2	Labs	Include the details of health facilities that have devices and conduct tests included in the 'tests' tab. This is a subset of facilities included in the health facility master.
3	Hubs	Include the details of health facilities that act as consolidation centres in a sample referral system. This is a subset of facilities included in the health facility master. Columns Inter-Admin 1 and Intra-Admin1 are optional.
4	Tests	Include the names of test types that are included in this analysis. Following columns are mandatory: Test Type, Referral Type, Status
5	Devices	Include the names of devices that are to be included in the analysis. Following columns are mandatory: Device Type, Shift Capacity, *Shift cost (per shift), *Overhaead cost (Annualized cost), Max Number of Shifts, Status *These costs must be added from the costing template
6	Modes	Include details regarding the means of transporting samples in the network at a national level . Following fields are mandatory: Mode, Mode Speed, CostPerKM
7	HF Demand	Include the annual number of tests originating at each health facility. This can be historical numbers for baseline models and projections for optimization scenarios. Following columns are mandatory: Health Facility, Test, Demand, Status
8	Lab Device Parameters	Include mapping of Devices with Labs, Following columns are manatory: Device Tpe, Lab, No. of existing devices, Maximum number of shifts, Status
9	Device Test Parameters	Include the device capacities by shift and the costs per test. Following fields are mandatory: Device, Test, Max tests per Shift, Cost per test*, Status *This cost must be added from the costing template

on | Overview | Health Facility Master | Labs | Hubs | Tests | Devices | Devices Future | Modes | HF Demand | HF Future Demand | Lab Device Parameters | Device Test Parameters | H

Tips on Costing template:

- Complete the User Selection sheet—including all possible test / device combinations that will be considered (for both baseline and future state scenarios)—before moving on to the Data Input sheets to avoid possible overwriting of data.
- Ensure that all country-specific assumptions and key parameters have been correctly inputted in Assumptions. Note that you can change them at any point.
- No changes can be made to the Results sheets, i.e. Device Cost and Test Cost, which are calculated based on the data entered in the Data Input sheets (green).
- Transfer the costs from the Device Cost sheet for shift cost, overhead cost, and start-up cost to the Scenario creation template (<Device>). Any international or local currency can be used.
- Transfer the costs from the Test Cost sheet to the Scenario creation template (<Device_Test>). Any international or local currency can be used.
- Ensure that, wherever available, you use drop-down options to enter data, which helps maintain the proper case font of the text data and helps avoid errors while uploading in the OptiDx app.

Tips on Scenario creation template: Data cleaning and validation

- Ensure correct geocodes are entered, based on the commonly accepted source for your country. You can use geocodes corresponding to each facility from pre-existing Health Management Information System (HMIS) / Laboratory Management Information System (LMIS) data. In case these are not available, you can use geocodes for the central point of corresponding towns / cities from publicly available sources.
- Ensure names of each facility, test, and device appear consistently throughout. No special characters can be included except underscore (__) which is used while defining facility and device names.
- Ensure the Health Facility Master List includes all facilities in the Health Facilities and Labs list.
- Make sure demand is expressed as the number of tests per year. Ensure working days and shift duration are captured accurately for your country, since this affects how total available capacity is calculated by OptiDx.
- Each lab might have multiple devices for the same or different test types, all of which should be included.
- All mandatory fields in the Scenario creation template should be populated.
- After data is populated in the Scenario creation template, check for cells that have been highlighted in red, which flags duplicate records or inconsistent data with respect to the master tables.
- Rectify the highlighted cells by checking for a record with the same name in the respective master tables. If the record is highlighted in the Historical Testing tab, check columns I, J, and K to find the inconsistent data source, and rectify it accordingly.
- Make sure that the site names in the Health Facility Master tab and device names in the Device tab have, respectively, 50 and 20 characters or less. Text highlighted in orange exceeds the character limit and must be shortened accordingly.
- Ensure that, wherever available, you use drop-down options to enter data, which helps maintain the proper case font of the text data and helps avoid errors while uploading in the OptiDx app.

Checklist Step 2: Collate data

1. Download Costing template and Scenario creation template from www.OptiDx.org (see Annexures C and D).
2. Identify data sources and collate data.
3. Review closely the instructions included in the data templates, and then add data.
4. Use the notes section to record important data assumptions.
5. Check for flagged data validation (in red) and make corrections.
6. Keep note of the file name for easy retrieval at the time of upload. Use of standard file nomenclature is recommended.
7. Once the dataset is ready, consider organizing a validation workshop with relevant stakeholders before uploading into OptiDx.

Tips on using OptiDx:

- Throughout the app, as well as under 'Include new country', you can edit data directly in the data tables. The columns that cannot be edited in that specific table are greyed out.
- To make changes to several rows at once, use the 'edit in Excel' or 'bulk update' feature, available at the top of each data table. Remember to click on the 'save' button at the top of the data table after making any changes.
- You will need to download the editor plug-in from llama.ai to be able to use the 'edit in Excel' feature. Steps to download the plug-in are included in Annexure E.
- If you delete rows in 'edit in Excel', make sure that you accept the pop-up that confirms that you want to delete those rows.
- Each action in OptiDx can take up to several minutes to run. The runtime depends on model size, which affects complex back-end processes, e.g. build referral linkages, commit devices, and run baseline.
- After committing data / running each step, the selected button turns grey. Once the action is complete, it returns to the original colour. At this point, you may proceed to the next step.

Step 3a: Build preliminary baseline model

Purpose: This section describes the process to create a new country and upload data into OptiDx in order to build a preliminary baseline model of a network and review the outputs. The purpose of this preliminary baseline model is to create a digital representation of how the network is physically set up, based on the essential data inputs mentioned in the preceding section, i.e. number of tests conducted, number of devices available, location of testing demand, and current testing capacity and costs. At this stage, the model does not accurately reflect the performance of the network, i.e. device utilization, costs, and service distances. It is first necessary to review whether the model is mapped correctly, i.e. number and location of sites, devices, inputs for calculating capacity, demand volumes, etc. Once you have built and reviewed this preliminary baseline model, you can use the Create and Run Scenarios section to:

1. build a historical baseline model, if you have actual data on referral volumes and lanes (i.e. which health facilities are referring samples to which laboratories), and maximum allowable distance (MAD). A historical baseline model enables you to map how the diagnostic network is currently functioning, identify gaps for improvement, and set a benchmark for comparison against future scenarios.

2. build optimized baseline or optimized future state models ('scenarios') that incorporate data estimates / assumptions based on the scope of your analysis. You can compare scenarios to identify the 'best-fit' solutions to meet testing demand within constraints. Note, however, that you must set up your historical baseline model (see above) to compare scenarios with the current performance of your network.

Please note that only users defined as 'Country admin' have access to the 'Settings' section to perform step 3a and build a new country model.

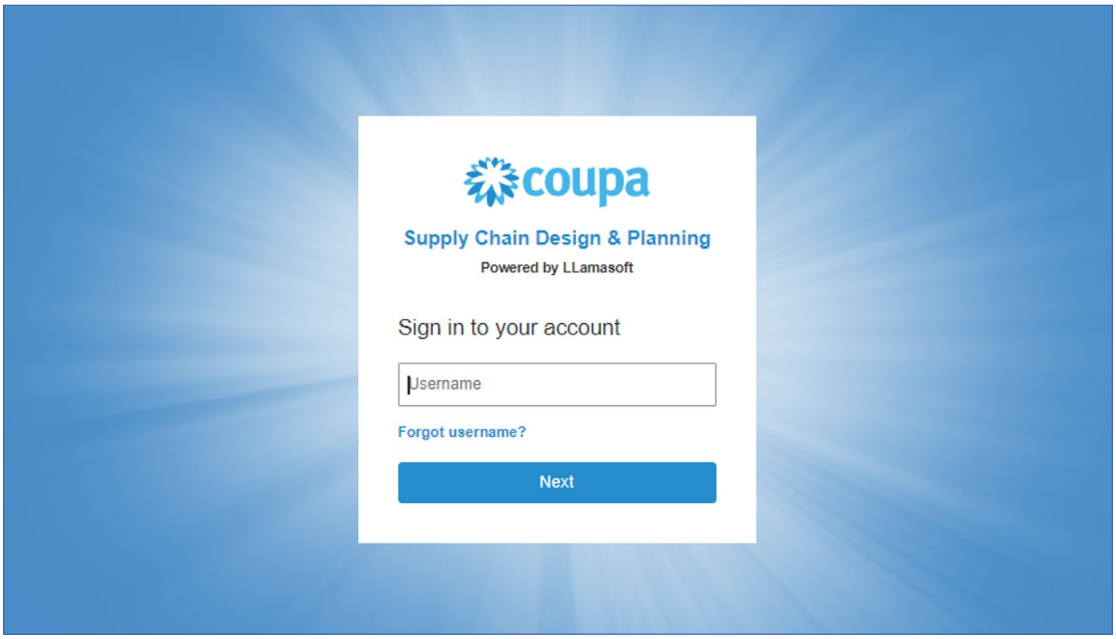
Tips:

- After completing each step, click the 'Commit' button on that page before proceeding to the next step.
- Click on the 'Back' button after each step to return to the main screen, Populate Model with Excel data, for new country creation.
- If you do not complete the process in one go, you can resume the process from the last step that was saved.
- Note that the Scenario creation template includes dummy data for guidance. Please delete the existing data and add your country data.

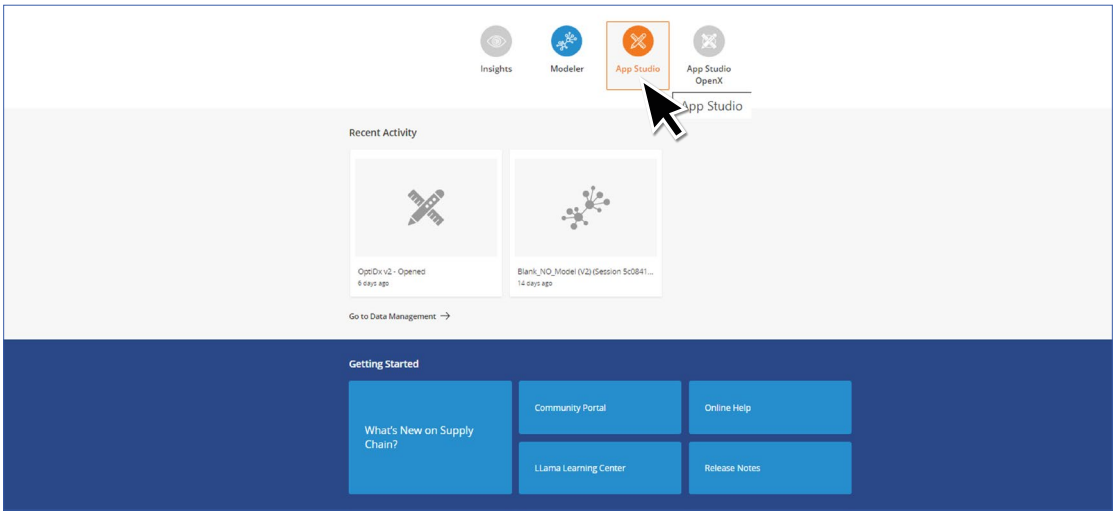
App navigation: Go to web browser (compatible with all browsers, but Google Chrome is preferable) > Go to **us.llama.ai** > Go to App Studio > OptiDx landing page > Settings > Include new country

Steps:

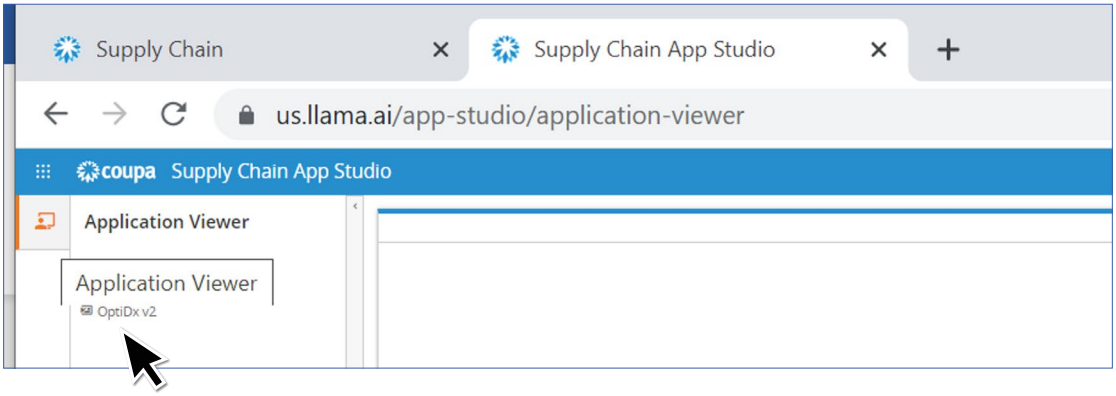
Type **us.llama.ai** in your web browser. Enter the username and password that you received via email from Coupa after registering.

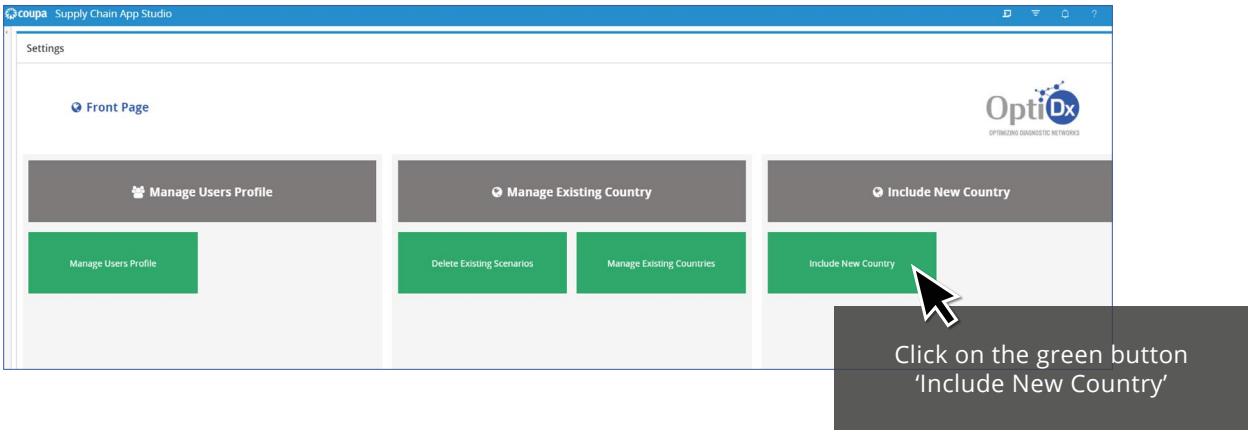


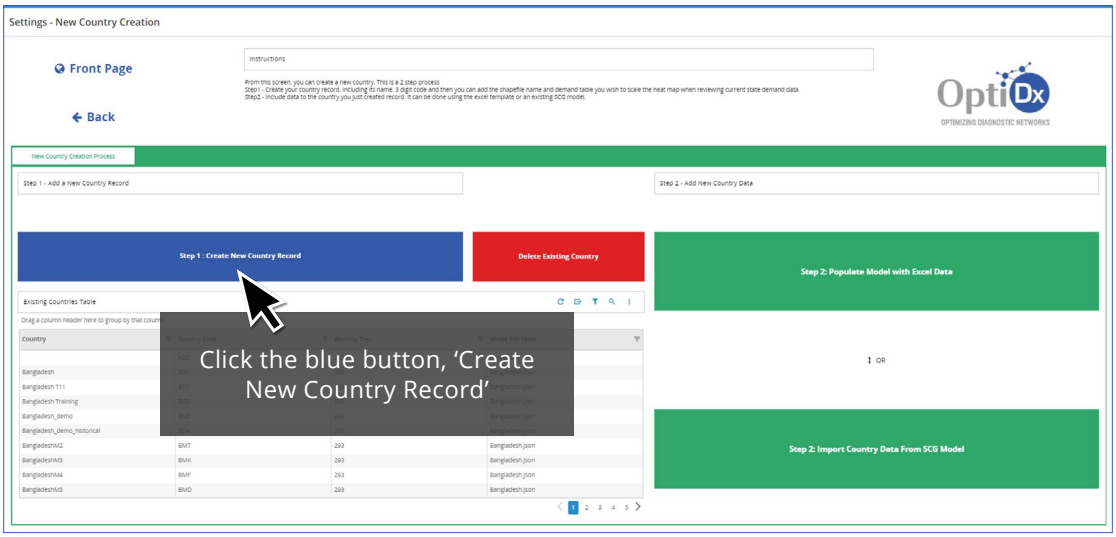
Once connected, go to the App Studio to reach the OptiDx app.



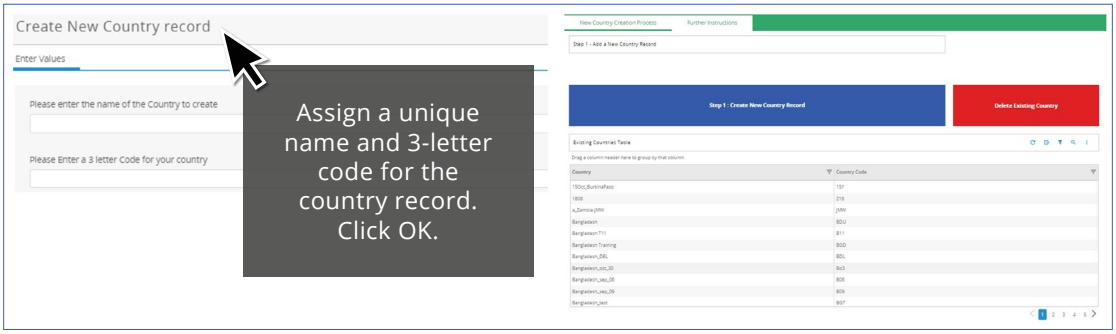
Click on Application viewer and select OptiDx V2.



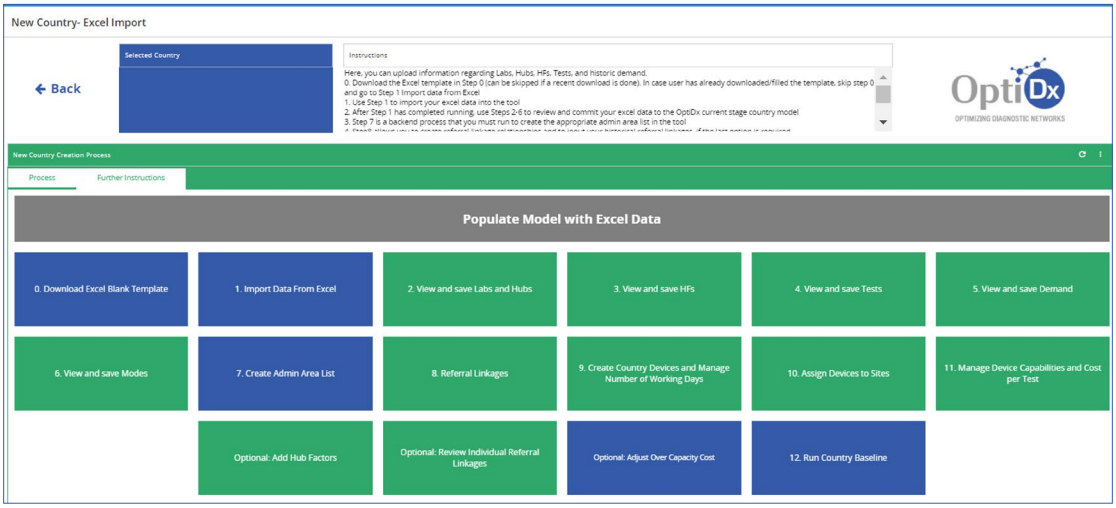




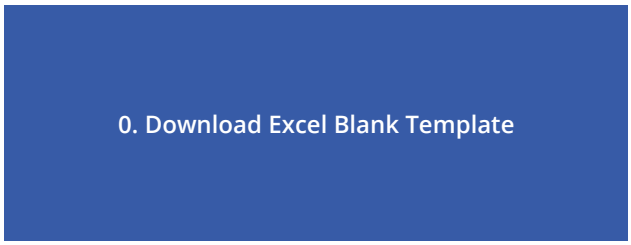
Next, 'Create a new country record'. Add name and 3-digit code, and then click 'OK'. Your country will show up in the table.



Then, on the Populate Model with Excel Data screen (pictured below), move through steps 0 to 11 to add new country data. You will return to the Populate Model with Excel Data screen after each step. Click on the next step to continue.

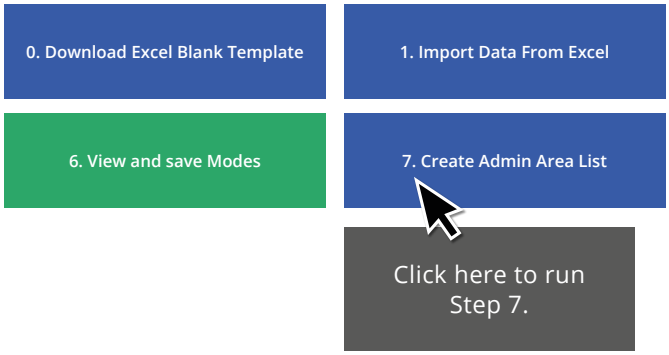


Step 0 and 1: Download Scenario creation template, add data, and then upload template to import data into OptiDx. (Detailed instructions on the Excel template are provided in Step 2.) Once the data is successfully imported, you will receive a confirmation via email.



Steps 2-6: Data from the Scenario creation template (uploaded in the previous step) will populate tables in steps 2-6. From the Populate Model with Excel Data screen (shown above), click on each step to review and commit data. Steps 7-10 are dependent on steps 1-6, and all the steps need to be reviewed and committed to create a new country model. Each step needs to be completed in the defined order. At the end of each step, remember to click 'Commit', and then click the 'Back' button to return to the main screen to continue with the subsequent steps.

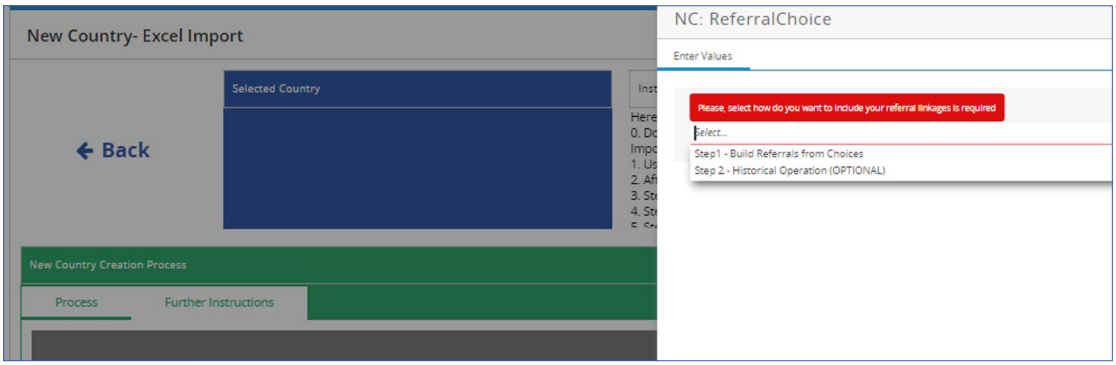
Step 7: Create Admin Area List requires that you click the button to allow the software to run in the back end. This step automatically creates a list of administrative regions within the country (e.g. provinces, districts), based on the data uploaded in the previous steps. Once you click the button, it will turn grey. The button will revert to blue once the process is complete.



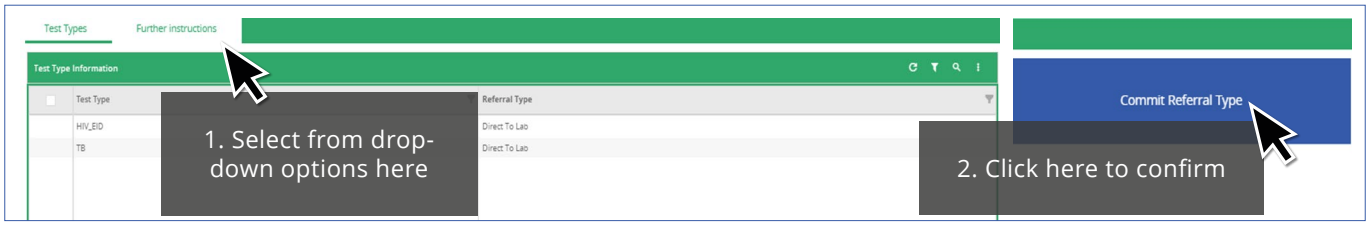
Tip:

- Make sure to set up referrals carefully in the New Country Creation process, since that allows you to test various combinations for optimization. Include current referral policies at Admin 1 levels, as well as any potential referral policies that you might want to consider in the future. For example, if your baseline model restricts samples from moving between Admin 2 areas, the model might fail to run if you test that option in future scenarios. This setting can be changed as needed in future scenarios.

Step 8: Click on **Referral Linkages**, and then select 'Build referrals from choices' to set up referrals between health facilities and hubs or testing laboratories. (Hubs and testing laboratories allow all samples to flow between all Admin 1 areas.) This is important, since it will allow future optimization models (built on this preliminary baseline model) to consider different combinations of referral policies, e.g. allow or restrict different types of samples to be referred across Admin 1 and Admin 2 areas. There is also a second option, Step 2: Historical Operation (Optional) which does not need any action at this stage. You can incorporate historical operations after the preliminary baseline model is built.



Creating Referral Linkages involves multple steps (Step 8a-e). **Step 8a:** Set whether samples go directly to the lab or pass through a hub, or whether both options are possible. You can make this selection via the drop-down option in the referral linkages column, and then click the blue button to commit the selection.

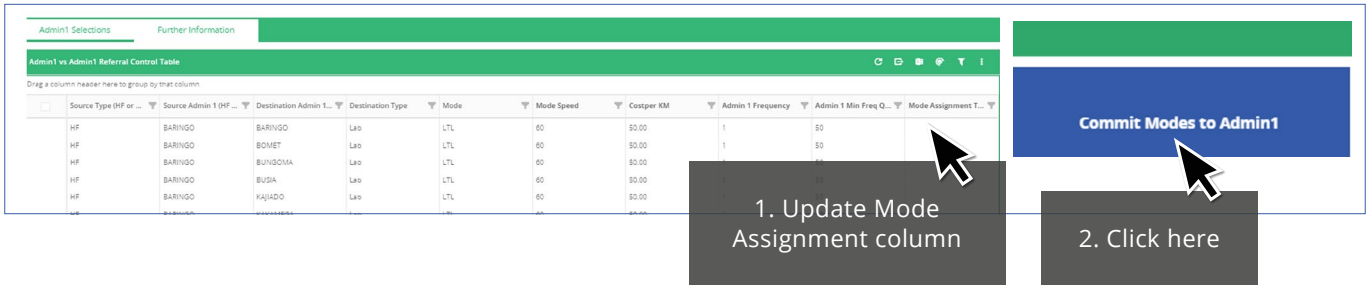


Step 8b: Use the 'Mode assignment' column to select how samples can be moved from Source (collection sites, i.e. health facilities) to Destination (testing sites, i.e. laboratories), and by which transport modes, within Admin 1 and Admin 2 areas. You have two options here:

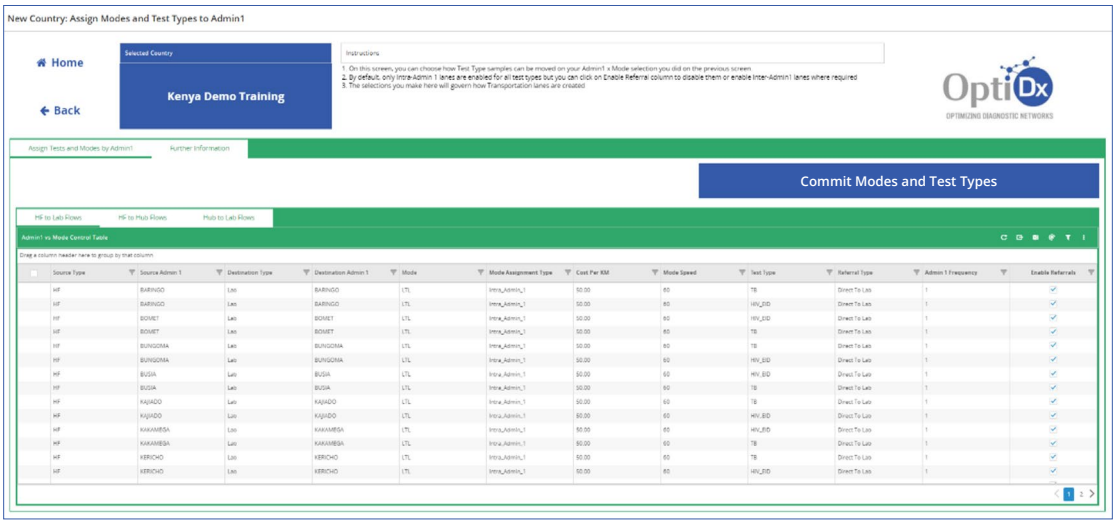
1) Inter-Admin 1, i.e. samples can be referred and transported to a laboratory in a different Admin-1 area

2) Intra-Admin 1, i.e. samples can only be referred to a laboratory that is located in the same Admin-1 area as the health facilty where the sample is collected

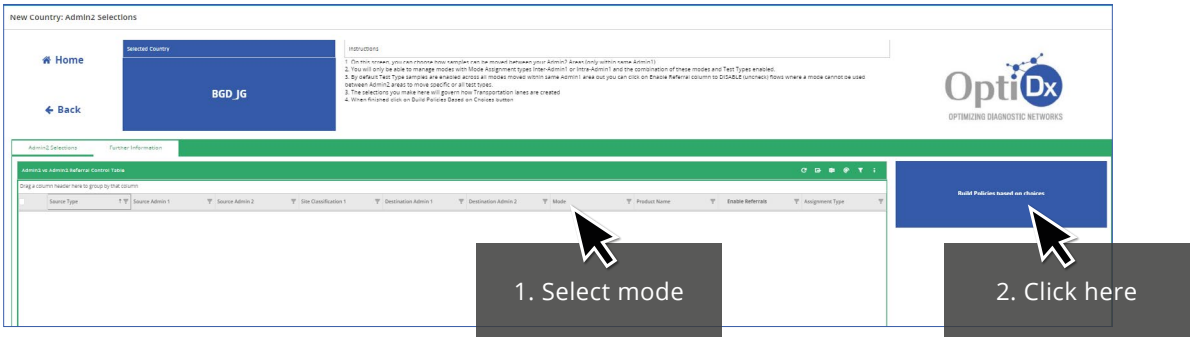
You can use the 'bulk update' function if referral rules are mostly uniform across all tests and admin areas, and use 'edit in Excel' to edit those that are different. For the purpose of this guide, we select 'Inter-Admin1' mode assignment in the Admin1 selections table, and then click the blue button, Commit Modes to Admin 1.



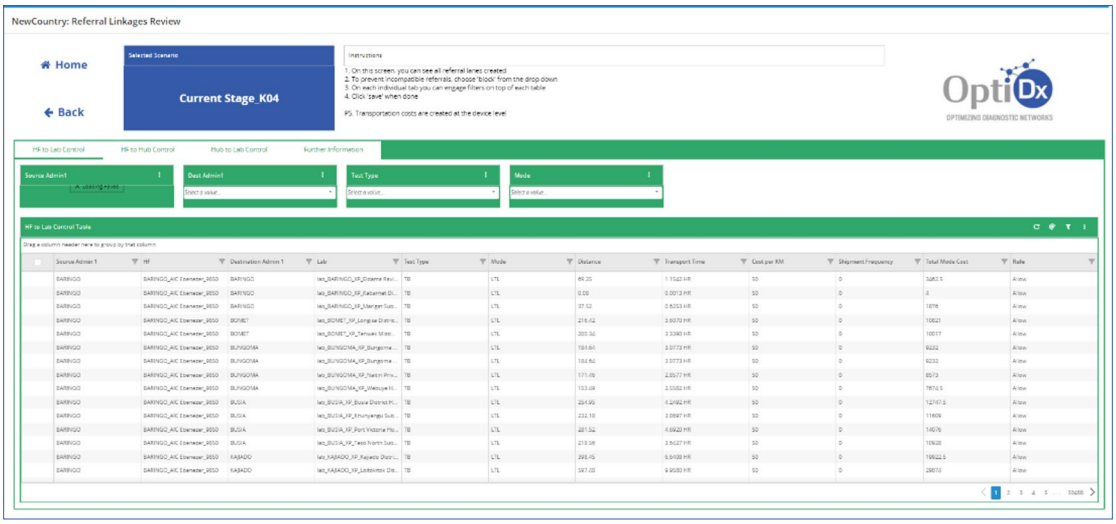
Step 8c: Based on selection in Step 8b, Inter-Admin1 (i.e. between Admin 1 areas) linkages will be created for Health Facility (HF)-Lab and Hub-Lab nodes, and Intra-Admin1 (i.e. within Admin 1 areas) linkages will be created for HF-Hub nodes. Only Intra-Admin1 linkages are enabled by default, since an un-restrictive selection may increase model complexity. Users may proceed with the default selection or select additional lanes by test type, depending on their high-level referral policy, then click 'Commit Modes and Test Types'.



Step 8d: Referral lanes are defined at Admin 2 level based on your Admin 1 level selections in the previous step. Simply review and commit the selections to the model by pressing the blue button Build Policies based on choices, as in the screenshot below. If certain referral linkages are not possible between the source-destination pairs at the Admin 2 level, select 'disable'.



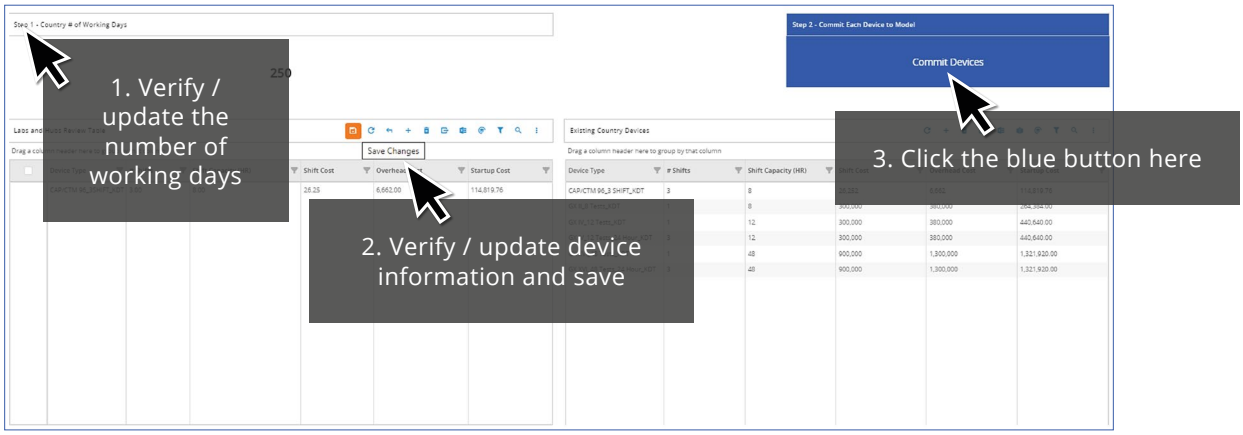
Finally, **Step 8e:** once the creation of referral linkages is complete, you can review the referral lanes at a granular level and block any specific referral linkages that are not applicable. Then click on the 'Back' button to return to the Populate Model with Excel Data screen to move on to the next step.



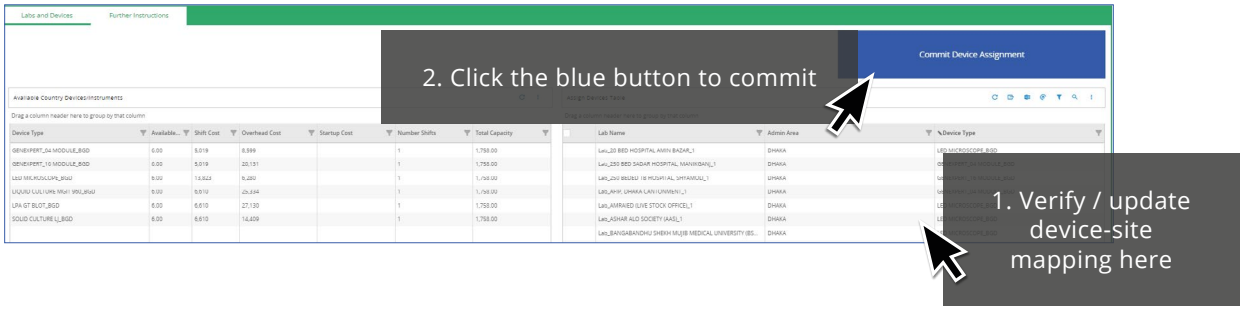
Step 9: Create Country Devices and Manage Number of Working Days allows you to update the number of working days by clicking on the number '250'. In the pop-up box, you can add the appropriate number of days. Next, use the table on the left to make changes, and save those changes using the orange icon (see screenshot below). Then, verify the device information by clicking the blue button, 'Commit Devices'. Each device must be verified individually. Once all devices are committed, click the 'Back' button to return to the Populate Model with Excel Data screen.

Tip:

Make sure that all relevant devices are committed in Step 9. Only committed devices will be visible in Step 10.

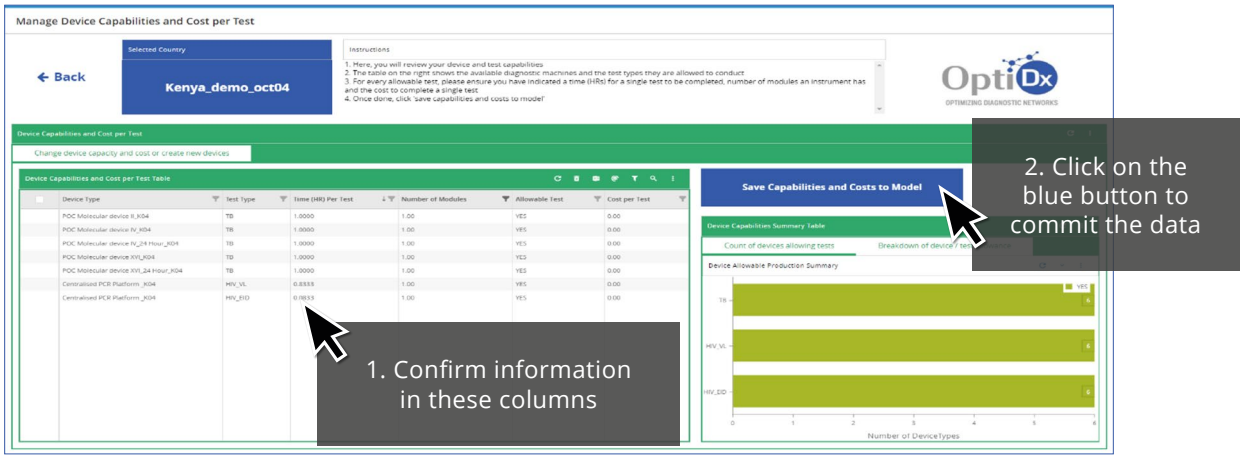


Step 10: With **Assign Devices to Sites**, you can confirm or make changes to the assignment of devices to testing sites (per the data uploaded). Review the list of devices and sites, and click the 'Commit Device Assignment' button in blue.



Click the 'Back' button to return to the Populate Model with Excel Data screen.

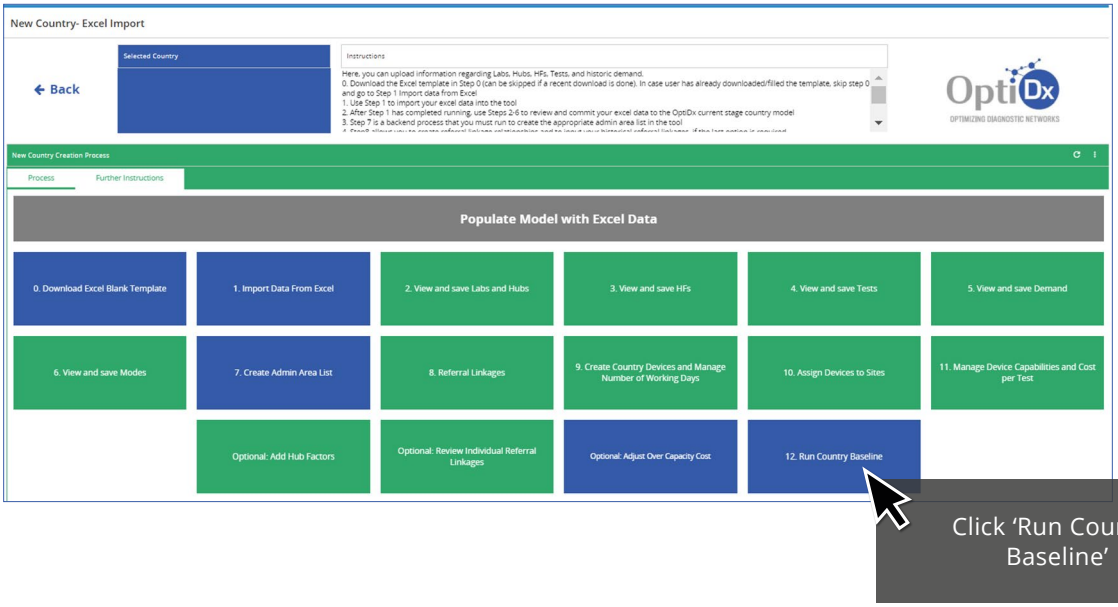
Step 11: Manage Device Capabilities and Cost per Test to confirm or make changes as needed to: the time per test, the number of modules, which tests are allowed on which devices, and the cost per test. Include a time per test for each row. The Number of Modules needs to have a default value of 1.00, irrespective of whether the device has modules or a number of modules. Under Allowable Test, select 'yes' if that device can execute that test, and 'no' if not. Click on the blue button, 'Save Capabilities and Costs to Model', to close this step and proceed to Step 12.



It is recommended that you not use the optional features, listed below, while building a preliminary baseline model during the New Country Creation process. It is more convenient to use these, if needed, in Make Changes to a Scenario.

- Add Hub Factors: This feature allows you to add various categories to define health facilities in your network, based on your local context.
- Review Individual Referral Linkages: This feature can be used to make granular updates to the referral policy.
- Adjust Over Capacity Cost: This feature is used to adjust the penalty costs associated with devices going over capacity in the model, if needed.

Step 12: Run Country Baseline.



Checklist Step 3a: Build preliminary baseline model

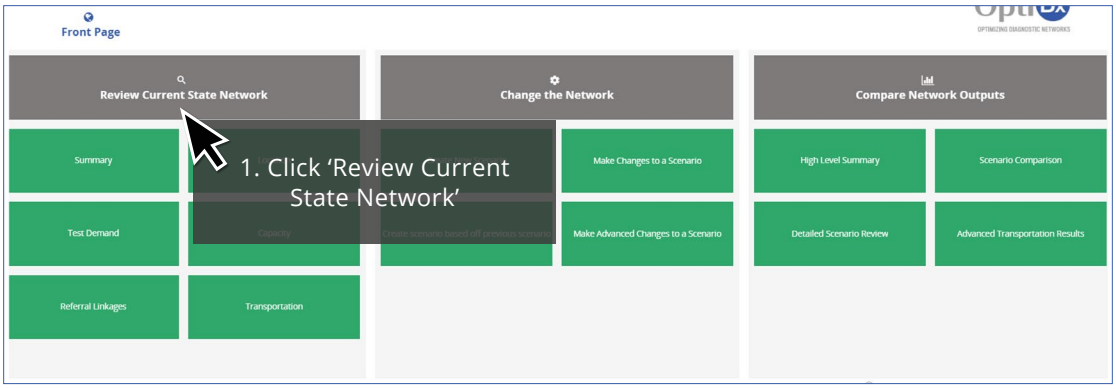
1. Create a new country.
2. Upload data from Scenario creation template via the Populate Model with Excel Data screen (steps 0 and 1).
3. Review and commit data to the model (steps 2-7).
4. Build device-site combinations and define referral linkage policies (steps 8-11).
5. Run the model.
6. Proceed to Review Current State Network, or make changes to network, as needed.

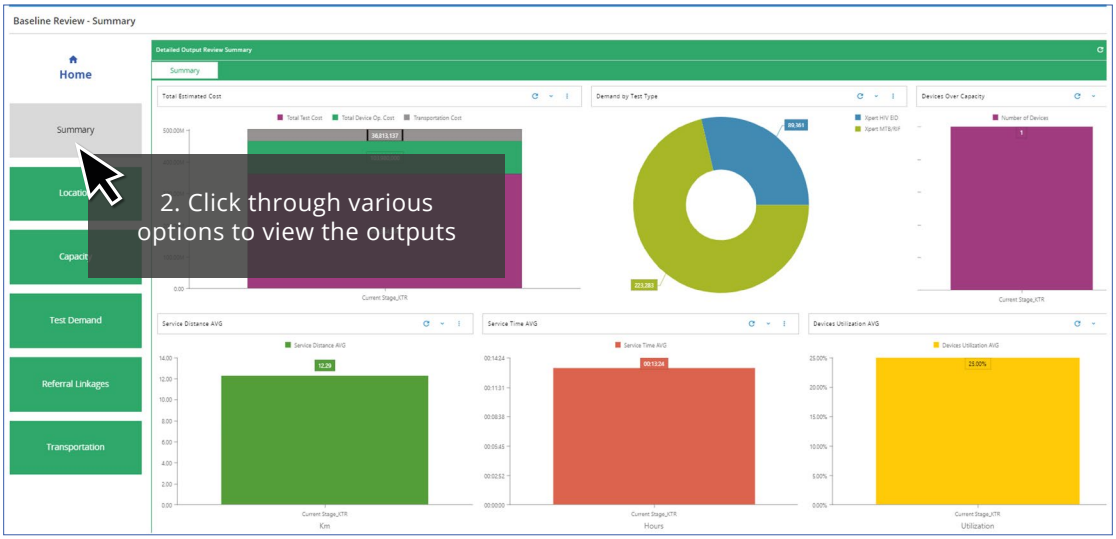
Step 3b: Review preliminary baseline outputs

Purpose: In this step, you can review the preliminary baseline model, including its basic layout and structure, and then make changes as required, before proceeding to build your historical baseline model or optimized scenarios.

App Navigation: Landing page > Select Country > Go > Review Current State Network

Steps:





Move through the various options that are in the vertical bar on the left side of the screen to see their key metrics / outputs.

Summary: View key outputs at the overall network level.

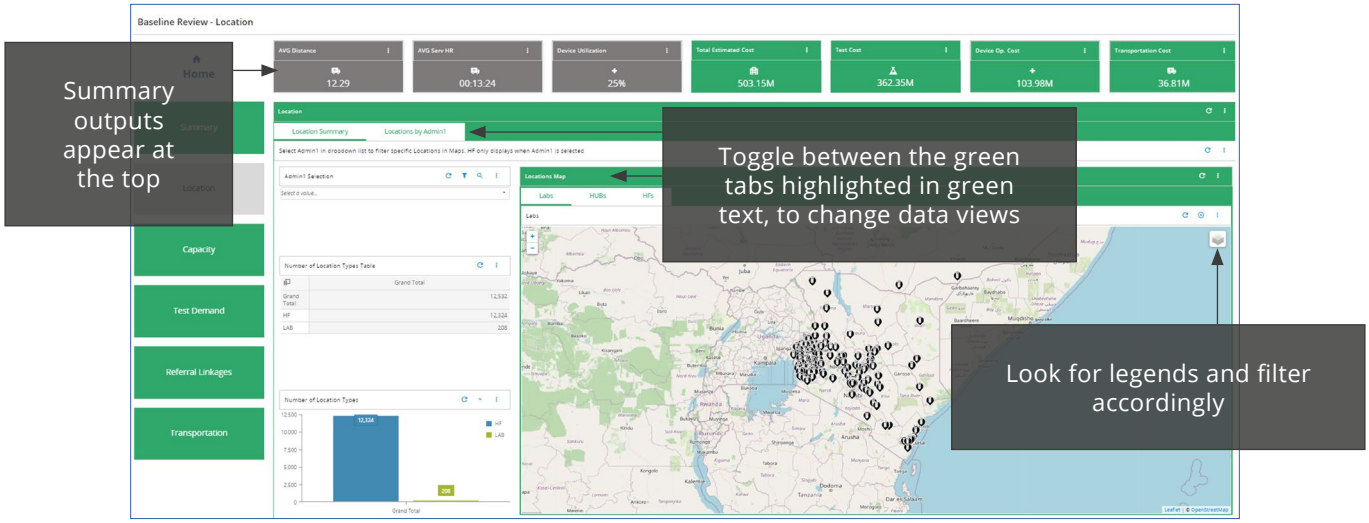
1. **Total Estimated Cost:** Countries may elect to use local or international currency in the model.
   - **Total Test Cost:** Cost of reagents to run tests on the devices.
   - **Total Device Operating Cost:** Device Operational Cost, including the cost of Lab Tech per shift, Device Acquisition Cost, and Annual Operating Cost.
   - **Total Start-up Cost:** Annualized fixed cost that would apply to a new device being installed at a new site. It includes all costs associated with setting up a new laboratory or testing site for a new device, including equipment and infrastructure.
   - **Total Transportation Cost:** Cost incurred to move test samples from health facilities to laboratories.

Tips:

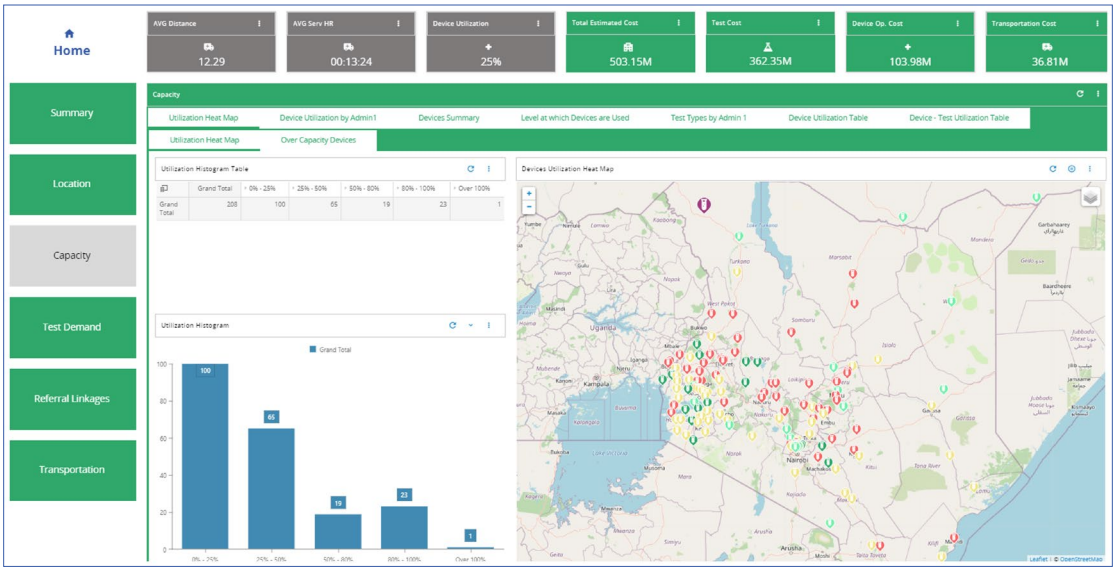
- The key summary outputs appear at the top of each screen in Review Current State Network.
- Tabs highlighted in green on each page help you view disaggregated outputs, e.g. by test type, sites, or admin areas.
- Check for filters on tables, maps, and graphs to view by a specific type of data.

2. **Demand by Test Type:** Number of tests per test type being considered.
3. **Devices Over Capacity:** Number of devices performing more tests than their available capacity per day (which can lead to bottlenecks and delays in testing).
4. **Service Distance AVG:** The average distance (in kilometres) that samples must be transported for testing.
5. **Service Time AVG:** The average time (in hours) for samples to be transported from the collection site to the testing site. Average service distance and time are calculated on the basis of a straight line between health facilities and labs (not actual road distances).
6. **Device Utilization AVG:** Average utilization of devices based on tests conducted, expressed as percentage of the total available testing capacity on that device.

Location: View locations of Health Facilities, Hubs, and Labs at a network level (Locations summary) and at different geographic levels (Location by Admin 1).



Capacity: View information related to utilization of testing capacity at a network level or by devices, test types, and admin areas.



1. **Devices Utilization Heat Map:** Colour-coded map in which you can visualize device utilization. Colours denote the following:
   - Red: Utilization 0-25%
   - Yellow: Utilization 25-50%
   - Light Green: Utilization 50-80%
   - Dark Green: Utilization between 80-100%
   - Purple: Utilization >100%

   Utilization Histogram: Graph and table displaying the number of sites by each utilization range (described above).

   Over Capacity Devices: Table with detailed information on the devices that are over capacity (>100%).

2. **Device Utilization by Admin1:** A graph with device utilization (number of tests done and utilization rate) by Admin 1 area that can be filtered by Admin 1 area and / or test.

3. **Devices Summary:** A histogram with the utilization rate by device type and a device utilization table with the utilization rate by device type that can be filtered by Admin 1 area

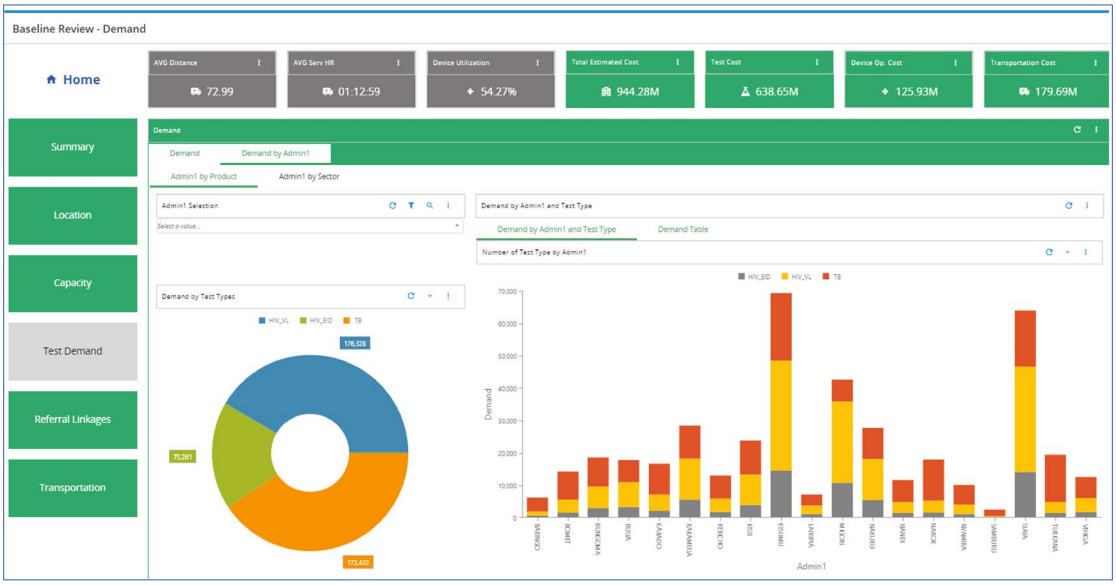
4. **Level at which Devices are Used:** Visualization of the number of devices per shift per Admin1 area.
   - Not running tests: Device not being used
   - Open at Level 1: Device operated on 1 shift
   - Open at Level 2: Device operated on 2 shifts
   - Open at Level 3: Device operated on 3 shifts

5. **Test Types by Admin1:** A histogram and table with the number of tests conducted by test type and Admin 1 area that can be filtered by admin1 area and / or test type. A doughnut graph that represents the proportion of each test type in a selected admin area.

6. **Device Utilization Table:** Provides detailed information on each device type.

7. **Device-Test Utilization Table:** Provides detailed information on each device that can be filtered by test types.

Test Demand: View location and volume of testing demand in the network.

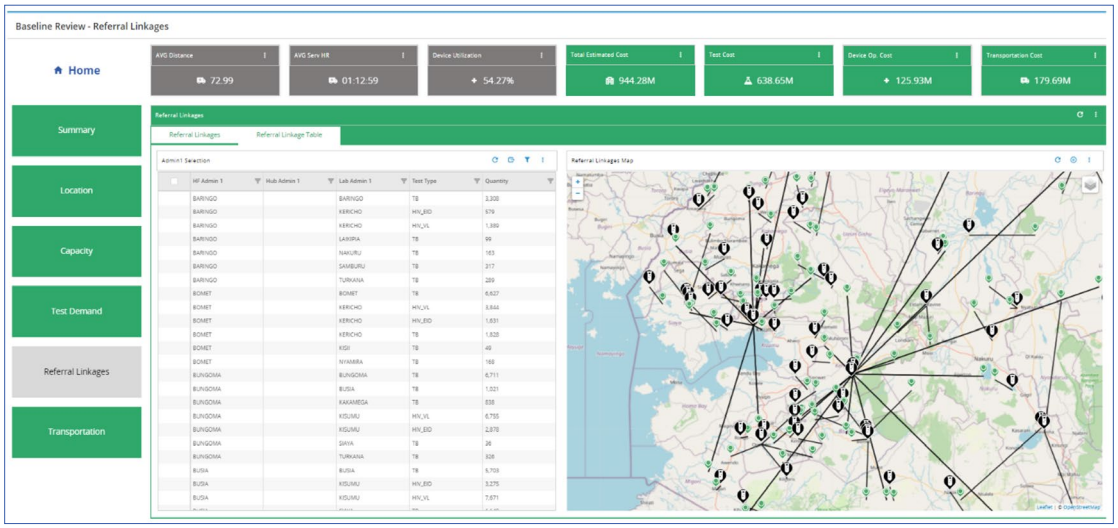


1. **Demand:** A bar graph and table displaying the total number of tests required to satisfy the network demand.

2. **Demand by Admin1:** A bar graph displaying the number of tests by each test type required to satisfy the demand of each Admin1 area.

Referral Linkages: View of the sample referral linkages in the network between health facilities, hubs, and laboratories.

1. **Referral Linkages:** Visualization of the referral linkages between Admin1 areas for the selected country. Points on the map denote average of the locations on each referral flow lane by test type.



2. **Referral Linkage Map:** A map showing types and volumes of samples being referred. This map can be filtered by Admin 1 areas and depicts the referral lanes that are selected in the adjoining table.

Transportation: View of sample transportation costs, average service distance, and average service time by Admin 1 area.

1. **Transportation Summary:** Three histograms depicting the Transportation Cost, AVG Distance, and AVG Time that it takes to move samples by Admin1 area. Using the blue button, 'Click to change Charts sorting option', information in the bar graph can be arranged by admin areas or values (ascending order), as needed.

2. **Distances Histogram:** A histogram and table that provide the number and percentage of tests transported between health facilities and laboratories, by distance bands, that can be filtered by test type.

3. **Flows Over MAD:** Visualization of the number of trips done over the maximum allowable distance (MAD) defined for the country. (Please note: This tab will appear blank if you have not applied a MAD constraint.)
    - **Flows Over MAD:** Visualization of number of trips done over the maximum allowable distance defined for the country.
    - **Flows Over MAD Map:** Visualization of all Flows Over MAD. Users can filter by Admin1 areas and Test Types.
    - **Flows Over MAD Table:** Detailed information on the Flows over MAD. You can also check the MAD defined by each combination.
4. **Transportation Map:** Referral lane level hub-spoke maps connecting HFs, Hubs, and Labs.
5. **Transportation Table:** Detailed information on referral flows between origin & destination nodes.
6. **Transportation Table Multi-Echelon:** Detailed information on referral flows between origin and destination nodes. It is especially useful when the network includes Hubs.

Checklist Step 3b: Review preliminary baseline outputs

- **Review outputs of the preliminary baseline model to ensure that the structure of the diagnostic network has been adequately captured.**
- **Discuss with all relevant stakeholders to validate inputs and assumptions and adjust as needed.**
- **Refine optimization questions and inputs for future scenarios based on detailed analysis of the current state.**

Step 4a: Run scenarios

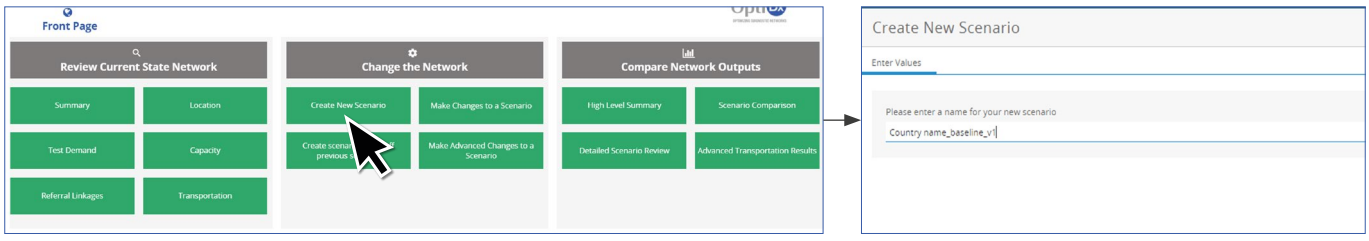
OptiDx allows you to build optimization 'scenarios', i.e. alternative potential configurations of the diagnostic network, by adjusting factors such as site locations, capacity, utilization, and sample flow, and by applying constraints such as maximum allowable distance (MAD). Analysing these scenarios helps assess and visualize the capacity of potential network changes to address specific objectives in a cost-efficient way, such as increasing access to testing or introducing a new test. You can also compare these potential new configurations with the current network design. Stakeholders' critical appraisal of the outputs of initial scenarios will also generate insights that help refine the scenarios. This iterative process is fundamental to developing the most appropriate interventions with OptiDx.

Tips:

- Designing and running scenarios is an iterative process. The aim is to analyze the impact of changing different input parameters and assumptions on network structure and performance.
- Based on the scope, identify a set of preliminary scenarios. Discuss the scenarios and inputs / constraints with stakeholders and run an initial round of scenarios. Review outputs of these scenarios with stakeholders and identify the next set of scenarios.
- Once a scenario is created, you can access them at any time by searching Make Changes to a Scenario.
- You can make multiple types of changes to each scenario, e.g. increase demand, add new test, and add new devices. You can run each type of change as a separate scenario or make multiple changes within a single scenario, depending on the objective.

The following paragraphs describe the step-by-step process to build and run scenarios:

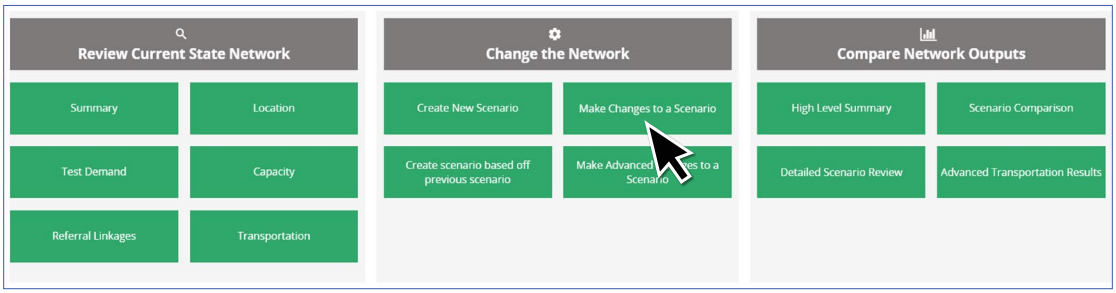
For all examples below, the first step is **Create New Scenario**. Give it an appropriate name (e.g. 'Country name_baseline_v1') and click 'OK' in the lower right-hand corner of the page.



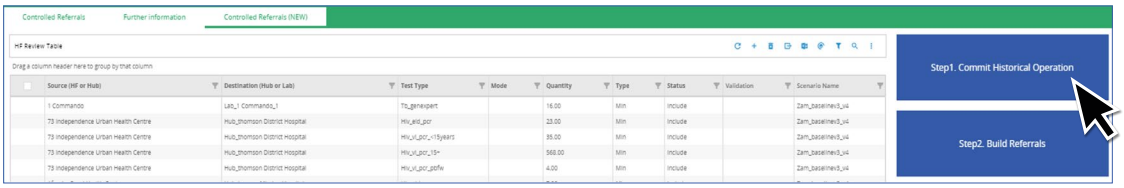
Incorporate historical sample referral / Build historical baseline model

Purpose: In this step, you create a historical baseline model based on past testing volumes and / or referrals. Building this model helps visualize the current performance of the network and sets a benchmark to enable comparison with potential network designs.

App navigation: Front page > Change the Network > Make Changes to a Scenario > Controlled Referrals



Review the data here. It should represent the data in the Historical Operations of the OptiDx Input data template. Click 'Step1. Commit Historical Operation', and run the model.



Tips:

- To enforce historical referral pathways, check that the 'Type' column is set to 'Min' (which refers to the minimum number of samples to be transported between a health facility and laboratory), and that the 'Status' column is set to 'Include'.
- Do not click 'Step2. Build Referrals', since it will use default values to build referrals, overwriting those built in the New Country Creation process.

Change demand levels

I. Existing demand

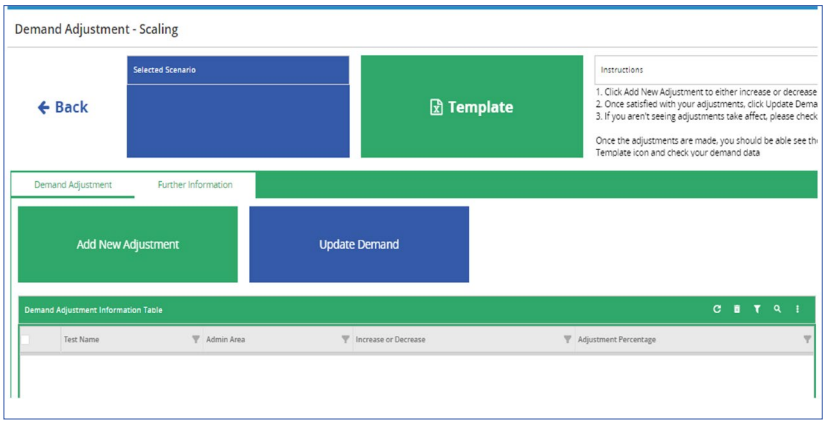
Purpose: While building future scenarios, demand for various existing tests and health facilities might change for a variety of reasons, such as change in the testing algorithm or population growth rates.

There are two options to update existing demand:

1. **Demand Scaling:** You can scale up or down demand at the overall network level or by Test type / Admin 1 area. This applies the scaling factor on all the sites conducting that particular test in the corresponding admin.

App navigation: Make Changes to a Scenario > Change Demand Level > Demand Scaling > Set Adjustment Factors to be applied across demand data sets at a time

- Click on 'Add new Adjustment'.
- Select the test / Admin1 and desired percentage adjustment.
- The pie chart on the right should be updated.
- Press 'Update Demand' button.
- Press 'Back' to return to the Make Changes to the Scenario screen and press Run Model.

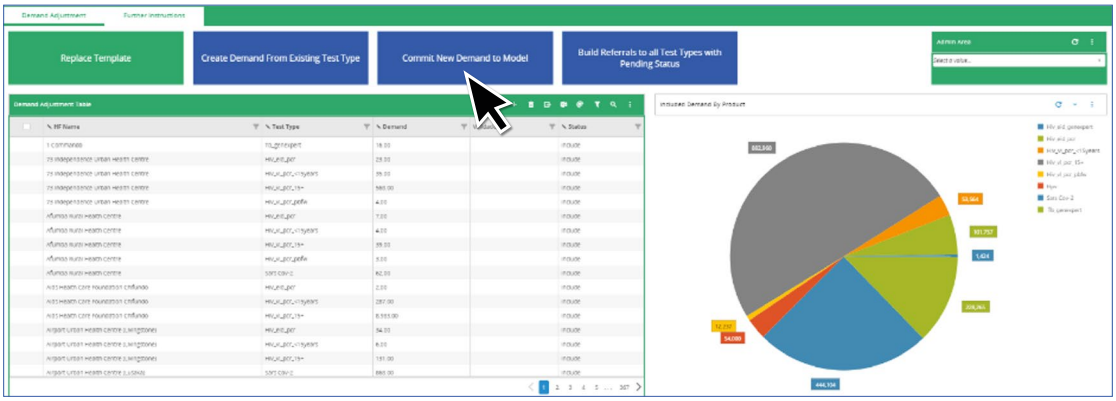


2. **Manually edit individual demand records**: You can use the 'edit in Excel' feature to manually make changes to demand data. This is recommended if you anticipate varying degrees of change in demand volumes across test types / Admin 1 areas.

App navigation: Make Changes to a Scenario > Change demand level > Demand template-manually edit individual demand records

Steps:

1. Select 'edit in Excel' button on the upper left-hand side of the 'Demand Adjustment Table'. The table should open in a temporary Excel file.
2. Delete old records and paste in your new data. Make sure the 'Status' column is set to 'Include' for all tests. Save the Excel table and then exit.
3. Click 'Commit New Demand to Model'. The pie chart should update to include the new demand by test type.
4. Press 'Back' to return to the Make Changes to the Scenario screen and press Run Model.



II. Adding new demand tables

Purpose: If new health facility-test combinations have been added (e.g., you have added demand for a test type at a health facility that previously did not have demand for that test type), then it is necessary to build new referrals for them.

App navigation: Make Changes to a Scenario > Change demand level > Demand template-manually edit individual demand records

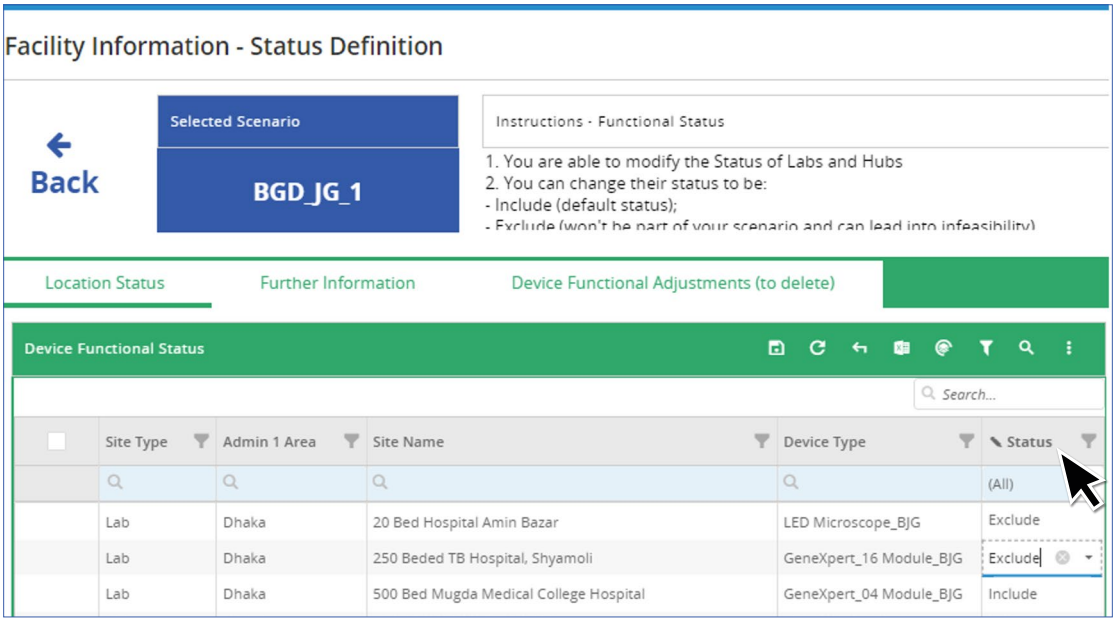
Steps:

1. Click 'edit in Excel' button on the upper-left hand side of the 'Demand Adjustment Table'. The table will open in a temporary Excel file.
2. Make sure the 'Status' column is set to 'Include' for all tests, and that all tests include the scenario name. Save the Excel table and then exit.
3. Click 'Commit New Demand to Model'. The pie chart should update to include the new demand by test type.
4. You may need to create referral linkages for new test types or health facility-test combinations in the demand table. For new test types, you can use buttons for either 'Build Referrals to all Test Types with Pending Status' or 'Overwrite Referral Linkages'. For new health facility-test combinations, select the latter. The process of overwriting referral linkages is similar to creating referral linkages (covered in New Country Creation).
5. Run Model.

Include or exclude devices or labs

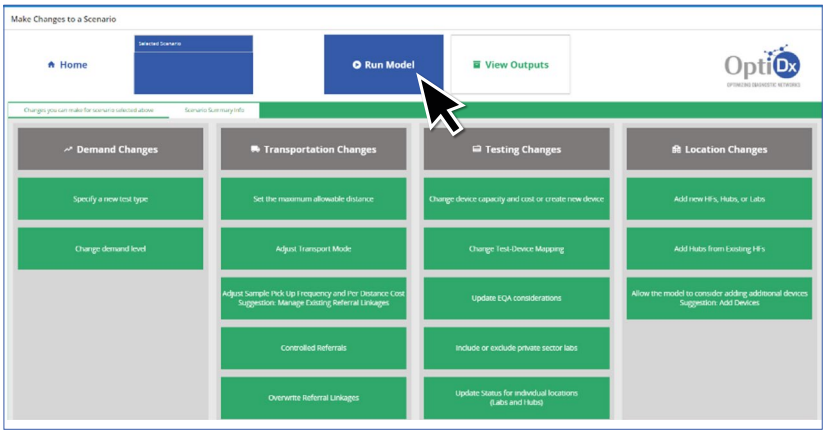
Purpose: While building future state scenarios, you might want to exclude certain devices or labs, e.g. when devices are being discontinued, or when shifting from centralized to point-of-care devices.

App navigation: Make Changes to a Scenario > Update Status for individual locations (Labs and Hubs)



Steps:

1. In Location Status, filter by Device Type. The default Status is 'Include'. Change the Status to 'Exclude' for that device type, or change Status to 'Exclude' for the labs you wish to close. If you select 'Consider', the model will include the site if optimal for that scenario.
2. Click Save.
3. Return to main screen and Run Model.

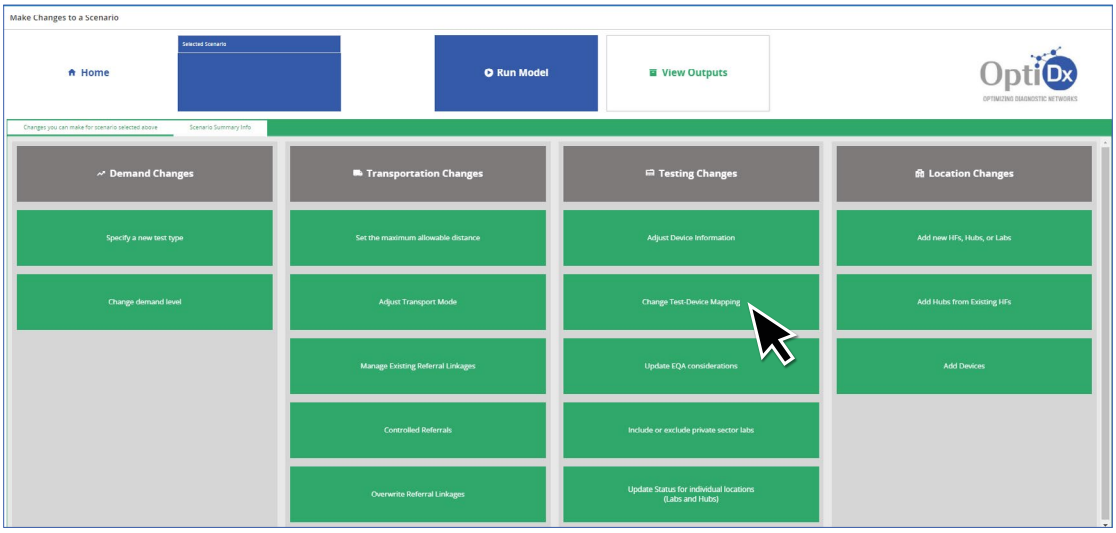


Using this functionality to exclude a lab ensures that no fixed device operating costs are included in the model output, i.e. these labs / devices are no longer functional and should not appear in the output. Another option to close a device type is to disallow all tests on that device type (explained in the step below). Although no testing will be done on the device, the device will still appear in the output and incur a fixed operating cost.

Change the device-test mapping

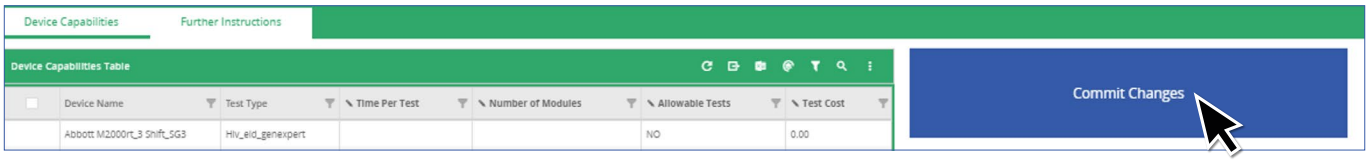
Purpose: Using this function, you can allow / disallow different test types included in the demand on a device, e.g. allowing GeneXpert devices to do HIV, HPV, or Covid testing.

Navigation in the app: Make Changes to a Scenario > Change Test-Device Mapping



Steps:

1. Edit in Excel. Change ‘Allowable Tests’ to ‘YES’ or ‘NO’.
2. Alternatively, bulk edit by filtering by test type or device, then change ‘Allowable Tests’ to ‘YES’ or ‘NO’.
3. Click Save and Commit Changes.

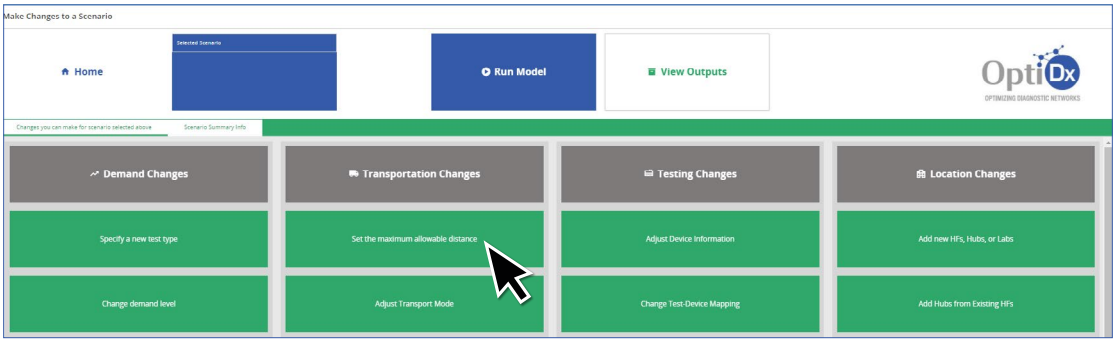


4. Return to ‘Make Changes to Scenario’ screen and click on ‘Run Model’.

Assign a Maximum Allowable Distance (MAD)

Purpose: This function instructs the model not to consider labs located more than a defined distance from referring sites. Setting a MAD means that your model considers access constraints when proposing optimized referral networks. In the absence of this constraint, the model will choose the origin-destination pairs that can be achieved at the lowest costs, considering all the costs and constraints included in the model. This MAD can be applied for all tests, or selected tests only, as needed. It can also be applied at a specific Admin 1 area level if needed. Different MAD values can be applied for different Admin 1 areas.

App navigation: Transportation Changes > Set the maximum allowable distance



Steps:

1. Filter by Test Type to change the MAD for select test types.
2. Bulk fill the Max Allowable Distance that will be applied (e.g. ‘10’ for 10 kilometres).
3. Click Save and Commit Changes.
4. Return to main screen and Run Model.

Please Note: This action only changes the MAD for the first echelon in the transportation policy. For example, if the test type is transported 'Via Hub', then the constraint will only be applied to the HF-Hub. If the test type is transported 'Direct to Lab', then the constraint will only be applied from the HF to the testing site.

If you want to change this transportation assignment, then you will need to overwrite the referral process:

1. Go to Transportation Changes > Overwrite Referral Linkages > Yes, overwrite.
2. Change the Referral Type for the Test Type (e.g. Direct to Lab or Via Hub). Build Referrals following the New Country Creation process (explained above).

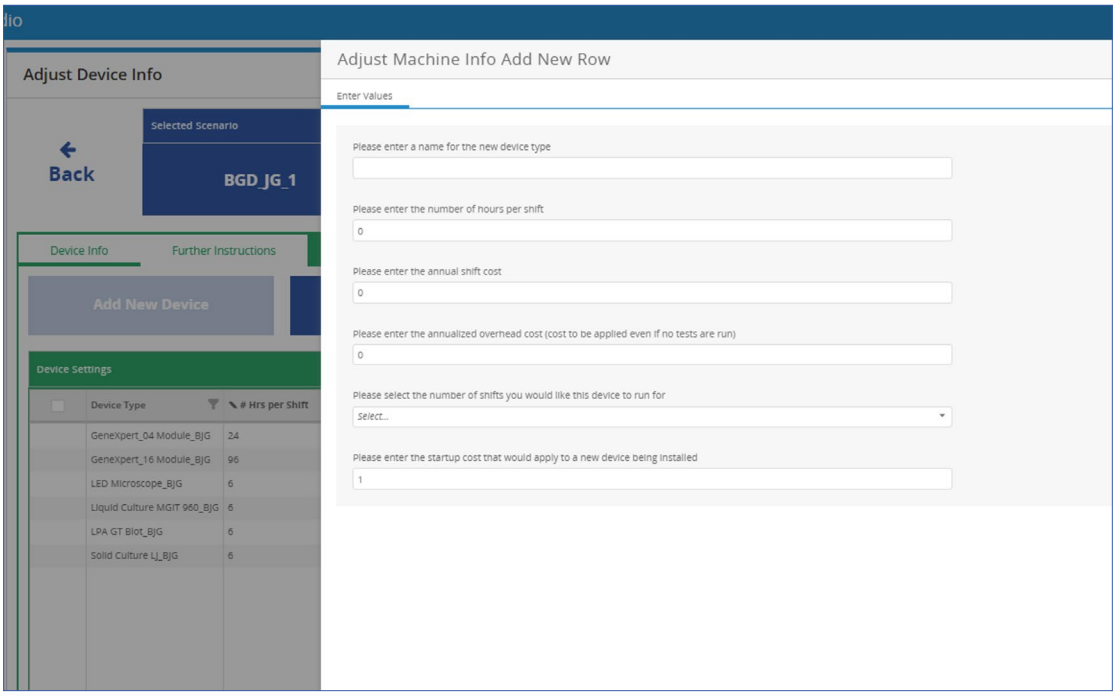
Add a new device

Purpose: When considering introducing a new technology, you might want to add a new device type into the model. The following steps help you add a new device type in the network and allows the model to recommend optimal locations. To increase the number of already-existing devices, skip directly to step 3 (described below).

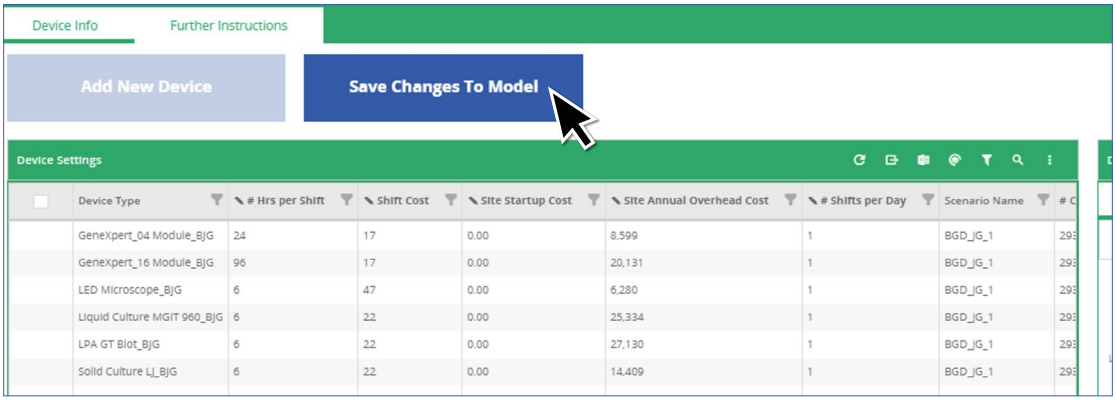
Steps:

1. **First, add the new device to the network:**

   App navigation: Make Changes to a Scenario > Adjust Device Information > Add New Device



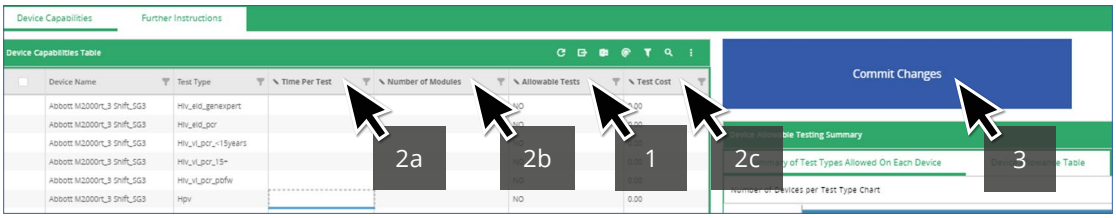
- Click Add New Device. A new page will pop up.
- Enter the device name, the number of hours per shift, annual shift cost, annual overhead cost, the number of shifts, and the start-up cost of the device (if placed at a new laboratory). Click OK at the bottom of the page.
- Click 'Save Changes to Model'. The new device should appear in the table.



2. Second, update the device test mapping:

App navigation: Make Changes to a Scenario > Adjust Device Information

- Filter by the new device (added in the previous step). To ensure that all tests can be conducted on this device, change the 'Allowable Test' column to 'YES'. (The device-test combinations that are not required should have 'NO' in this column.) For these allowable tests, edit the time per test, number of modules for the device (use the default of 1.00), and the test cost.
- Save and Commit changes.

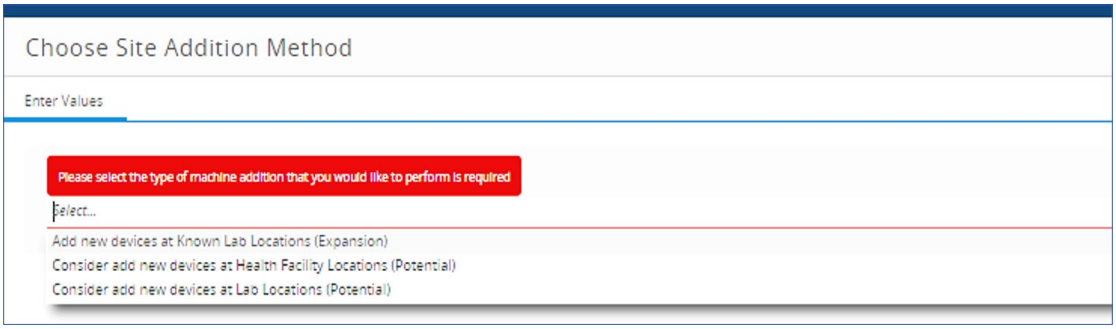


3. Third, indicate where the model can place the new device, using one of these options:

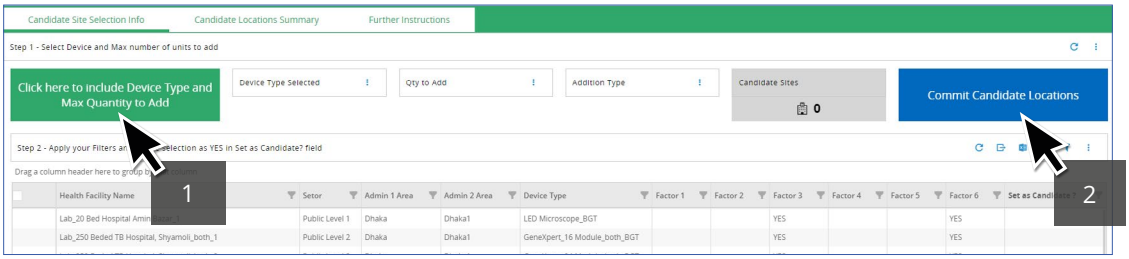
- Place additional devices at known locations: Select this option if you know the exact locations where devices need to be added.
- Allow model to choose where to place additional devices from a defined set of candidate health facility locations: Select this option if you do not have exact locations, but rather a set of possible health facilities from which the model can choose.
- Allow model to choose where to place additional devices from a defined set of existing lab locations: Select this option if you do not have exact locations, but rather a set of possible laboratories from which the model can choose.

The example below shows the selection of Option 3:

App navigation: Location Changes > Add devices > Consider add new devices at Lab Locations (Potential)



- Select 'Click here to include Device Type and Max Quantity to Add'. Select the newly added device, choose device addition type (max or fixed), and indicate how many of these devices should be added. (See tips below.)



- Filter by sites that you want the model to consider as candidate locations for the placement of the new device. Note: you can select more candidate locations than the number of devices you wish to place.
- Bulk fill 'Set as Candidate?' to 'Yes'.
- Click Save and Commit Candidate Locations. The number of Candidate Sites that you have selected should appear in the grey box. (See screenshot above.)
- Review the constraints in 'Candidate Locations Summary'.
- Return to main screen and Run Model.

Tips:

- While selecting device addition type, note that 'Max constraint' type means that the model can select any number of devices less than or equal to the max number specified. 'Fixed constraint' means that the exact number of devices will be included for optimization. It is strongly recommended to time DNO ahead of procurement decisions and use Max constraint to inform the number of instruments needed (if any).
- Users can commit constraints for multiple device types, which are captured in 'Device addition summary'.

Step 4b: Compare network outputs

Purpose: Once you have built the baseline model and created optimization scenarios, you can review outputs of each optimized scenario in detail with 'Compare network outputs'. It allows you to compare the trade-offs associated with a given scenario—in terms of access, device utilization, and costs—with baseline models as well as with other scenarios. Decision-makers can use these outputs to weigh the pros and cons of each scenario based on local contexts and requirements, which might vary within the same country. Figure 4 provides an example of how trade-offs need to be considered between two approaches while making decisions on the best-fit approach to scale up access to testing within a diagnostic network.

Tips:

- Use the High Level Summary to compare costs, service distance, demand met, and average device utilization across all scenarios at the overall network level. It can help identify priority scenarios that might be of relatively greater interest for implementation.
- Next, conduct a detailed comparison between any two scenarios using Scenario Comparison, e.g. the breakdown of total costs, and which sites are going over capacity or sending samples beyond the maximum allowable distance.
- Go to Detailed Scenario Review to look across device-test combinations, filter data by Admin 1 areas, and extract customized graphs / charts or detailed data tables.
- You can use Scenario Comparison and Detailed Scenario Review to evaluate how specific metrics change across pairs of scenarios.

Figure 4: Comparing scenarios to decide on the preferred scenario for implementation (reproduced from the DNO guide)

TRADE-OFFS

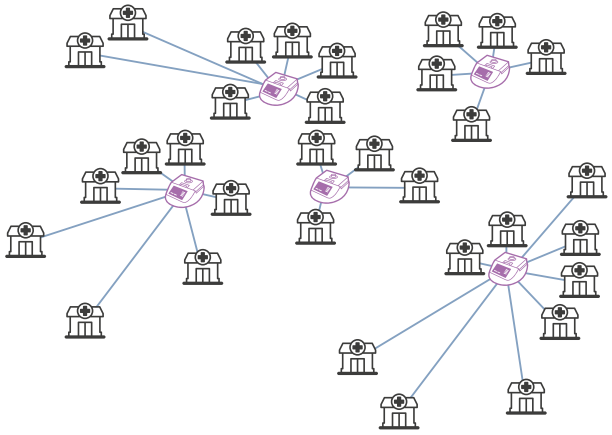
Case study: improving access to testing within a defined turnaround time while maximizing cost efficiency. Existing capacity in the network is underutilized and there is limited budget to invest in strengthening the system.

What approaches can be considered to scale up access to testing within the diagnostic network?

DNO considers two different scenarios:

SCENARIO 1

Enhance use of available capacity within the network through sample referral. Do not allow model to consider new labs or devices.



DNO output

No new devices added, optimal allocation of sample referral flows to existing devices

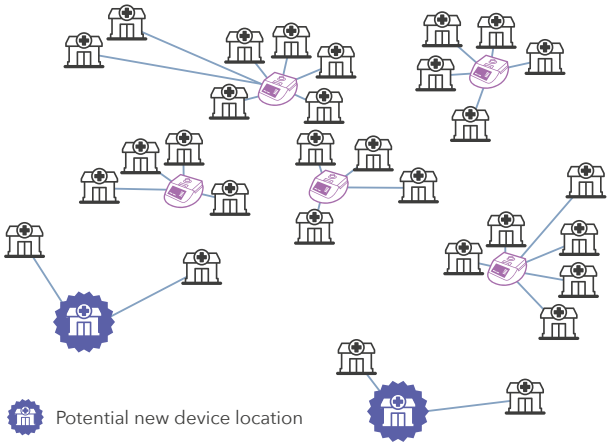
Pros	Cons
• Testing demand can be met with existing device footprint • Usually lower overall cost • Higher device utilization	• Some long transport legs, which may delay turnaround time and negatively impact access to care

SETTING-SPECIFIC FACTORS TO CONSIDER:

- Transport referral may be costly and difficult to sustain in challenging environments
- Turnaround time requirements for priority tests may not be achieved with a more centralized testing network in some settings

SCENARIO 2

Allow model to consider addition of new labs or devices if needed AND improve sample referral linkages.



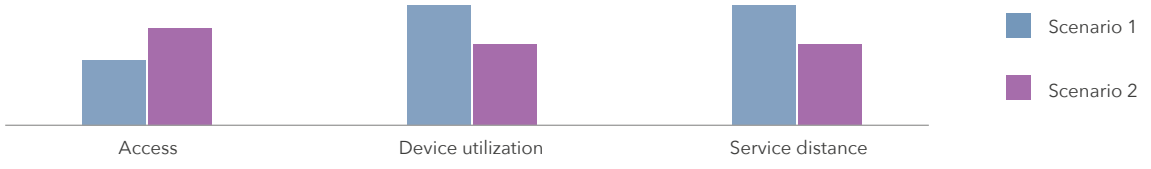
DNO output

Addition of two new devices at existing health facilities, plus optimal allocation of sample referral flows

Pros	Cons
• Reduced distance to testing sites, eliminating long transport legs	• May have higher overall cost in some settings • Lower device utilization

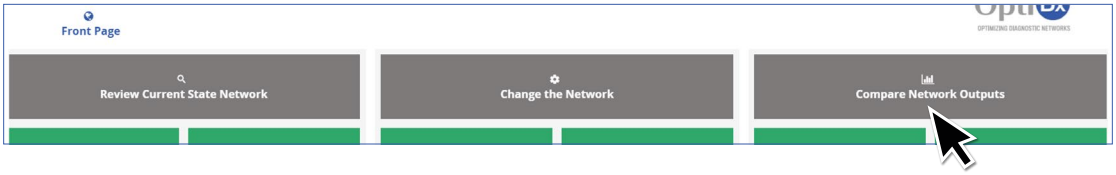
SETTING-SPECIFIC FACTORS TO CONSIDER:

- Additional budget and trained personnel required
- Additional devices may be preferred to enable on-site testing in remote settings
- Utilizing devices for multi-disease testing can lead to better use of available capacity



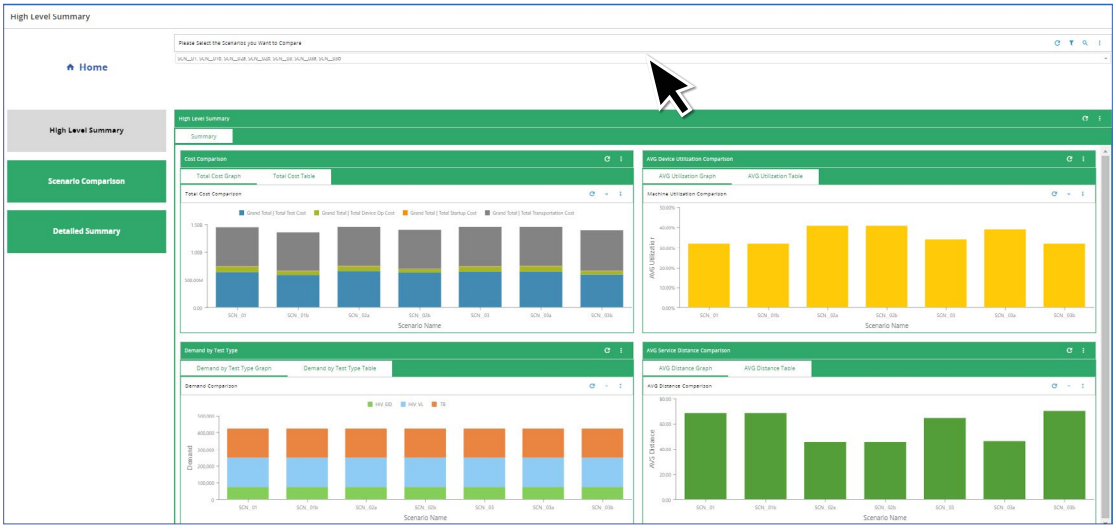
Decision-makers weigh up pros and cons for each scenario in their setting to decide on the preferred scenario for implementation

Navigation: Front page > Compare Network Outputs



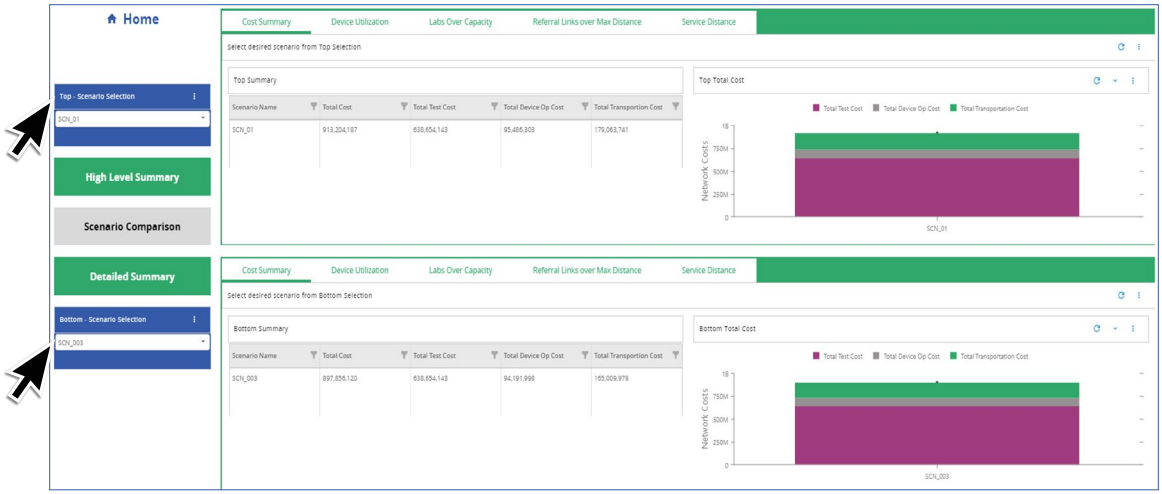
Steps:

High Level Summary Here you can compare the summary of different scenarios like Total Cost, Demand by Test Type, average device utilization across all device types, and average service distance. In the drop-down list on top of screen, select the scenarios whose outputs you wish to compare.



Scenario Comparison view This view allows users to compare across several parameters by selecting a scenario in the Scenario Selection drop-down menu:

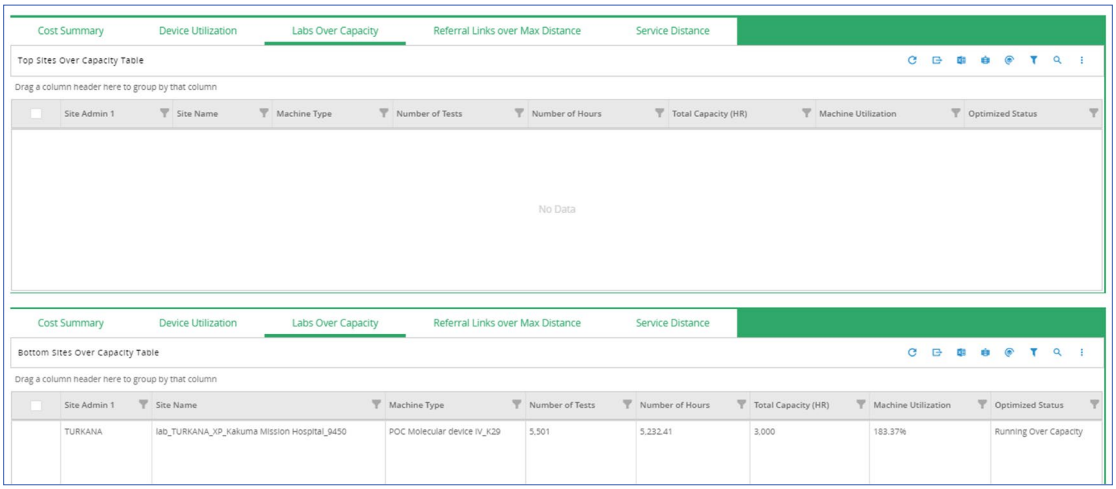
- **Cost Summary:** Includes Total Cost, Total Test Cost, Total Device Op[erating] Cost, and Total Transportation Cost



- **Device Utilization by Admin 1:** Proportion of total available device capacity utilized in each scenario in each Admin 1 area

- **Service Distance:** Average distance in kilometres travelled by samples originating from each Admin 1 area.

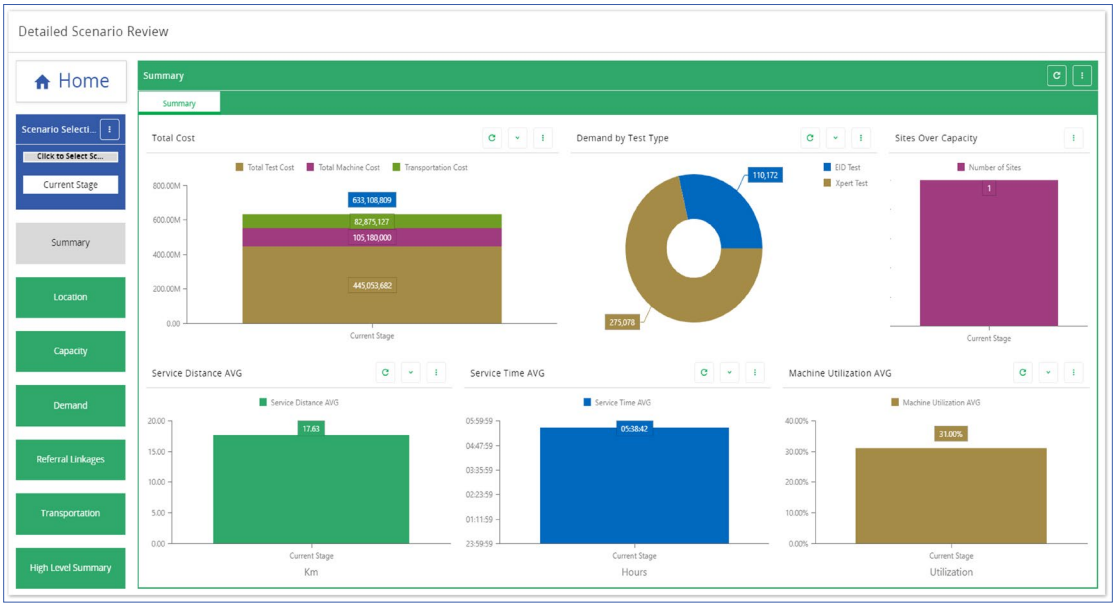
- **Labs Over Capacity:** See which labs (if any) exceed their capacity when making the defined changes in each scenario.



Tip:

Please note that the High Level Summary and Scenario Comparison views present aggregated data across all test types and devices. A deeper analysis of each scenario using Detailed Summary is recommended to analyse metrics individually for each test type, e.g. TB, HIV EID, or HIV VL. For example, overall service distance might decrease in Scenario B compared to Scenario A, but you might want to consider how service distance changes for TB samples compared to HIV viral load samples.

Detailed Summary This tab presents disaggregated metrics for each scenario using the same views as Review Current State Network (for analysing the preliminary baseline model). In this option, users can select different optimized scenarios and view the results in detail.



Step 5: Select outputs for implementation

A country's overall health strategy and goals for laboratory systems strengthening and different disease programs need to be considered while selecting potential outputs for implementation. The multi-stakeholder technical working group (or equivalent mechanism) should consider the options and prioritize solutions that help expand rapid and equitable access to testing and that improve cost-efficiency of the network. For example, in Figure 4 on page 43, a country might prioritize Scenario 2 if the aim is to reduce service distances for sample referral in hard-to-reach areas and has funds available to procure additional devices, to be placed in regions where establishing reliable SRS is not possible. A country might prioritize Scenario 1 if it is looking to maximize its use of existing device capacity in urban areas with a good pre-existing sample referral network, or if establishment of a reliable sample referral network in remote and hard to reach areas is feasible.

Different interventions might be needed to implement the recommendations emerging from the analysis, either across the network or in specific regions. These interventions include preparing funding requests / budgets, procuring additional instruments, developing guidelines and operational plans to implement integrated disease testing or a new sample referral network in a specific province or county, and creating micro-plans to relocate devices or reroute sample referrals between selected sites. Timelines for obtaining approvals and securing fund allocations, as needed, should also be factored in while developing an implementation plan.

Ongoing monitoring of the implementation of the recommendations, along with updating the analysis periodically, are critical to ensure that the DNO is aligned with long-term goals and progress of the network. OptiDx enables users to easily update their network models to address evolving needs and priorities, for example, when there are significant changes in the network, including to test demand, sites, and devices, updated testing algorithms, or plans for service integration. Visit www.optidx.org for case studies that detail different countries' experiences using OptiDx to conduct DNO analysis.

Using OptiDx to conduct RO

This section provides an overview of the route optimization (RO) functionality in OptiDx, which typically follows a DNO analysis. RO creates a detailed plan of the sample referral network recommended using DNO. It takes inputs related to travel times, frequency, speed by route, and / or mode for transporting samples from health facilities to Hub / Labs, given specific requirements such as allow / prohibit cross-border referrals between administrative areas. RO compares different types of route plans, such as direct from HF to Hub / Lab or multi-stop routes, and you can define requirements by mode, test types, and admin areas that meet the overall aim of the network.

Data requirements

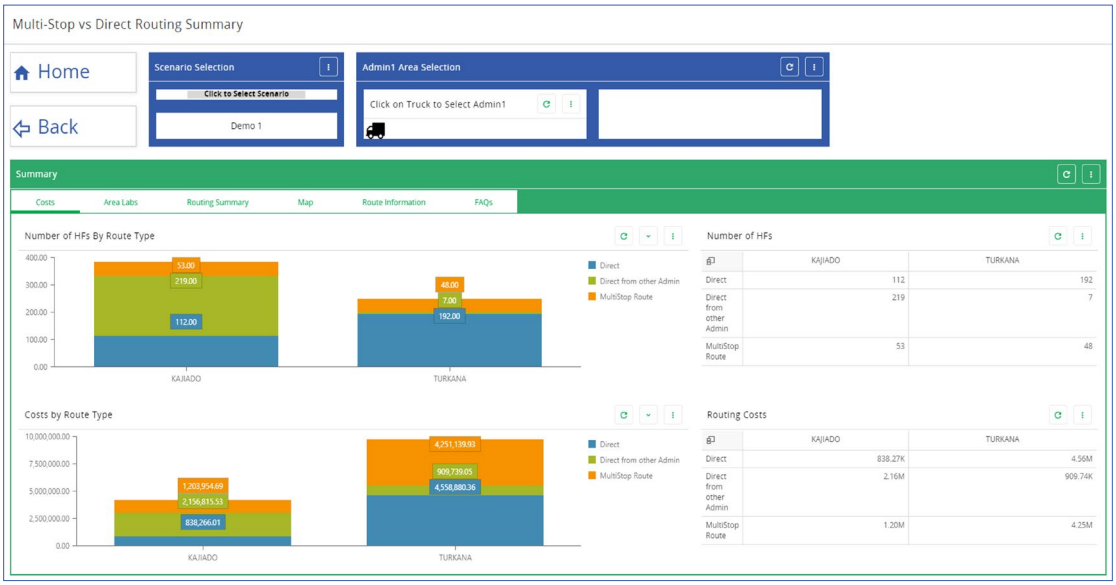
In addition to the data inputs for DNO mentioned under Step 2, 'Collate and prepare data', RO analyses require:

- A validated DNO historical baseline model
- Existing and / or potential transport modes for each Admin 1 area
- For each transport mode: average speed, available hours per day per mode, and cost per km
- Sample pick-up frequency at facility

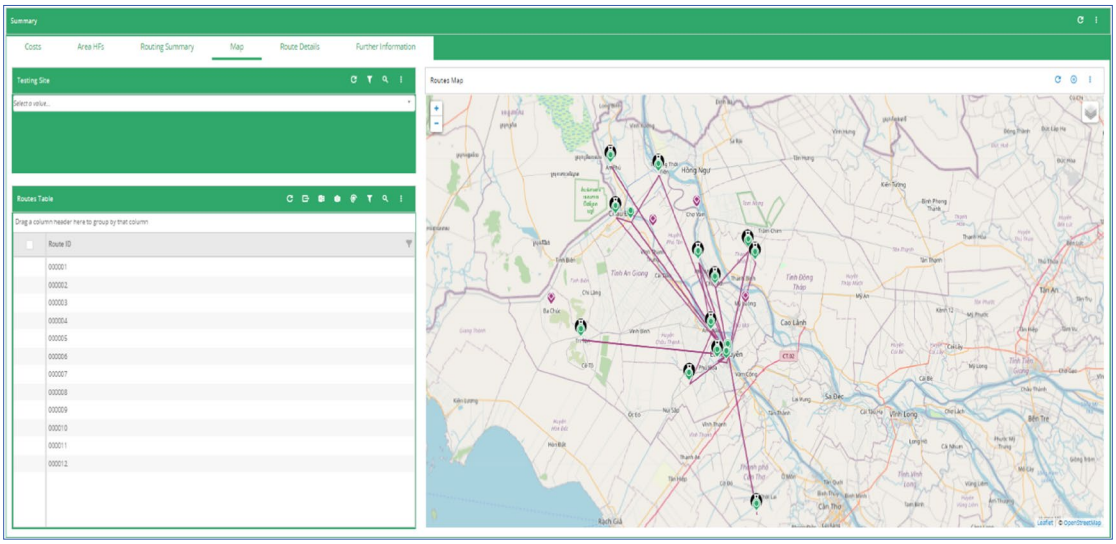
Examples of RO outputs

1. Multi-stop results

In a multi-stop route, samples are picked up from multiple facilities en route from the starting point to the testing laboratory. A direct-to-lab route implies that samples are transported between a single starting point (health facility) and a single destination (testing laboratory). An RO analysis can recommend the best-fit approach between clusters of health facilities and testing laboratories based on distances, costs, and referral policies. You can assess how routes are set up in your network by viewing outputs, such as number of health facilities and transportation costs by the route type (i.e., multi-stop route or direct-to-lab).

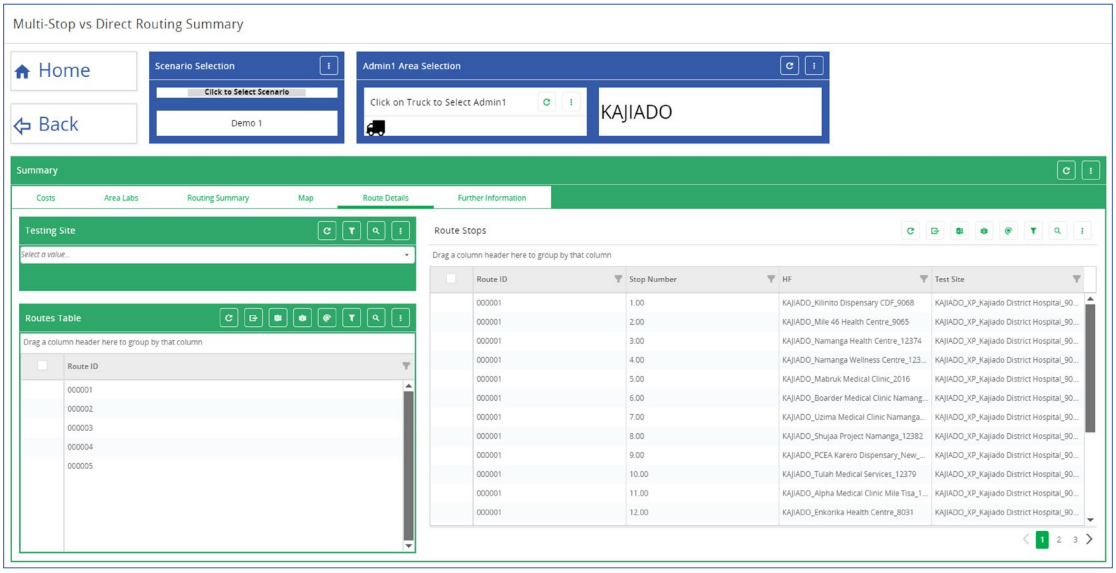


You can also visualize the transport lanes on a map to see the origin and destination points of each transport lane and easily identify longer lanes that are potentially causing testing delays.



2. Distance band results

You can look at details of transport routes, including which health facilities, labs, and hubs are included in each route, and the sequence of locations in each route.



The RO functionality of OptiDx is currently under revision. Detailed guidance on steps for conducting RO in OptiDx will be included in an updated version of this guide.

Annexures

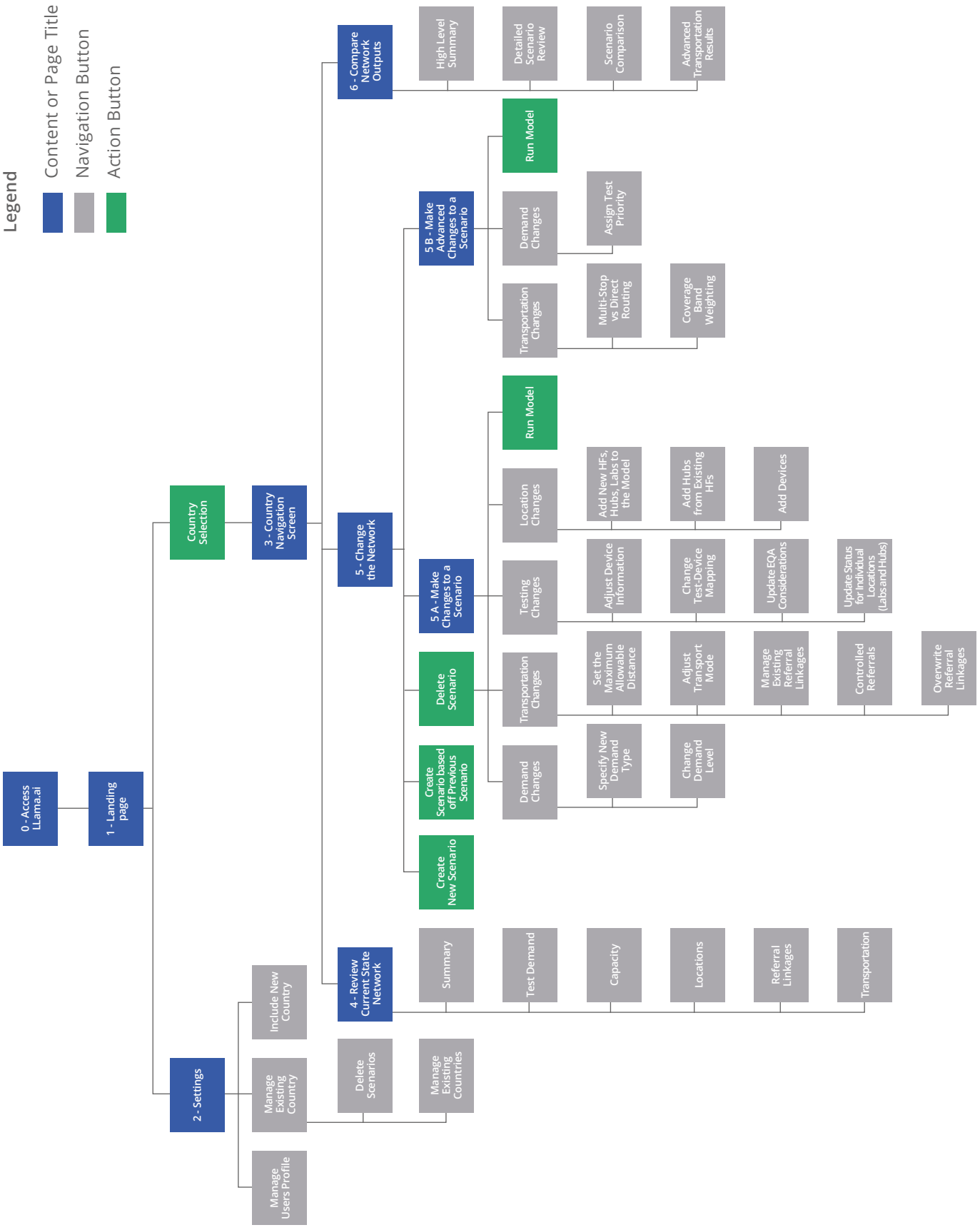
Annexure A: OptiDx terminology guide

Term	Definition
Admin Area	Sub-national geographical region corresponding to an administrative unit. Admin areas are defined at two levels: 1) Admin 1 area, i.e. the first-level administrative country subdivision, e.g. a state or a province; 2) Admin 2 area, i.e. second-level administrative country subdivision below Admin1 area, e.g. district. Admin Area allows users to define the scope of inputs, assumptions, and constraints. Admin areas corresponding to referring health facilities are referred to as 'Collection Admin Area' or 'Source Admin Area', while those corresponding to labs or testing sites are referred to as 'Testing Admin Area'. [Data Input]
Capacity	Capacity is the number of tests that can be performed on a given device or devices in a given time period. In OptiDx, total testing capacity available is represented in terms of time, i.e. the total hours available to perform a given test, assuming each test takes a pre-defined amount of time.
Cost per test	Unit cost incurred to perform a specific test. It includes the cost of reagents & consumables used to conduct a test, disaggregated by device & test type. This is calculated using the Costing template provided. [Data Input]
Country Code	A unique 3-digit code that is used to represent the country. It is defined by the user and can be any combination of digits. [Data Input]
Current State Network	A digital representation of the structure of the diagnostic network (also referred to as the preliminary baseline model), created via the new country creation process in OptiDx. Where available, a historical baseline model is created to reflect the actual current state, which can then be compared with future state scenarios.
Demand	Number of tests ordered over a one-year period. Demand may be expressed per referring health facility, per laboratory / testing site, per Admin Area, or for the whole diagnostic network, and it is typically disaggregated by test type. For the current state network, actual testing volume is often used as a proxy for demand. For future state scenarios, projected test demand is calculated based on national targets. Year can imply either financial or calendar year.
Demand Scaling	Functionality that allows users to apply a projected increase or decrease in demand for a test type within the OptiDx app, instead of making changes to the input data. It can be used to assess the impact of change in demand on the network. [Data Input]
Device	Also referred to as testing platform or analyser, Device denotes the type of diagnostic instrument or equipment in a laboratory or testing site on which testing can be performed. Where the same technology is available in multiple sizes, the devices are entered separately in OptiDx to allow for device-specific capacity to be considered in the model. For non-instrumented tests, 'Device' can be used to denote the testing capacity at a site. [Data Input]
Device Capability	Users can update device-test combinations in the network and enter input parameters like cost, time per test, allowable tests, etc., using this functionality. [Data Input]
Device Operating Cost	Annualized cost incurred in operating a testing device. It is the fixed cost of operating the device over a one-year period and includes the cost of the device itself (e.g. procurement costs, warranty, maintenance, etc.), human resource costs, and quality assurance costs. If a new device is placed at a new site, this cost will also include the Start-Up Cost. [Data Input]
Device Utilization	The level of usage of the device within a set time period, i.e. number of tests (actual for baseline and theoretical for future scenarios) that can be conducted, as a proportion of the maximum theoretical capacity. [OptiDx Output]
Excel Plug-in	Connection between MS Excel & OptiDx used to make significant changes to data inputs in OptiDx. This can be accessed through the User icon in top-right corner of OptiDx. Small changes to the data can also be made directly in the app via 'Tables' view.
Facility Level	The administrative hierarchy level for a health facility. This can be defined as per the multi-tiered public health infrastructure of a country, e.g. Level 1 commonly denotes the community level primary health clinics, and Level 4 denotes tertiary hospitals. [Data Input]
Health Facilities	Physical location where demand for a diagnostic test originates or where samples for a diagnostic test are collected. This may be the same as 'labs' when testing is conducted on-site. Also referred to as 'collection point' or 'source'.

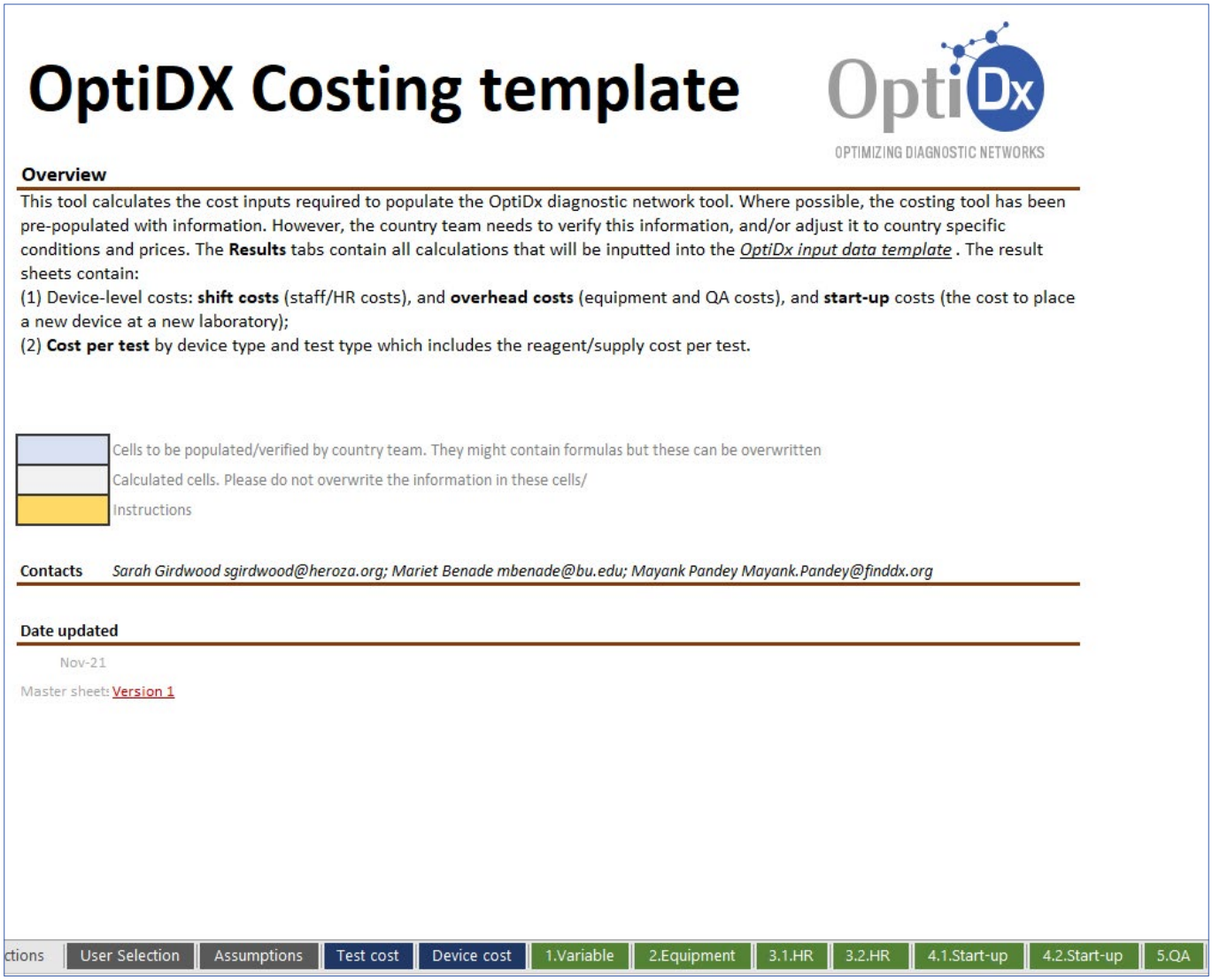
Term	Definition
Hubs	The physical locations where samples may be pooled after leaving the health facility. The hub may offer certain testing on-site or may only serve as an intermediate pooling and processing point (i.e., for centrifuging) for samples before they are transported to the testing facility. Hubs may also offer quality checks and documentation points for samples.
Labs	The physical locations where the samples are tested. If the diagnostic test is offered on-site, then this could be the same physical location as the collection site. If testing occurs off-site, then this would be the physical location of the laboratory. Where testing is done outside a laboratory, the term 'Labs' is used to denote the Testing Site location.
Maximum Allowable Distance (MAD)	The maximum distance over which a sample can be allowed to travel between any Health Facility and Lab / Hub in the network. It may be used as a constraint aimed at improving access to services in an optimization scenario. The maximum distance can be applied at the health facility Admin 1 area level and can be varied by test type. [Data Input]
Mode Cost per Km	The average cost per km to transport a sample in the referral system via a particular mode of transport.
Mode Speed	Average speed at which each type of transport defined under 'transportation mode' operates within the network.
Model	A digital representation of the diagnostic network comprising the location and volume of test demand and capacity, and the sample referral system, that delivers healthcare services to meet the health needs of target populations with applied constraints.
Module	Number of compartments in a device which can perform a test type simultaneously. For example, GeneXpert devices are available in 4-, 6-, or 12-module versions. Number of modules is an OptiDx input that is used to calculate device capacity.
New Country Creation	Process of setting up a baseline / current state model for a country in OptiDx.
Number of Shifts	Maximum number of shifts that can be run on a given device in a 24-hour day based on local context, such as site opening times and HR availability. A typical working day with 1 shift is 8 hours, but some sites might function in 2 shifts of 6 hours each. [Data Input]
OptiDx	Web-based, open-access tool developed by FIND, Coupa, and the USAID Global Health Supply Chain Program-Procurement and Supply Management (GHSC-PSM) project, to conduct diagnostic network optimization and route optimization analysis.
Overhead Cost	Annualized cost incurred in operating a testing device. It is the fixed cost of operating the device over a one-year period and includes the cost of the device itself (e.g. procurement costs, warranty, maintenance, etc.), and quality assurance costs. Together with the human resource cost, it forms part of the Device Operating Cost. This is an input in OptiDx.
Referral Linkages	The connections or linkages between the Health Facilities and Hubs / Labs and between the Hubs and Labs that represent the flow of samples within the network. [OptiDx Output]
Sample Pick-up frequency	Number of times per week when samples are collected from Health Facilities / Hubs to be transported to a laboratory for testing. The frequency can be defined at national or Admin 1 area level.
Scenarios	A set of defined inputs, assumptions, and constraints that are applied together to analyse potential reconfigurations of a country's current diagnostic network to answer 'What if' questions (given changes in inputs such as capacity or demand) created through stakeholder discussions. Scenarios are benchmarked against the baseline to compare access, efficiency, and cost metrics.
Sector	The nature of ownership / management of a health facility in the network, i.e. public or private health sector.
Service Distance	Distance over which samples are transported from a Health facility to a Hub / Lab. It can be viewed at an overall network level or at a facility or Admin area 1 level. [OptiDx output]

Term	Definition
Service Time	Time required to transport samples from a Health Facility to a Hub / Lab. It can be viewed at an overall network level or at a facility or Admin area 1 level. [OptiDx output]
Shape file name	Simple, non-topological format for storing the geometric location and attribute information of geographic features. Geographic features in a shapefile can be represented by points, lines, or polygons (areas). It is used to create a map of the country. [Data Input]
Shift	Number of rotations for which laboratories operate in a 24-hour period. Smaller laboratories might function for 1 shift of 6 or 8 hours, whereas central laboratories might operate multiple shifts.
Shift Capacity (HR)	Maximum number of hours a device can operate per shift, e.g. 6 or 8 hours. It is expressed in hours and helps define total network capacity. [Data Input]
Shift Cost	This is an annual cost and represents the direct cost of staff to operate a device per day or per shift over the course of a year. It forms part of the calculation of the total Device Operating Cost. [Data Input]
Start-Up cost	Annualized fixed cost that applies to a new device being installed at a new site. It includes all costs (equipment and infrastructure) that are associated with the set-up of a new laboratory or testing site for a new device. It is an input into OptiDx. This cost should only be applied if a device is placed at a site that currently does not operate a similar device and that would require additional infrastructure adjustments or additional equipment in order to be able to operate that device.
Test Type	Refers to one or more generic tests which are conducted in the network and included in the analysis. It can be defined as per the scope of the study. For example, for HIV Viral load, the demand may be met using multiple specific tests by different manufacturers and on different devices (e.g. Xpert HIV VL, mPIMA, Roche, Abbott), or could be specific to one manufacturer.
Time Per Test	Number of hours (or minutes expressed in hours) that are needed to conduct one test on a device. This is an input in OptiDx to calculate shift capacity.
Total Estimated cost	Annual total estimated cost for operating the country diagnostic network. It includes the Total Test Cost, Device Operating Cost, and Transportation Cost. It varies depending on the inputs for each scenario. [OptiDx Output] Note: This cost is not appropriate for budgeting purposes as it includes annualized capital costs in order to facilitate trade-off decisions within the model. It provides, however, a useful estimate of the cost to operate the network over the period of a year.
Total Test Cost	Variable cost of conducting a test. It covers the cost of reagents and consumables used to run a test, disaggregated by device and test type. This is an input and output metric in OptiDx.
Transportation	Includes outputs available in OptiDx related to distances travelled by samples in the diagnostic network, disaggregated by test type and Admin 1 Area.
Transportation Cost	All expenses incurred per year to transport samples from Health Facilities / Hubs to the laboratories for testing. It is a function of the Cost per Km (fuel, maintenance, depreciation, driver salaries, etc.), sample pick-up frequency, and distance travelled.
Transportation Mode	Different means by which samples are transported from Health Facilities / Hubs to laboratories for testing. Common transport modes include motorbike, motor vehicle, and third-party courier.
User level	Type of user access that determines the extent of functionalities in OptiDx, i.e. whether the user can only view and modify existing country models, or also create new country models.
Working Days	Total number of working days in a year for which labs in the network are operational, excluding non-working days and public holidays.

Annexure B: Site map of OptiDx



Annexure C: Costing template



OptiDX Costing template

OPTIMIZING DIAGNOSTIC NETWORKS

Overview

This tool calculates the cost inputs required to populate the OptiDx diagnostic network tool. Where possible, the costing tool has been pre-populated with information. However, the country team needs to verify this information, and/or adjust it to country specific conditions and prices. The **Results** tabs contain all calculations that will be inputted into the *OptiDx input data template* . The result sheets contain:
(1) Device-level costs: **shift costs** (staff/HR costs), and **overhead costs** (equipment and QA costs), and **start-up** costs (the cost to place a new device at a new laboratory);
(2) **Cost per test** by device type and test type which includes the reagent/supply cost per test.

Cells to be populated/verified by country team. They might contain formulas but these can be overwritten
Calculated cells. Please do not overwrite the information in these cells/
Instructions

Contacts *Sarah Girdwood sgirdwood@heroza.org; Mariet Benade mbenade@bu.edu; Mayank Pandey Mayank.Pandey@finddx.org*

Date updated

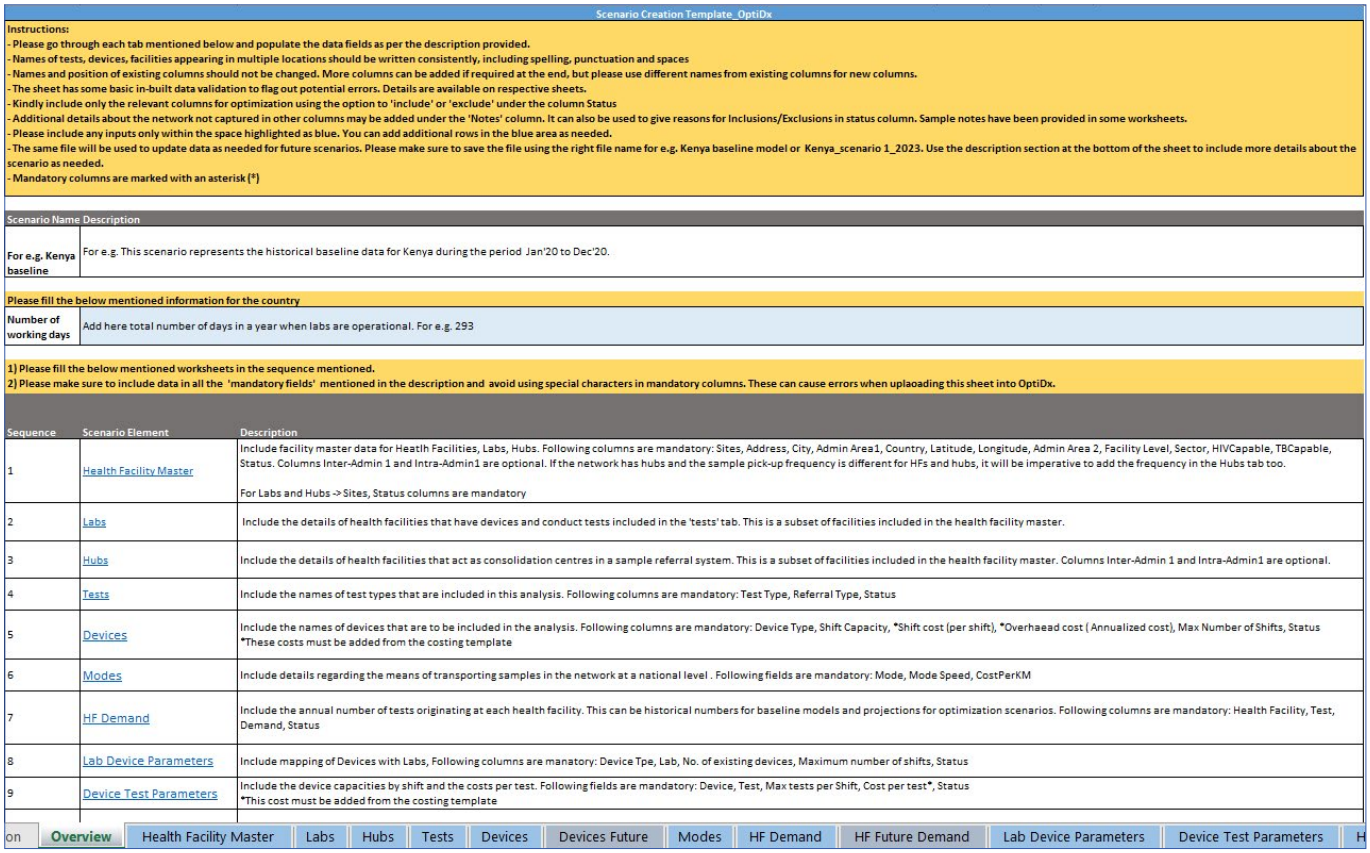
Nov-21

Master sheet: Version 1

ctions | User Selection | Assumptions | Test cost | Device cost | 1.Variable | 2.Equipment | 3.1.HR | 3.2.HR | 4.1.Start-up | 4.2.Start-up | 5.QA

Download the template from https://www.optidx.org/resources/

Annexure D: Scenario creation template



Scenario Creation Template_OptiDx

Instructions:
- Please go through each tab mentioned below and populate the data fields as per the description provided.
- Names of tests, devices, facilities appearing in multiple locations should be written consistently, including spelling, punctuation and spaces
- Names and position of existing columns should not be changed. More columns can be added if required at the end, but please use different names from existing columns for new columns.
- The sheet has some basic in-built data validation to flag out potential errors. Details are available on respective sheets.
- Kindly include only the relevant columns for optimization using the option to 'include' or 'exclude' under the column Status
- Additional details about the network not captured in other columns may be added under the 'Notes' column. It can also be used to give reasons for Inclusions/Exclusions in status column. Sample notes have been provided in some worksheets.
- Please include any inputs only within the space highlighted as blue. You can add additional rows in the blue area as needed.
- The same file will be used to update data as needed for future scenarios. Please make sure to save the file using the right file name for e.g. Kenya baseline model or Kenya_scenario 1_2023. Use the description section at the bottom of the sheet to include more details about the scenario as needed.
- Mandatory columns are marked with an asterisk (*)

Scenario Name	Description
For e.g. Kenya baseline	For e.g. This scenario represents the historical baseline data for Kenya during the period Jan'20 to Dec'20.

Please fill the below mentioned information for the country

Number of working days	Add here total number of days in a year when labs are operational. For e.g. 293

1) Please fill the below mentioned worksheets in the sequence mentioned.
2) Please make sure to include data in all the 'mandatory fields' mentioned in the description and avoid using special characters in mandatory columns. These can cause errors when uplaoading this sheet into OptiDx.

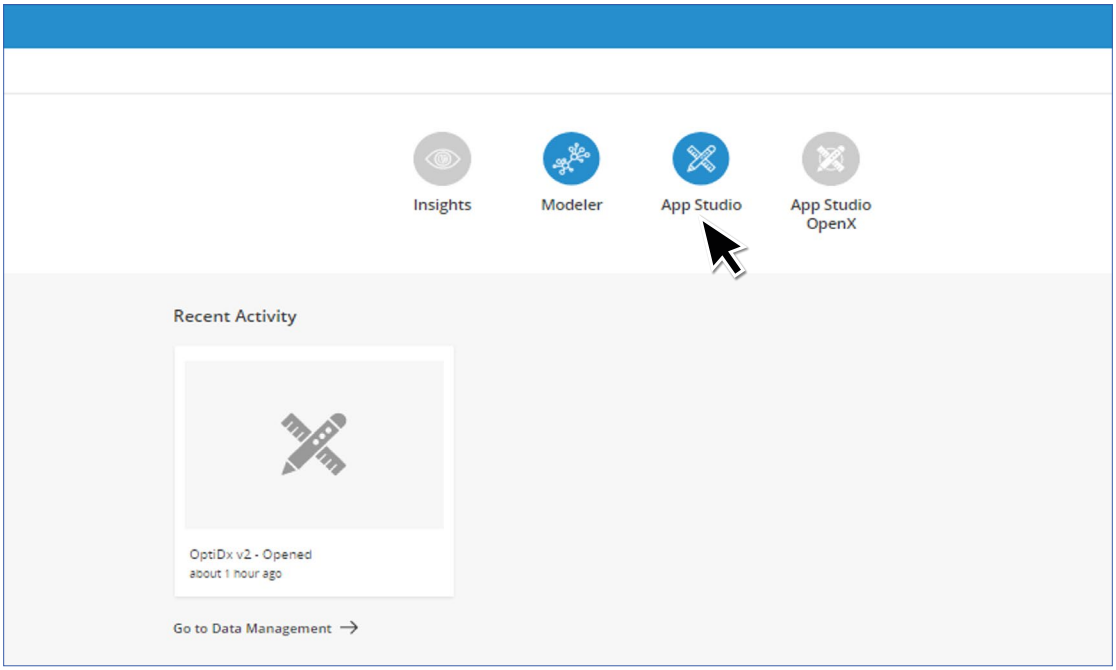
Sequence	Scenario Element	Description
1	Health Facility Master	Include facility master data for Heatlh Facilities, Labs, Hubs. Following columns are mandatory: Sites, Address, City, Admin Area1, Country, Latitude, Longitude, Admin Area 2, Facility Level, Sector, HIVCapable, TBCapable, Status. Columns Inter-Admin 1 and Intra-Admin1 are optional. If the network has hubs and the sample pick-up frequency is different for HFs and hubs, it will be imperative to add the frequency in the Hubs tab too. For Labs and Hubs -> Sites, Status columns are mandatory
2	Labs	Include the details of health facilities that have devices and conduct tests included in the 'tests' tab. This is a subset of facilities included in the health facility master.
3	Hubs	Include the details of health facilities that act as consolidation centres in a sample referral system. This is a subset of facilities included in the health facility master. Columns Inter-Admin 1 and Intra-Admin1 are optional.
4	Tests	Include the names of test types that are included in this analysis. Following columns are mandatory: Test Type, Referral Type, Status
5	Devices	Include the names of devices that are to be included in the analysis. Following columns are mandatory: Device Type, Shift Capacity, *Shift cost (per shift), *Overhaead cost (Annualized cost), Max Number of Shifts, Status *These costs must be added from the costing template
6	Modes	Include details regarding the means of transporting samples in the network at a national level . Following fields are mandatory: Mode, Mode Speed, CostPerKM
7	HF Demand	Include the annual number of tests originating at each health facility. This can be historical numbers for baseline models and projections for optimization scenarios. Following columns are mandatory: Health Facility, Test, Demand, Status
8	Lab Device Parameters	Include mapping of Devices with Labs, Following columns are manatory: Device Tpe, Lab, No. of existing devices, Maximum number of shifts, Status
9	Device Test Parameters	Include the device capacities by shift and the costs per test. Following fields are mandatory: Device, Test, Max tests per Shift, Cost per test*, Status *This cost must be added from the costing template

on | Overview | Health Facility Master | Labs | Hubs | Tests | Devices | Devices Future | Modes | HF Demand | HF Future Demand | Lab Device Parameters | Device Test Parameters | H

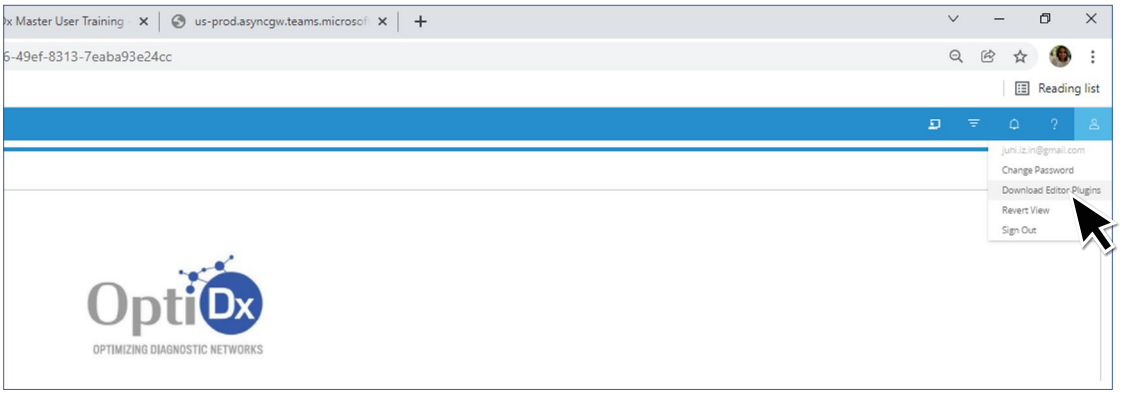
Download the template from https://www.optidx.org/resources/

Annexure E: Downloading editor plug-in from llama.ai

To access the plugin, log in to the llama.ai platform, then click on the 'App Studio' icon.



Navigate to the OptiDx landing page. In the top right corner is an icon of a person's silhouette. Click on the icon.



You will see a drop-down menu. Select 'Download Editor Plugins'. Once that is downloaded, you can double-click the msi to run the installer.

Assuming you have IT permissions that allow you to install the plug-in, this should take you no more than 5 minutes. If you do not have permissions, you may need to contact IT for help. When running the installer, choose the 'complete' option.

Annexure F: Common errors in building a preliminary baseline model

Sr. No.	Which step in the NCC process	Error message / issue	Source of error	Probable causes	How to avoid	How to resolve
1	Step 0	Dummy inputs uploaded in the model	Step 0	Dummy inputs not deleted from input file	Overwrite existing data in the OptiDx input template	Re-populate the OptiDx input template and delete dummy data
2	Step 1	Email alert that some / all sheets in template are not uploaded	Step 1	Data has not been correctly entered into the template	Populate the OptiDx input data template as per instructions provided in Overview sheet	Re-populate the input data template and check for any warnings / errors
3	Step 2 or Step 3	Labs and Hubs may not be present within geo boundary	Step 2 or Step 3	Incorrect geocode	Input the correct geocode in the input template	Re-check geocoding and update the geocodes in step 2 or step 3
4	'Capacity' in the Detailed Scenario Review	The utilization in results are undervalued	Step 2	Device name mismatch among different tabs	Use the same device name across all the tabs for a given device type	Re-check that you are using a consistent device name throughout
5	'Referral Linkages' and 'Transportation' in the Detailed Scenario Review	The lane distances are unrealistically long	Step 2 or Step 3	Missing geocode (latitude and longitude)	Avoid HFs or Labs with missing or empty string in geocode in the input template	Populate the geocode of HFs or labs with the missing geocode
6	Step 6	Create referral linkages process does not output desired lanes (some Origin-Destination linkages are missing)	Step 2 or Step 3	You failed to click the 'Commit' button in Steps 2 or 3	Press 'Commit' button in all steps	Re-visit step 2 and 3 to commit sites
7	Run Baseline	Model status 'Failed'	Step 5	Empty demand value may be present	Avoid empty demand value for HF	Go to step 5 and update HF demand

Sr. No.	Which step in the NCC process	Error message / issue	Source of error	Probable causes	How to avoid	How to resolve
8	Step 5	Demand assigned to a non-existent HF	Step 5	At least one HF in step 5 is not present in step 3	The HFs present in step 5 should be present in step 3	Go to step 5 and either remove or rename the HF present in step 5 and not in step 3. Alternatively, go to step 3 and add additional HFs.
9	Step 8	Desired lanes not created or no lanes created after committing Steps 8.1 to 8.5	Any preceding step in the process	Improper selection in one of the intermediate steps	Select 'Mode assignment type' from the drop-down menu in step 8 (New Country: Admin Selections)	Select 'Mode assignment type' from the drop-down menu in step 8 (New Country: Admin Selections)
10	Step 8	Desired lanes not created or no lanes created after committing Steps 8.1 to 8.5	Any preceding step in the process	Improper selection in one of the intermediate steps	In step 8, set 'Enable Referrals' to 'True as per the requirements' (New Country: Assign Modes and Test Types to Admin 1)	In step 8, set 'Enable Referrals' to 'True as per the requirements' (New Country: Assign Modes and Test Types to Admin 1)
11	Run Baseline	Model status 'Failed'	Step 2	Same name for HF and Lab	Use prefix 'lab' and 'hub' for respective facilities in the input template	Go to step 2 and update the names with the prefix 'lab' or 'hub'
12	Step 11	Missing test-device combination	Input template	Different device name in nc_device and nc_devicetest tabs	Consistent device and test types across different tabs	Update the device name in the input template and reupload the data. Rerun all the steps.
13	Any step	Application termination		Issues with the server		Rerun the model from the previous step or build a new model
14	Any step	Long run-times		Issues with the server		Rerun the model from the previous step or build a new model

OptiDx

OPTIMIZING DIAGNOSTIC NETWORKS

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