USAID | DELIVER PROJECT

Tanzania: 2020 Supply Chain Modeling

Forecasting Demand from 2020–2024

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Abstract
In 2010, LLamasoft, Inc., with technical assistance from the USAID | DELIVER PROJECT, Task Order 1, developed a modeling framework that could be used to forecast public health supply chain needs and to enable policymakers to strengthen the logistics infrastructure when they are planning future needs.

To understand and analyze the current and future state (2020–2024) of supply chain requirements for procuring and distributing essential medical commodities in Tanzania, after the pilot was applied in Kenya, the model was applied for the second time in Tanzania. Any country, at any future time, can use the developed methodology in this report.

Cover photo: Clients wait outside a health dispensary in Tanzania. 2009. USAID | DELIVER PROJECT.

USAID | DELIVER PROJECT
John Snow, Inc.
1616 Fort Myer Drive, 11th Floor
Arlington, VA 22209 USA
Phone: 703-528-7474
Fax: 703-528-7480
Email: askdeliver@jsi.com
Internet: deliver.jsi.com

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Acronyms

3PL	third party logistics provider
CWH	Central Warehouse
DC	Distribution Center
GPS	global positioning system
QALY	quality-adjusted life year
RWH	Regional Warehouse
SSA	Sub-Saharan Africa
TSH	Tanzanian shilling
USD	United States dollar
AIDS	acquired immunodeficiency syndrome
ARV	antiretroviral (drug)
CPR	contraceptive prevalence rate
DALY	disability-adjusted life year
DMO	District Medical Officer
HIV	human immunodeficiency virus
IT	information technology
JSI	John Snow, Inc.
MDG	Millennium Development Goals
MOH	Ministry of Health
MSD	Medical Stores Department (of Tanzania)
MSH	Management Sciences for Health
ORS	oral rehydration solution
PEPFAR	U.S. President's Emergency Plan for AIDS Relief
SDP	service delivery point
STI	sexually transmitted infection
TB	tuberculosis
UN	United Nations
USAID	U.S. Agency for International Development
WHO	World Health Organization

Acknowledgments

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Executive Summary

In the developing world, logistical shortcomings can seriously impact the quality of human healthcare. Because of this, the USAID | DELIVER PROJECT partnered with LLamasoft, Inc., to develop a reusable modeling framework that could be used to forecast developing countries' future public health supply chain needs. The model was designed to be robust and general; this ensured that it could be applied to any country, for any future timeframe, and could give policymakers key data to guide the effective design of their supply chain networks. In 2010, the framework was piloted in Kenya for 2020–2024; the goal was to show how the modeling approach could help policymakers accurately visualize and understand the most likely and possible situations they might face in 10 years. This report covers a similar application of the framework in Tanzania.

To accomplish the project objectives, the relationships between key public health variables were modeled; including population, disease prevalence, and economic conditions; and the resulting requirements for health supply material. The modeling framework included three separate, but interlinked, models: (1) a Health Model for predicting the future location and quantity of treatable health conditions of interest, (2) a Material Requirements Model for translating the project health conditions into delivery needs for the supply system, and (3) a Supply Chain Model to generate metrics of interest by modeling the pull and flow of generated material requirements through a defined supply chain network.

During the time of the study, the medical delivery system in Tanzania was going through several structural changes. Therefore, the timing of the analysis was crucial for Tanzania's Medical Stores Department (MSD)—they had to assess the supply chain network changes that needed to be made if the changes were to be successfully implemented. At the request of the executive management team at the MSD, several near-term (six months to one year) changes to the system were also analyzed. This study focuses on the transportation challenges that the MSD will face, both in the near term and long term, as a result of the implementation of the new system, Direct Delivery. The new delivery system changes added the responsibility for last mile distribution to the MSDs list of activities; previously, the health facilities completed this task.

From the study, the authors determined that the current delivery structure, based on administrative boundaries, provided an ineffective customer-to-warehouse assignment. Health facilities were being served by their assigned warehouses, or the warehouse that had the necessary capacity, instead of the warehouse that was closer. When Direct Delivery was implemented, it was expected that a significant portion of the costs would shift from the health facilities to the MSD; the results show that by optimizing the customer-to-warehouse assignments, the MSD could reduce the transportation costs 14–17 percent. The study also shows that even if supplies for various vertical programs are still donated, they cannot be effectively delivered without significant investments in warehousing and transportation assets. If the delivery of these products is mandated, other essential health supplies will be rationed and this will negatively impact the general health of the population. The main conclusion is that if the increased demand is not addressed, most of the public sector will not be serviced, resulting in a loss of life. It is essential that stakeholders understand the importance of investing in the supply chain network.

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Background

Public health supply chains deliver essential medical commodities to underserved communities in the developing world. Therefore, logistical weaknesses can seriously impact the quality of human healthcare. In some cases, it can mean the difference between life and death. By strengthening the existing supply chain systems, essential commodities are more availability to health care providers and consumers, which results in improved health for communities in underserved areas. Today, health needs have increased because of the world's growing population and the changing disease burden; it is imperative that public health systems ensure cost effective and reliable supply chains to meet those demands.

The USAID | DELIVER PROJECT, in collaboration with LLamasoft, Inc., has undertaken the 2020 Supply Chain Modeling project as a way to develop a reusable framework to forecast developing countries' public health supply chain needs for the future. The 2020 model can be applied quickly to any country, for any future timeframe. This will help policymakers accurately visualize and understand the most likely and possible situations that they may face, and how to make informed decisions about designing effective supply chains to meet those demands. In 2010, the framework was piloted in Kenya for 2020–2024, with the goal of showing how the modeling approach can be used to help policymakers accurately visualize and understand the most likely and possible situations that may face them in 10 years. In 2011, the framework was applied for the second time in Tanzania. This report explains the findings and results.

Project Objectives

The goal of this project was to predict future supply chain needs and performance metrics over five years (2020–2024) in order to inform Tanzanian policymakers and to improve their long-term strategic planning processes.

The three main objectives were—

1. To develop the three interlinked models by applying the previously created framework: a health model, a material requirements model, and a supply chain model.
2. To understand and analyze the current and future (2020–2024) supply chain requirements for procuring and distributing essential medical commodities in Tanzania by applying the health, material requirements, and supply chain models.
3. To determine the most pressing needs for revamping the supply chain network in Tanzania by applying multiple future state scenarios to the modeling framework.

Modeling Framework

The approach for this study used a modeling framework that comprised three separate, but interlinked, models: (1) a Health Model for predicting the location and quantity of treatable health conditions of interest in the future, (2) a Material Requirements Model for translating the health conditions into delivery needs for the supply system, and (3) a Supply Chain Model that generates metrics of interest by modeling the pull and flow of generated material requirements through a defined supply chain network. To forecast the essential health commodities, we analyzed the relationships between the three interdependent models.

Health Model

In response to the United Nation's Millennium Development Goals (MDGs) 4, 5, and 6 (child health, maternal health, and combat HIV and AIDS, respectively), the conditions emphasized the health model that included reducing child mortality; improving maternal health; and combating HIV and AIDS, malaria, and other serious diseases, with the longest-term detrimental effects on human lifetime potential. Conditions modeled for reducing child mortality included measles, vitamin A deficiency, diarrhea, worms, and respiratory infections. Sexually transmitted infection (STI) prevalence, maternal mortality, pregnancy, and birth rates were modeled for the MDG 5: to improve maternal health. HIV and AIDS, malaria, tuberculosis, and leprosy were included for MDG 6 because these very serious diseases can result in severe illness or death. In addition to conditions within the MDGs, selected lifestyle diseases—cardiovascular diseases, hypertension, diabetes, and asthma—were included in the health model. Health professionals anticipate higher prevalence rates of these lifestyle diseases in developing countries during the coming years. The World Health Organization (WHO) Global Burden of Disease work was also reviewed; the Pareto principle, or 80-20 rule, was applied to this data. Most of the emphasis was placed on keeping diseases that represent the 20 percent of diseases in the model because they cause 80 percent of disability-adjusted life years (DALY) and mortalities for the MDG region of sub-Saharan Africa.

Prevalence rates were obtained for each of the conditions described above and, when possible, were grouped by age and administrative region. Additionally, geocoded population data for Tanzania was collected at the district level. As the main components of the health model, the prevalence rates and population data were used to determine the number of people who need treatment for these conditions and diseases and how to distribute the treatment across Tanzania.

Material Requirements Model

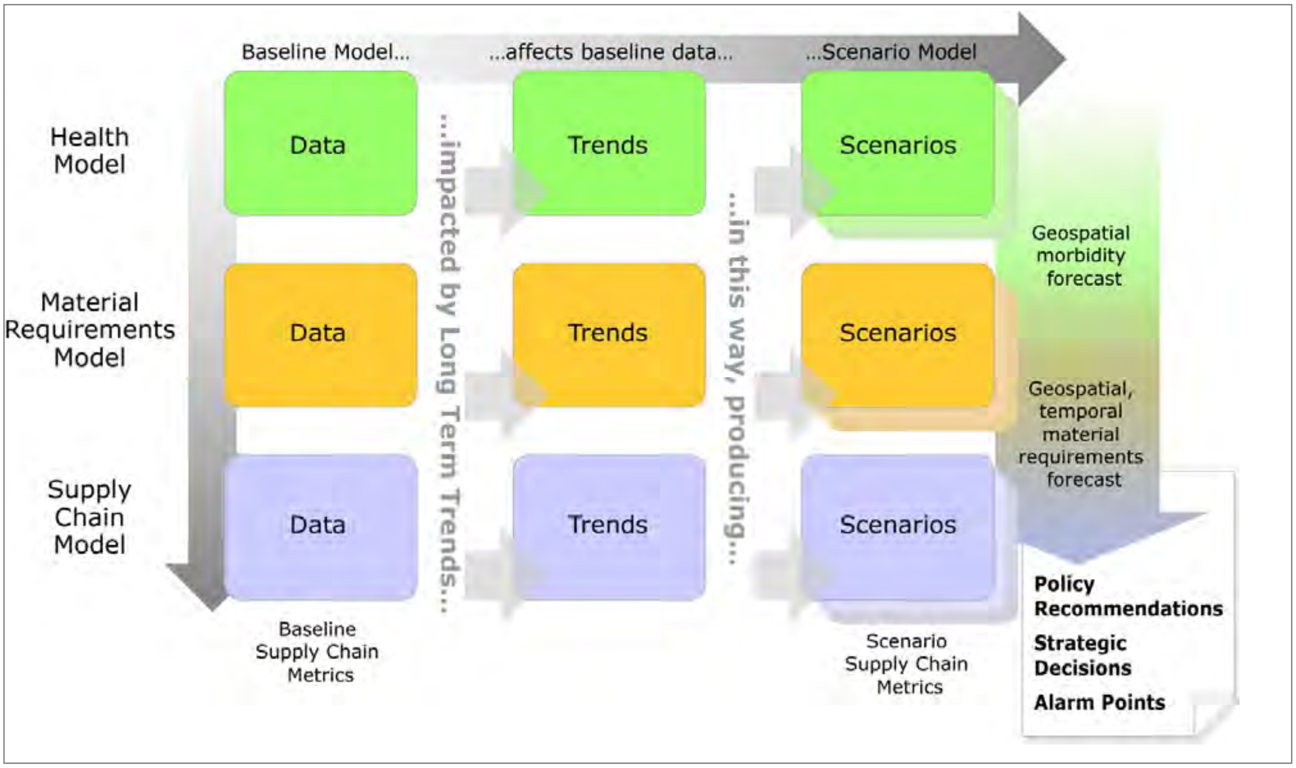
The materials for the material requirements model focus on key pharmaceuticals needed to treat a person with one of the in-scope conditions. In addition to medicines required to treat conditions—diagnostic and preventive commodities like HIV and malaria test kits, bed nets, vaccine packages, family planning commodities, and mother-child health related items—were also included. Another component of the material requirements model is treatment rates for each disease; not everyone who suffers from a disease receives treatment; this must be considered when determining the overall material needs for a country. An additional bundle of essential medicines would be required to cover other disease and conditions not specifically identified. For each of the health commodities included, the price, quantity, weight, and volume were used as characteristic definitions.

Supply Chain Model

The Supply Chain Model was defined by the following parameters: supply chain financials (warehouse operating, administrative, labor, and transportation); and supply chain configuration (warehouse location, available warehouse space, and capacity). The network was modeled at an aggregated district level based on demand-driven flows of the material needs; they used the material requirements model explained above.

Using this approach, the observed trends for any of the three models of the framework can easily be incorporated to create different scenarios and to compare the overall effects on the supply chain model outputs. The framework, illustrated in figure 1, shows that considering observed or expected trends of a country's *health state.* can be used to determine supply chain recommendations.

Figure 1. Visual Overview of the Interdependent Model Framework



Future State Scenario

In this study, two main questions were considered for future state analyses. First, the added strain on the supply chain network from increased volume is considered. The increased volume is determined using population growth, and disease prevalence and treatment rate trends. Another major component is the effect that the newly mandated system of direct delivery will have on the system's access and financials. Finally, several health model scenarios that aim to observe the effect of changing health interventions on the supply chain were also analyzed.

Methodology

The project team first collected the required data during a two-week in-country trip; including as inputs the Health, Material Requirements, and Supply Chain Models that, together, make up the modeling framework. The team then determined the necessary assumptions for both the baseline and future state scenarios. Next, Supply Chain Guru, LLamasoft's flagship network optimization and analysis tool, was used to determine the key supply chain, service, and financial metrics for the baseline and for future state supply chain scenarios. Finally, the results were analyzed and summarized.

Data Collection

The following data was collected on-site in Tanzania; it was used for the Health Model, Material Requirements Model, and Supply Chain Model.

Health Model

Census data for 2002 and projections for 2010–2030, available from the Tanzania National Bureau of Statistics, were used to predict the expected Tanzanian population for 2020–2024. The census data is available down to the district level (for 126 districts); it is divided by gender and age.

The prevalence rates for the in-scope conditions came from the Tanzania Ministry of Health, WHO, and the President's Emergency Plan for AIDS Relief (PEPFAR) reports; peer-reviewed publications; and conference abstracts. See appendix B for the prevalence and treatment rates, by disease.

Material Requirements Model

To determine a country's health supply needs, the Material Requirements Model compiles all the information needed from its health model. This entails gathering data on what treatment a person with an in-scope condition should receive, as required by age and gender. See appendix A for some of the main resources used in this model.

The total material needs of a country were then calculated based on the Health Model and the treatments from the material requirements model. The treatment rates were applied to predict the total forecasted demand.

Supply Chain Model

The Medical Stores Department (MSD) operates the Tanzanian public health supply chain, an autonomous department of the Ministry of Health (MOH), which was formed by an act of Parliament in 1993. The MSD is headquartered in Dar es Salaam with the central warehouse, which is as the main storage and primary entry point for public health commodities. The country is further divided into nine medical zones, each with its own warehouse, and referred to as the zonal warehouse. The following section, Tanzania Supply Chain Background explains the structure of the network and distribution system.

To build the Tanzania supply chain model, the team gathered the following data elements. First, the team obtained latitude and longitude values for the district capitals and used this information to calculate distance for the distribution of medical supplies, based on population (using the population data gathered in the health model). Next, we determined the volume and weight for one package of each commodity in the material requirements model, and the commodity cost. This information came mainly from the *International Drug Price Indicator Guide* (Management Sciences for Health [MSH] 2008), the *Logistics Fact Sheet: Antiretrovirals* [ARVs] (from John Snow, Inc. [JSI]), or the Logistics Fact Sheet: HIV Test Kits (from JSI).

The MSD provided the historical shipment data for 2010–2011, which detailed the amount and value of commodities shipped out of the central warehouse, by date. This data was used to (1) create an additional commodity in the supply chain model, which represents the other essential medicines that are not yet specifically modeled as part of the disease and program specific commodities identified in the material requirements model; and (2) validate the requirements model against the anecdotal 2011 average fill-rate of orders (approximately 60).

Additionally, the MSD provided an itemized budget for the overall operations in 2010–2011, including administrative, transportation, and operational costs. The MSD annualized budget was used to (1) determine transportation costs from the central warehouse to the zonal warehouses, per cubic meter, per kilometer; (2) calculate the cost to operate a square foot of warehouse space; and (3) determine the average handling cost for each unit of product flowing through a warehouse. In addition to the overall budget, MSD provided an estimated budget for the anticipated transportation costs under the new delivery plan. This was used to estimate the last mile delivery costs, per unit, per kilometer, within each of the nine medical zones. The historical shipment and itemized budget were used to calibrate and validate the model that was built for 2011; it is the baseline used to compare the results for the 2020–2024 future state models.

Tanzania Supply Chain Structure Background

Before we can discuss the results from the supply chain models, it is important to understand the current structure of the supply chain network, as well as the proposed changes. Tanzania has 26 regions and 126 districts. As mentioned earlier, the country is divided into nine medical zones, with each zone having one to five regions. See appendix C for a list of the medical zones and the corresponding regions and districts in those zones. Figure 2 displays the breakdown of the nine medical zones and also shows the locations of the zonal warehouses (marked as *msd*).

Figure 2. Tanzanian Medical Zones

Historically, the MSD has been responsible for delivering products from the central warehouse in Dar es Salaam to the nine zones; and, subsequently, from the zones to all the districts. Each district has a District Medical Officer (DMO) who is responsible for storing the goods. Larger hospitals and smaller health facilities then arrange to pick up the commodities from the DMO. Over the years, it was noted that many of the lower-level health facilities, including the health centers and dispensaries, did not have adequate supply of the needed products. Without the funding to transport the goods from the DMO to their facilities, these health facilities faced a significant shortage of goods, and many patients were denied crucial treatments.

Because of these issues of access to care, the government mandated a new delivery system—Direct Delivery. Under this system, the MSD would be responsible for the final delivery of goods to the health centers and dispensaries. Hospitals would continue to transport their goods from the zonal warehouse, but lower-level health facilities would no longer pay the transportation costs. Although it is expensive to implement, the primary goal of this program is to ensure patient care through the public health system—that patients receive the health commodities they need, in a reasonable amount of time.

At the time this analysis was done, the MSD was implementing the direct delivery system. Because the MSD was drastically changing the way it normally operates, this became the focal point of the analysis.

Baseline and Future Projection Assumptions

General Assumptions

The following assumptions were made across the modeling framework:

- The exchange rate for the Tanzanian shilling to the U.S. dollar was 1,500: 1; which was an approximated average exchange rate during FY2010–2011.
- There is no inflation, so the monetary values reported in the model reflect constant prices.

Health Model Assumptions

The following assumptions were made across the Health Model framework:

- Population growth rate is equal for all districts.
- The breakdown of population by gender and age group is constant across districts.

Material Requirements Model Assumptions

The following assumptions were made across the Requirements Model framework:

- The treatments by condition are summarized in appendix B.
- The treatments (number of tablets/vials of medicine per person, per year) are the same between the baseline and 2020–2024, except that a new vaccine package, which is bulkier and more expensive, will be used for 2020–2024.
- Without a quantitative analysis, the current fill rate is set at 60 percent, based on interviews with MSD personnel.
- Based on interviews with members of the MOH, approximately 60 percent of the health facilities (including lower level and hospitals) are public.

Supply Chain Model Assumptions

The following assumptions were made across the Supply Chain Model framework:

- The operating costs for the warehouses relate directly to the volume of the warehouse, which was calculated on area and number of pallet positions.
- The operating cost per square foot, determined using the calculation above, is applied to the warehouses in the future, from 2020–2024.
- The derived transportation cost from the central warehouse to the zonal warehouse is the same per unit, per distance, cost for all zones.
- The currently estimated last mile costs are also used in the future state scenarios; economies of scale were not considered.

Quantification Analysis

First, with LLamasoft's Supply Chain Guru, the modeling framework was used to generate a *baseline* set of metrics, given current conditions and the most likely expected trends based on current trajectories. The baseline was used to analyze how the system is currently operating. As a first step, it is important to confirm that the model can reproduce current conditions; the future state scenarios can then be run with confidence.

Next, a range of possible future state supply chain metrics were forecasted using a variety of possible conditions, with key variables adjusted and relationships tested. In Tanzania, because the main question was the move from the current state to the direct delivery system, total transportation costs are the highlighted metric in all the scenarios. The transportation cost included items such as fuel, repair and maintenance of vehicles, per diem payments to the drivers, boat rentals, and administrative costs associated with transportation. Another cost element in the analysis of the various scenarios was the total fixed operating costs for the warehouses. The costs input come from the utilities, personnel, training, and general office costs listed in the annual budget.

As mentioned previously, the current fill rate at the MSD is approximately 60 percent. All scenarios display results for this 60 percent fill rate, including a situation when the fill rate is almost 100 percent. Therefore, the change in cost is analyzed, comparing costs between the current system to a system where the MSD satisfies all the needs of the public sector in Tanzania.

Key Findings

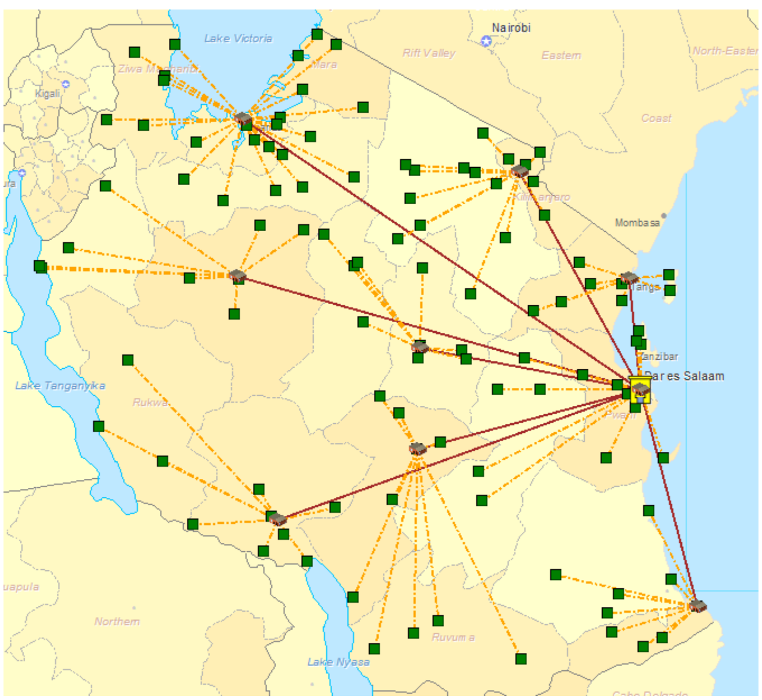
Current State Analysis

Baseline Analysis

The first step in any modeling exercise is to set a benchmark for the software and verify that the tool can reproduce the known data. This model is the comparison point for all other scenarios. In the baseline for Tanzania, the products flow from the central warehouse to the zonal warehouses. From there, the DMOs are the final destination (one for each of the 126 districts). Districts receive product only from their assigned zonal warehouse. This model, and all that follow are modeled to represent the MSD's activities, not necessarily the actual flow of the product down to consumption. Thus, in the baseline, the products are only delivered to the districts.

Figure 3 depicts the current network structure in Tanzania. The central warehouse is located in Dar es Salaam; it is shown as a yellow structure. The solid maroon lines represent the product flow from the central warehouse to the zones, and the dashed yellow lines represent the flow out of the zonal warehouses to the districts. All the following scenarios will be represented in the same way, except the yellow dashed line represents the delivery from zonal to the service delivery point (SDP), in a given district. As seen by the greater number of districts, most of the Tanzanian population focuses around Lake Victoria in the north, and the northern and northeastern parts of the country.

Figure 3. Current Network Structure in Tanzania



The transportation cost under the baseline, with no direct delivery, was just under $3 million. The baseline shows that, although it appears to be a sufficient amount of warehousing space, the space is not in the areas where it is needed. Therefore, several facilities were under-used, while the zonal warehouses in Mwanza, Mbeya, and Moshi were over-used. This result is consistent from interviews with the MSD personnel that several warehouses were full and that goods were often stored in alternate warehouses (farther from the SDP). Often, these alternate sources were leased warehouse spaces that were very costly to operate. Because the MSD knew about the issue, plans are in place to expand several warehouses, which were considered for all the scenarios run for 2020–2024.

Six-Month Plan: Phase I of Direct Delivery Implementation

The first phase in the implementation of direct delivery is to roll out the program to nine regions: one region in each zone. In this scenario, for all the districts that are part of the selected nine regions, the product flow is modeled down to the SDP. This considers the additional cost of transportation to move the products from the DMO to the SDPs. Because this model does not physically show the SDP, the resulting map is identical to figure 3. In addition, the capacity issues observed in the baseline were the same because neither the volume of the product flow, nor the warehouse capacities, changed. However, the baseline costs are not identical.

Under this scenario, the transportation costs are just under $8 million. Based on the cost estimates that we received from the MSD, this number is almost twice the amount that the MSD expected. It should be noted that this is not a strict cost increase, because the additional $5 million is the cost for a task that the MSD previously conducted. Thus, the cost increase represents the cost transferred from the thousands of small health centers and dispensaries to the MSD.

One-Year+ Plan: Full Roll-Out of Direct Delivery

In this scenario, the full roll-out of the direct delivery plan is modeled. Therefore, the MSD is responsible for transporting all the products from the central warehouse to the more than 6,000 SDPs. Similar to the six-month plan, the map depiction and capacity constraints are the same.

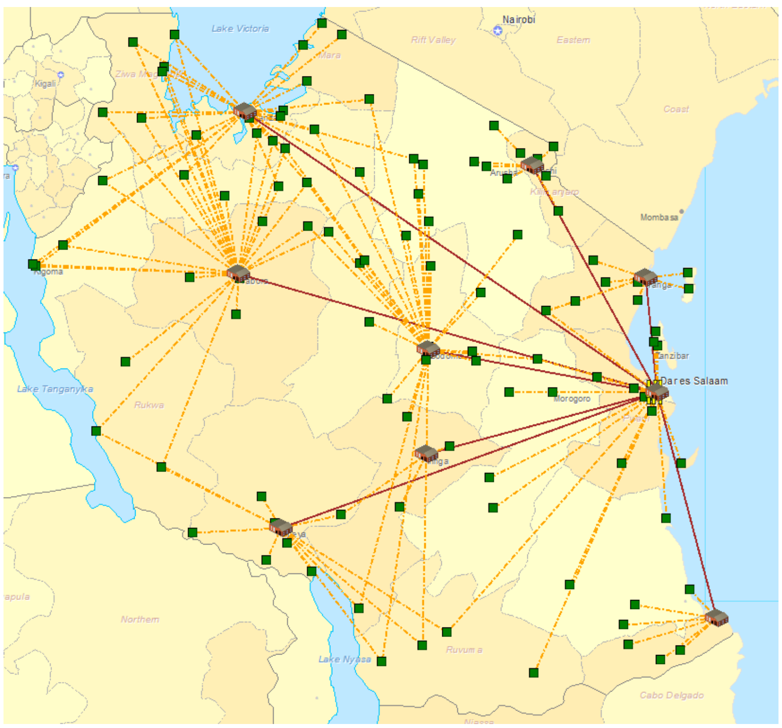
The transportation costs under this scenario increases to nearly $11 million. In particular, several regions and customers are very expensive to serve because they are located far from their assigned zonal warehouse.

Optimized Direct Delivery

As mentioned earlier, each of the nine medical zones include several regions; they were created based on administrative boundaries. The zones were not created based on a quantitative analysis of the population's medical needs. Thus, several customers are forced to receive supplies (source) from a zonal warehouse that is either too far away or is struggling with capacity issues. In this scenario, the customers are not required to source from their assigned zones, but they will be served at the lowest cost. This means that if the nearest facility is at capacity, they will be served by the next closest warehouse with product in stock. However, the decision is not based solely on product availability, but also on the cost of transportation from that warehouse. As mentioned earlier, for each of the nine zones, the MSD estimated the transportation costs for the last mile delivery under the direct delivery plan. Depending on the terrain (flat land versus mountainous region), the costs vary widely across zones.

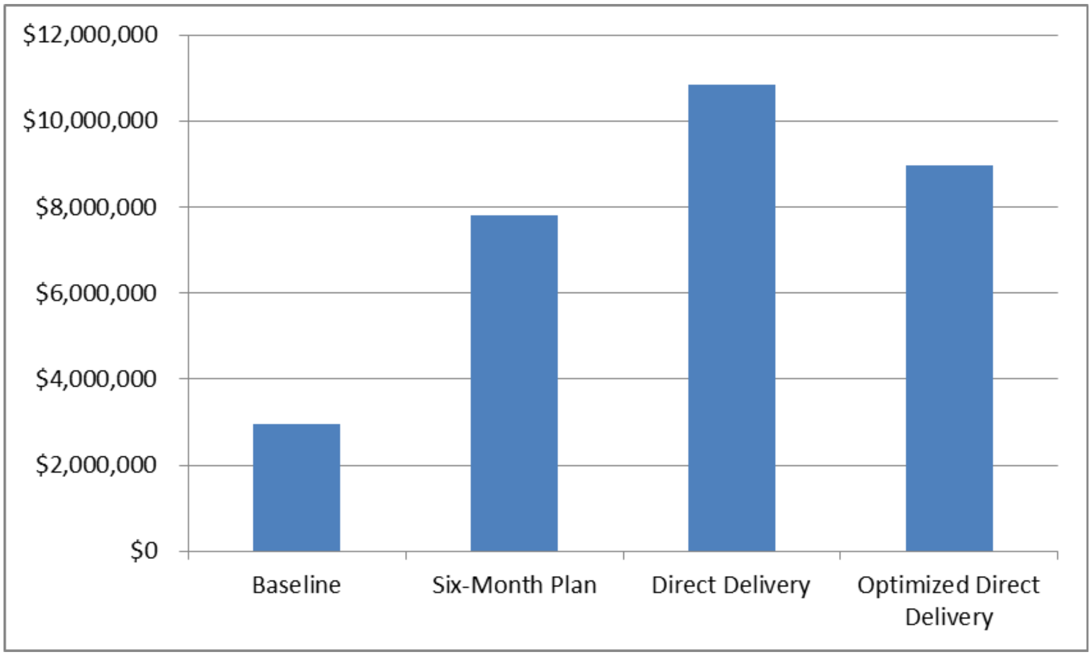
Figure 4 shows the optimized network with updated assignments. Under this scenario, there was a 17 percent reduction in the transportation cost, compared to the previous scenario, which had the complete roll-out of direct delivery under the current zonal system. Due to the removal of the zone-customer constraint, the capacity constraints are not an issue and no warehouse is over capacity. The figure shows that the number of districts served by several of the warehouses is reduced, because (1) several of the warehouses were much smaller and were at capacity, and (2) some regions were much more expensive to serve than others. For instance, the Moshi zonal warehouse (top right, serving significantly fewer customers than before) is an example of both conditions. Under all scenarios with the current zonal assignments, this warehouse was always over-capacity. Also, it is located in a very mountainous region and the last mile transportation in this area is usually very expensive.

Figure 4. Optimized Direct Delivery, 2011



Note that the drastic increases in transportation costs are not true increases, but are an additional cost. Figure 5 illustrates the transportation costs of the baseline and the three scenarios discussed thus far. The current MSD budget estimated for direct delivery is almost half the amount that the model predicts it will cost. However, the budget estimates for each region are best guesses of the actual costs; because, previously, the MSD has not been in charge of last mile delivery. It is possible that several of the cost figures are inflated; significant cost savings may be seen in last mile delivery if optimal transportation routes are used and third party logistics providers (3PLs) are hired.

Figure 5. Transportation Cost Comparison, 2011



To decrease costs while improving the supply of much needed medical products, several changes could be made to the supply chain network. The analysis clearly shows attention should be paid to the location of the demand, particularly the health needs of the population. Some analysis and attention is already being placed on increasing warehouse capacities in certain zones. The models for the future state (2020 on) consider this planned increase in capacity. When adding capacity in new locations, careful thought should be given to the optimal location for those new facilities. And last, it is clear (both visually and quantitatively) that several districts could benefit from being served by zonal warehouses where they are not currently assigned.

Future State Analysis

The following scenarios analyze the future state, 2020–2024, and the effects that the changes in health and requirements models will have on the supply chain. With the MSD's current challenge of implementing direct delivery, the analysis of the supply chain model focuses largely on this aspect.

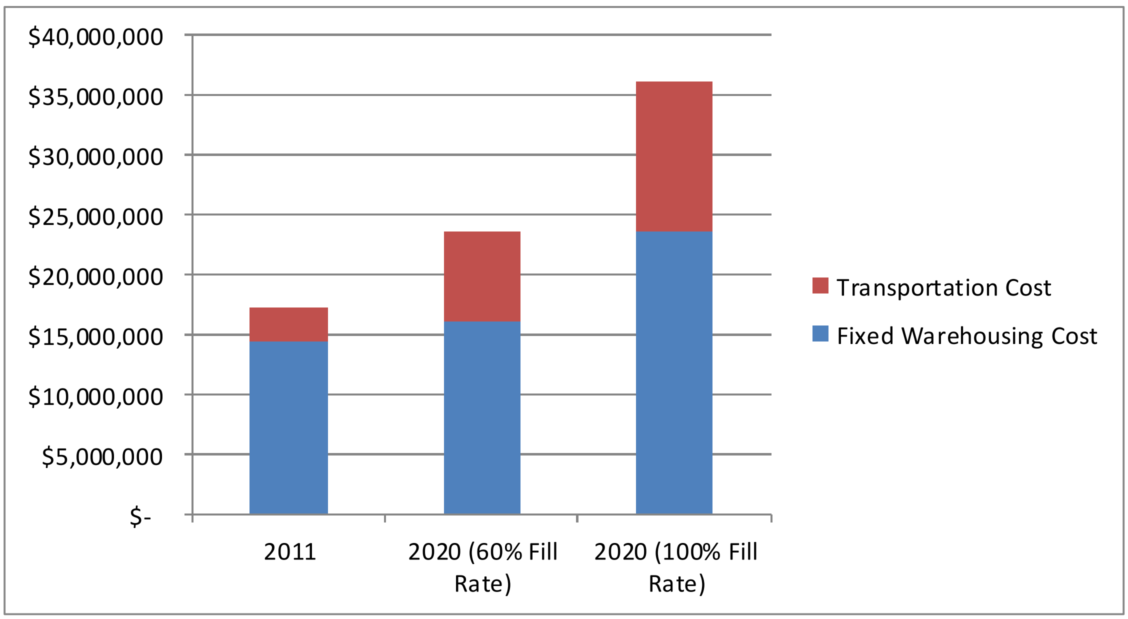
Network Structure Remains the Same

In this scenario, we analyzed the situation when the MSD does not implement direct delivery and keeps the same network structure. Thus, the central warehouse and nine zonal warehouses would still be in place and the MSD would not incur the cost of distributing the goods to the last mile. The expansion plans for the warehouses are considered. Therefore, this scenario compares the true increase in costs to the supply chain network from the increasing medical needs of the growing population. Within this scenario, we analyzed the current fill rate of 60 percent and a fill rate of nearly 100 percent. Table 1 shows the percentage increase in the various cost elements, while figure 6 shows the breakdown of costs and the increase in costs from the 60 percent fill rate to 100 percent.

Table 1. Change in Cost Elements per Baseline

	2011 Baseline	2020 at 60% Fill Rate	% Change	2020 at ~ 100% Fill Rate	% Change
Warehousing Cost	$14,348,000	$ 16,130,042	12%	$ 23,658,098	65%
Transportation Cost	$ 2,954,087	$ 7,536,118	155%	$ 12,509,956	323%

Figure 6. Breakdown of Costs



To continue to serve the people of Tanzania, significant investments will be needed during the next decade, even without the additional burden of last mile delivery. It should also be noted that for the scenario with an almost 100 percent fill rate, the planned expansions for warehouse capacities would not be sufficient. An additional 35,000 square feet of efficient warehousing space will be needed if the MSD's goal is to serve all the public sector and to ensure that the needs of not only the health facilities (health centers and dispensaries), but also public hospitals, are met in full.

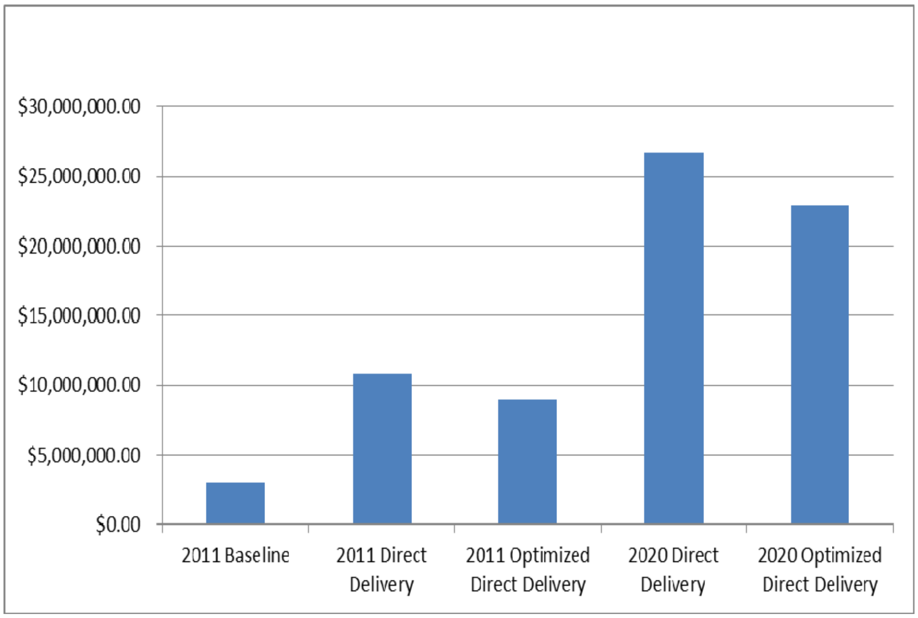
Continued Plan for Direct Delivery

The next set of scenarios analyze the effect on the supply chain, and the resulting changes needed if, in a decade, the direct delivery plan is still in place. As we've seen from the previous future state scenarios, the population growth, increased treatment rates, and improved service goals would result in significant upgrades and investments to the supply chain network even if the MSD was not responsible for the additional costs of last mile delivery. Because the direct delivery plan is already underway, the following future state scenarios (2020–2024) examined the effect of restructuring the current network structure to account for the additional demand flowing through the system and the added last mile delivery. In the scenarios, we analyzed fulfilling 60 percent or 100 percent of the public sector needs.

Optimized Direct Delivery

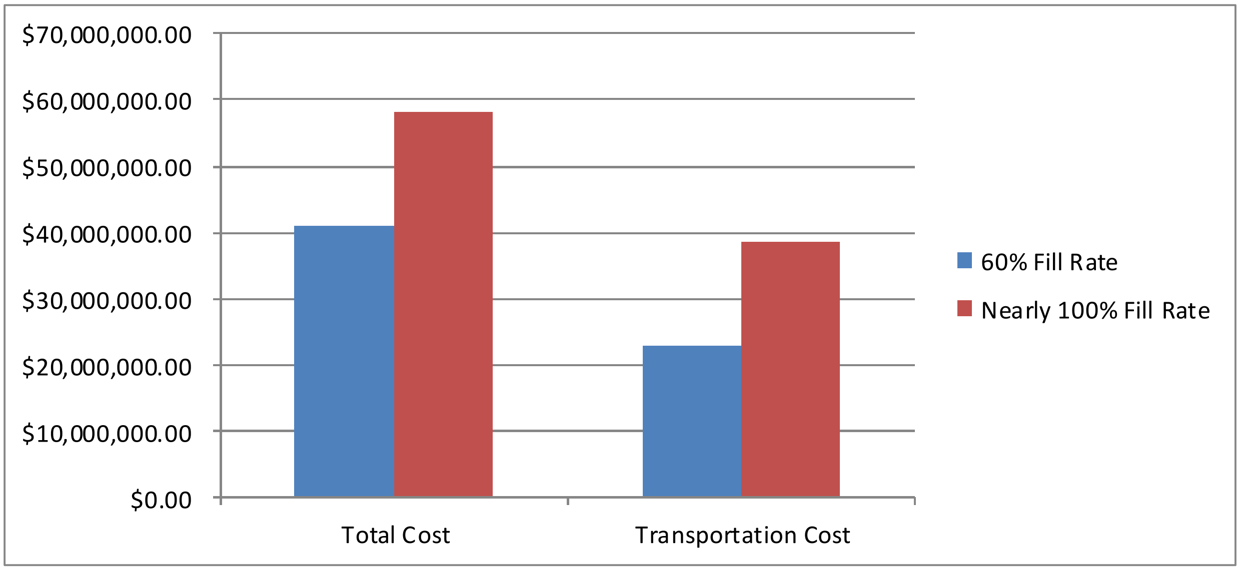
Using the 60 percent fill rate, we did an analysis similar to the one with the 2011 data to see the benefits if the customer-zone assignments were changed. The transportation costs for direct delivery with the current zonal structure is slightly more than $26 million. However, after the network was optimized to allow customers to be served by the most economical zonal assignment, the transportation costs dropped to under $23 million. Thus, changes to capacities and zonal assignments could result in a 14 percent reduction in transportation costs alone. Figure 7 shows the jump in costs from moving to direct delivery and the increasing costs of direct delivery in the future state, plus the benefits of an optimized network.

Figure 7. Comparison of Transportation Costs



As shown in figure 8, the costs incurred under the direct delivery system in 2020 are drastically higher if the MSD had a near-perfect fill rate. The total cost shown in the figure includes the transportation cost, fixed warehousing costs, and some of the handling costs. It should be noted, that the scenario with the near-perfect fill rate analyzed the fixed operating costs of the warehouses and the transportation costs from the additional product flow. However, the task of reaching a near-perfect fill rate is difficult, and it will require other investments in the information technology (IT) systems and administrative processes.

Figure 8. Optimized Costs with Direct Delivery, 2020



As noted in a previous future state scenario, with an improved fill rate, the increased cost in transportation (not including direct delivery costs) was $12.5 million. At the same fill rate, under the direct delivery plan, the transportation cost increases to $38.5 million. Thus, the difference of $26 million would be required for the last mile distribution. This cost would have been distributed among the health facilities, but now the MSD would need to budget the additional amount.

Prioritization of Third Party Logistics Provider Use in Zones and Regions

As mentioned earlier, the costs used in this model for the last mile delivery as part of the direct delivery plan are preliminary estimates from the MSD. At this time, the MSD does not use the services of a 3PL, but when they move to direct delivery, they may need the local 3PLs services; they may find that using a 3PL will add cost savings.

Several different ways can be used to prioritize the order when looking for 3PL assistance in direct delivery. First, the zones and regions with the highest volume could benefit from the efficiencies in transportation that a 3PL can provide. Mwanza is the medical zone with the most volume—it is the most populous zone and the MSD serves nearly 25 percent of this zones population. Mwanza is followed by the medical zones of Dar es Salaam and Dodoma, also very populous regions. Large urban areas and cities in these areas increase the likelihood of a local established 3PL industry. The regions with the highest volume were Tanga (which belongs to a one-region zone), followed by Mwanza and Shinyanga, both belonging to Mwanza.

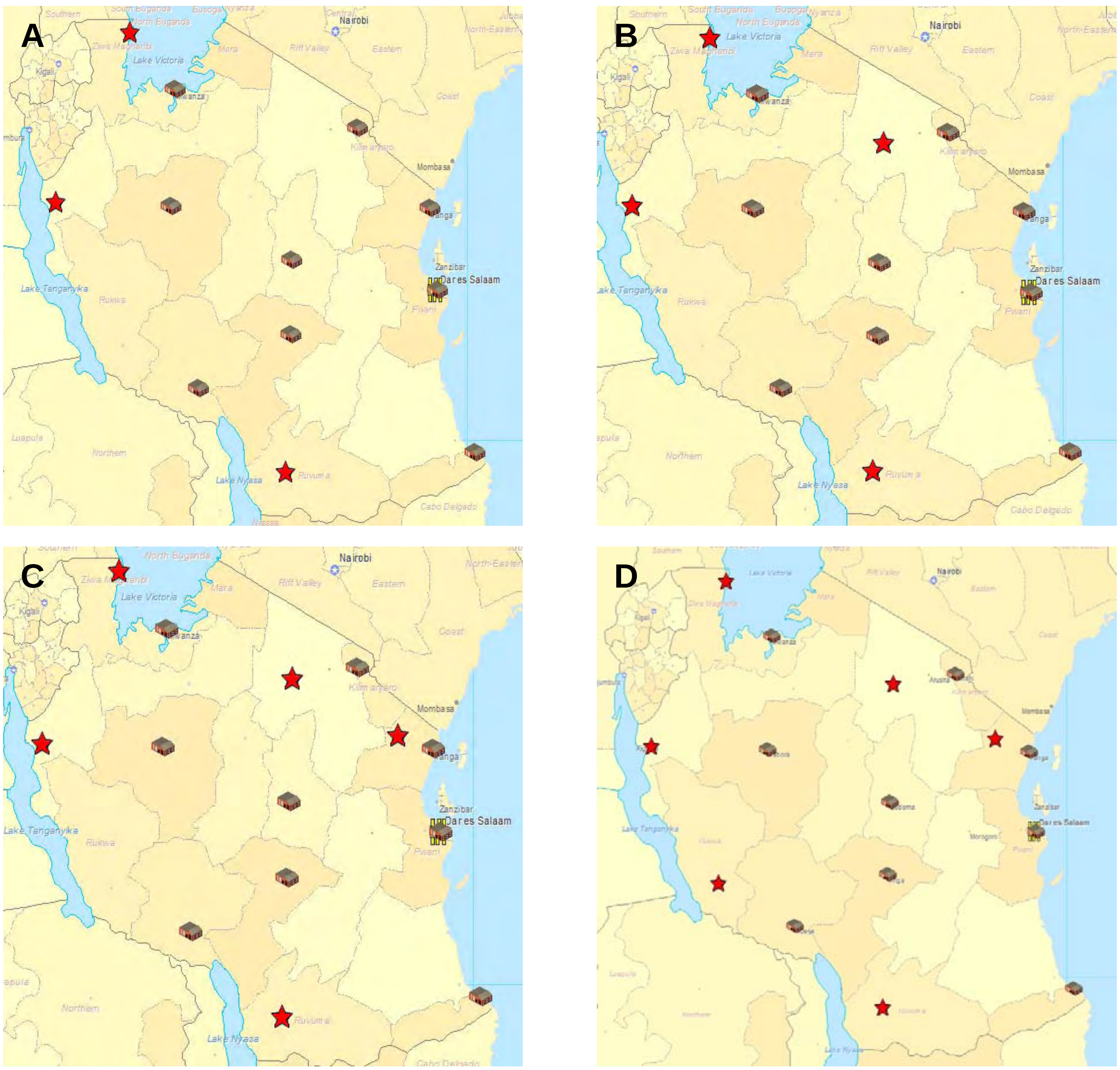
The second way to prioritize the roll-out of 3PL partners is to look at the areas that cost the most to serve. They may be in regions that are difficult to get to, or are farther away from the MSD zonal stores. In these cases, although the larger-scale 3PL providers may not be present, different modes of outsourced transportation could be of value. Mbeya is the most expensive medical zone to serve, followed by Mtwara and Mwanza. The most expensive regions to serve include Ruvuma (which does not have a zonal warehouse nearby), followed by Kigoma and Rukwa.

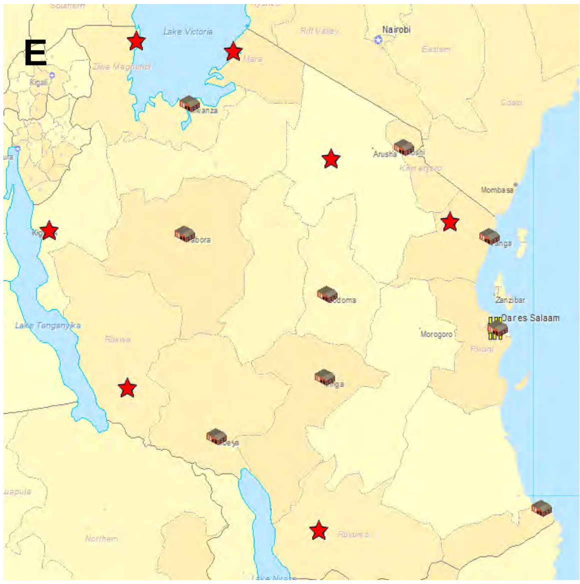
A combined analysis of the two results will aid in arriving at a better solution. For instance, although the Dar es Salaam medical zone has a high volume, it is the cheapest to serve because the central warehouse is co-located with the Dar es Salaam zonal warehouse.

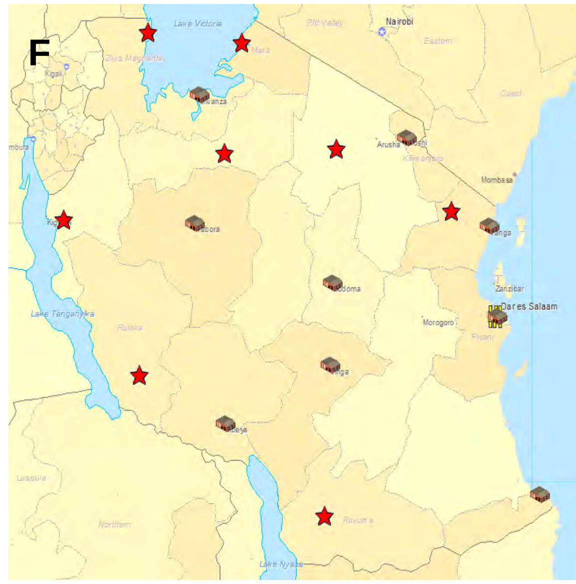
Optimal Locations for Additional Hubs

To assist with the task of direct delivery, the MSD is analyzing the need for additional hubs across the country. These hubs would be smaller warehouses that would function similar to a cross-dock. Based on the demand distribution (which is a function of population) and the current location of the zonal warehouses, an analysis was done to identify the best locations to add hubs. The following figures (figure 9 A–F) show the optimal location of the hubs (marked by red stars) in places where the MSD wants to add three to eight additional hubs.

Figure 9. Proposed Locations for Additional Hubs







The next step in this analysis, which was not a part of the current analysis, is to assess the costs of adding and maintaining the hubs, with the resulting benefit of lowered transportation costs and increased access to products. This would help identify the optimal number of hubs to add, after which the benefits seen as part of lowered transportation costs and service levels would be outweighed by the costs of operating these facilities.

Health Model Scenarios

All the scenarios discussed to this point have focused on the structural changes that the MSD must face in the near- and long-term. Significant changes to various disease characteristics over the next decade are likely, as well. While the changing prevalence rates and improved treatment rates were already considered in the future state analysis, several other possible changes can be anticipated. A select few changes are addressed in the following scenarios. It should also be noted that some of the anticipated changes—a reduction in malaria prevalence by 50 percent by 2020 due to the increased use of bed nets; and the increase in lifestyle diseases, such as diabetes and hypertension—have already been included in the future state models. See appendix D for more information on the sources for the following scenarios.

Introduction of a Rotavirus Vaccine

The rotavirus is known to cause about 40 percent of all hospitalizations for diarrhea in children under the age of five. The Rotarix vaccine was found to be 78 percent efficacious against the rotavirus. Introducing the Rotarix vaccine would result in a 78 percent decrease in 40 percent of the childhood diarrhea cases. This scenario analyzes the change in costs as a result of this link between the vaccine and the prevalence rate. For the scenario, we assumed that the Rotarix vaccine is already considered under the vaccine bundle that has been modeled. Additional costs for procuring this vaccine, or the cold chain storage, were not considered.

The decrease in the prevalence of childhood diarrhea after the vaccine was introduced resulted in 3 percent lower overall costs. The transportation costs were reduced by 4 percent, accounting for the fewer products needed to treat diarrhea. Since the procurement and potential cold chain costs are not explicitly taken into account in this scenario, the introduction in the Rotarix vaccine may prove to be more expensive from a supply chain perspective but, of equal importance, it could be a life-saving intervention.

Effects of Increasing the Contraceptive Prevalence Rate

Family planning is a significant unmet demand in Africa. The Futures Group studied the impact of population growth if all unmet needs for family planning were satisfied. Results from the study showed that if contraceptive prevalence rates (CPR) increased at an reasonably optimistic rate from 2005 to 2050, the United Nation's (UN) medium population estimates would not be impacted during the modeling period, "because of the dynamics of population momentum, the unmet need scenario's population projection approximates the UN medium projection." Therefore, for this scenario, we did not model an increase in population; however, the increase in CPR requirements showed an impact on the supply chain.

We used the CPR projections from the report to model this scenario. We assumed that the proportion of contraceptives projected would remain the same. See table 2 for the CPR.

Table 2. Assumed Tanzania Contraceptive Procurement Rates, 2005–2050

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Tanzania CPR	22.5	26.86	31.22	35.58	39.94	44.3	48.66	53.02	57.38	61.74

If the system has a limited capacity, the model is set up to prioritize products related to certain disease conditions. Each treatment category is assigned three values: critical fraction, standard fraction, and non-critical fraction. The critical fraction is the fraction of the total demand for the category that is of the highest importance to satisfy; while the standard and non-critical fractions refer to the portion of the demand that are of average and low importance, respectively. For instance, 70 percent of all malaria, tuberculosis (TB), and HIV drugs were assigned the highest priority, compared to 50 percent of all family planning and maternal health products, which had the highest priority. For several other treatment categories (such as hypertension, diabetes, and others), only 30 percent of the total demand is considered to be of the highest importance.

For this scenario, remembering the goals to improve the CPR, the critical ratio for *family planning* increased to 70 percent, placing it in the highest priority group with malaria, TB, and HIV. Without the additional throughput at the system, the prioritization of the family planning products comes at the expense of other commodities. Although, in reality, eliminating a commodity should be a carefully deliberated decision—the model based the selection on the given parameters. To accommodate the additional units of demand, the product titled, *Other Essential Medicines and oral rehydration solution (ORS)* was negatively affected. This bundle of medicines was required to cover disease conditions that were not specifically modeled. However, this bundle contains several important antibiotics, as well as male and female sterilization products that would affect the family planning initiative.

Several customers did not receive their share of the other essential medicines product or ORS. With an increase in volume, the capacity constraints of the system forced the rationing of products and allowed products that were considered more important. In other instances, this shortage of the *lower priority* products was more drastic. The situation would probably be the same in this case. One explanation might be that the volume of the other essential medicines bundle was underestimated because the MSD carries a wide range of products. Therefore, if the priority of a particular vertical program is increased, without considering the strain it would place on the logistics system, there would be adverse effects on primary care.

Effects of Changes in Male Circumcision Rates on HIV Prevalence

Some evidence relates increased male circumcision rates to a reduction in the prevalence of HIV in both males and females. A USAID Health Policy Initiative stated that increasing the male circumcision rate to 80 percent would decrease in HIV+ cases in the long term. While the significant effects of the circumcision would be observed until about 2030 on, table 3 shows the number of HIV-positive cases averted during specific years.

Table 3. Number of HIV+ Cases Averted

Year	2020	2021	2022	2023	2024
Cases	18,700	20,000	21,200	22,400	23,600

For this scenario, we analyzed two sub-scenarios: (1) a disposable male circumcision kit, and (2) a reusable kit. For each of the sub-scenarios, the additional product (the circumcision kit) was modeled. The number of HIV cases averted was low compared to the total number of cases expected during those years, slightly decreasing the volume of products in the supply chain. The decrease in volume was found for 20 percent of products in the supply chain, all of which were HIV related products.

Because fewer of the reusable kits are needed, the increase in the volume of products from the kits was less than the decrease in the volume of HIV products no longer needed. Thus, the overall costs were reduced by 2 percent and the transportation costs by 1 percent. However, note that the reusable kits require stringent sterilization, which could add to the cost. The addition of the disposable kits increased the overall costs and transportation costs by less than 1 percent.

Even with the relatively small effects on new HIV positive cases during 2020–2025, the added male circumcision campaign will not significantly increase long-term costs. When the large number of cases averted in later years is considered, this would be a beneficial campaign with measurable benefits for the population and the health system.

Conclusion

The goal of this project was to show how the repeatable modeling approach can be used a second time to help policymakers accurately visualize and understand the most likely and possible situations facing them in a 10-year period. Multiple future state scenarios were conducted to demonstrate the various ways a supply chain network could be restructured to accommodate additional demand and increase service levels. However, this is only one list that shows the different variables that can be assessed.

The results from the current state and the future state analysis for the supply chain structure show that, while the MSD is expected to be responsible for the costs of direct delivery, substantial improvements can be made using quantitative analysis—for example, increased service levels and decreased costs. Thus, the inefficiencies in the current structure of the supply chain network should be closely analyzed.

All the scenarios show that, to make any improvements, significant investments must be made to the supply chain network. To improve the access to care in rural areas, the transportation must be improved. To prioritize and focus on a particular vertical program, additional resources are needed. If not, other essential medical supplies will be rationed, and health outcomes will not improve. Most important, the MSD needs to meet its expectations (go from a 60 percent fill rate to a 100 percent fill rate), and the budget allocated for operations, especially transportation, must significantly increase.

With the information already collected for Tanzania, several opportunities are still available. Additional scenarios can be analyzed to determine relevant and timely results—for example, the optimal number and composition of medical zones. Also, as the direct delivery program continues to be implemented, a more detailed transportation analysis can be conducted, which could include a more extensive analysis for selecting regions for 3PL partners and for analyzing the optimal assignments and routes for delivery. However, one key lesson learned from this activity and others is that the support and commitment from all the key stakeholders is crucial to the success of the project. With that in place, to provide relevant and timely recommendations, these activities should be done before a significant decision is made for investments and changes to the medical supply chain.

Appendix A

Resources Used for Material Requirements Model

Condition	Resource
Tuberculosis	For determining treatments: Treatment of Tuberculosis Guidelines, fourth Edition, WHO (http://whqlibdoc.who.int/publications/2010/9789241547833_eng.pdf)
	For determining percentage of patients requiring various treatments: Data collected from TB control programs and estimates generated by WHO (http://www.who.int/tb/country/data/download/en/index.html)
	Pharmaceutical product details: from STOP TB Product list (http://www.stoptb.org/gdf/drugsupply/drugs_available.asp)
STIs	United Republic of Tanzania, Ministry of Health and Social Welfare. 2007. *Standard Treatment Guidelines Tanzania Mainland, Third Edition, 2007.*
HIV/AIDS	MSFs: Untangling the Web of Antiretroviral Drug Prices: http://utw.msfaccess.org/
	Epidemiological Fact Sheet on HIV/AIDS 2008: http://apps.who.int/globalatlas/predefinedReports/EFS2008/full/EFS2008_KE.pdf
	PowerPoint presentation by WHO 2008 survey on ARV use: http://www.who.int/hiv/amds/who_survey_arv_use_2008_market_renaudthery.pdf
	"NEW WHO recommendations on ART regimen: Preliminary assumptions on future use of 1st and 2nd line regimen" PowerPoint (Rapid d4T example was used (2012)): http://www.who.int/hiv/amds/who_new_ar_recom_assump_future_renaudthery.pdf
	WHO Antiretroviral therapy of HIV infection in infants and children: http://www.who.int/hiv/pub/guidelines/paediatric020907.pdf
	WHO survey: ARV Use in 2008 and market trends in low and middle income countries: http://www.who.int/hiv/amds/who_survey_arv_use_2008_market_renaudthery.pdf
	Finalization of WHO ART Treatment Guidelines for Children: http://www.who.int/hiv/amds/who_paediatric_art_guidelines_crowley.pdf
	"Methodology and Assumptions used to estimate the Cost of Scaling Up Selected Child Health Interventions", WHO, March 2005.
	WHO survey: ARV Use in 2008 and market trends in low and middle income countries" http://www.who.int/hiv/amds/who_survey_arv_use_2008_market_renaudthery.pdf
	USAID | DELIVER PROJECT, Task Order 1. 2008. *Logistics Fact Sheets: ARV Drugs*. Arlington, Va.: USAID | DELIVER, PROJECT, Task Order 1. http://deliver.jsi.com/dlvr_content/resources/allpubs/factsheets/LogiFactShee_ARV_Comp.pdf

Condition	Resource
	USAID | DELIVER PROJECT, Task Order 1. 2008. *Logistics Fact Sheets: HIV Test Kits*. Arlington, Va.: USAID | DELIVER PROJECT, Task Order 1. http://deliver.jsi.com/dlvr_content/resources/allpubs/factsheets/LogiFactShee_HIVT_Comp.pdf
Diarrhea	United Republic of Tanzania, Ministry of Health and Social Welfare. 2007. *Standard Treatment Guidelines Tanzania Mainland, Third Edition, 2007.*
	Interviews with practitioners in Tanzania
Malaria	Guidelines for the Treatment of Malaria, Second edition, WHO, 2010.
Leprosy	United Republic of Tanzania, Ministry of Health and Social Welfare. 2007. *Standard Treatment Guidelines Tanzania Mainland, Third Edition, 2007.*
Worms	United Republic of Tanzania, Ministry of Health and Social Welfare. 2007. *Standard Treatment Guidelines Tanzania Mainland, Third Edition, 2007.*
Respiratory Infections	United Republic of Tanzania, Ministry of Health and Social Welfare. 2007. *Standard Treatment Guidelines Tanzania Mainland, Third Edition, 2007.*
	Interviews with practitioners in Tanzania
	"Methodology and Assumptions used to estimate the Cost of Scaling Up Selected Child Health Interventions", WHO, March 2005.
Family Planning	Profiles for Family Planning and Reproductive Health Programs, 2nd Edition by the Futures Group (http://www.policyproject.com/pubs/generalreport/Profiles116FP2ed.pdf)
	United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects DEMOBASE extract. 2007.
Vitamins	"Methodology and Assumptions used to estimate the Cost of Scaling Up Selected Child Health Interventions", WHO, March 2005.
	"Constraints to Scaling Up Health Related MDGs: Costing and Financial Gap Analysis:, WHO, September 2009.
	United Republic of Tanzania, Ministry of Health and Social Welfare. 2007. *Standard Treatment Guidelines Tanzania Mainland, Third Edition, 2007.*
Diabetes Mellitus	"Constraints to Scaling Up Health Related MDGs: Costing and Financial Gap Analysis:, WHO, September 2009.
	Interviews with practitioners in Tanzania
Maternal Health	"Constraints to Scaling Up Health Related MDGs: Costing and Financial Gap Analysis:, WHO, September 2009.
	United Republic of Tanzania, Ministry of Health and Social Welfare. 2007. *Standard Treatment Guidelines Tanzania Mainland, Third Edition, 2007.*
Hypertension & Cardiovascular Disease	"Constraints to Scaling Up Health Related MDGs: Costing and Financial Gap Analysis:, WHO, September 2009.
	Interviews with practitioners in Tanzania
Asthma	United Republic of Tanzania, Ministry of Health and Social Welfare. 2007. *Standard Treatment Guidelines Tanzania Mainland, Third Edition, 2007.*
	Interviews with practitioners in Tanzania
Vaccines	"Landscape Analysis: Trends in Vaccine Availability and Novel Vaccine Delivery technologies: 2008-2025", OPTIMIZE, July 2008.

Other Resources

Management Sciences for Health. 2008. *International Drug Price Indicator Guide*. Cambridge, MA: MSH. http://erc.msh.org/dmpguide/pdf/DrugPriceGuide_2008_en.pdf

USAID | DELIVER PROJECT, Task Order 5. 2011. *USAID Contraceptive and Condom Catalog 2011*. Arlington, Va.: USAID | DELIVER PROJECT, Task Order 5. http://deliver.jsi.com/dlvr_content/resources/allpubs/guidelines/ContCondCatalog2011.pdf

Appendix B

Prevalence and Treatment Rates

Table 1. Tuberculosis

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	0.107%	0.15%	100%	100%
Arusha	0.168%	0.15%	100%	100%
Kilimanjaro	0.141%	0.15%	100%	100%
Tanga	0.170%	0.15%	100%	100%
Morogoro	0.176%	0.15%	100%	100%
Pwani	0.190%	0.15%	100%	100%
Dar es Salaam	0.432%	0.15%	100%	100%
Lindi	0.138%	0.15%	100%	100%
Mtwara	0.148%	0.15%	100%	100%
Ruvuma	0.114%	0.15%	100%	100%
Iringa	0.183%	0.15%	100%	100%
Mbeya	0.121%	0.15%	100%	100%
Singida	0.089%	0.15%	100%	100%
Tabora	0.056%	0.15%	100%	100%
Rukwa	0.052%	0.15%	100%	100%
Kigoma	0.048%	0.15%	100%	100%
Shinyanga	0.110%	0.15%	100%	100%
Kagera	0.098%	0.15%	100%	100%
Mwanza	0.158%	0.15%	100%	100%
Mara	0.149%	0.15%	100%	100%
Manyara	0.189%	0.15%	100%	100%
Unguja North	0.048%	0.15%	100%	100%
Unguja South	0.048%	0.15%	100%	100%
Town West	0.035%	0.15%	100%	100%
Pemba North	0.016%	0.15%	100%	100%
Pemba South	0.016%	0.15%	100%	100%

Resource: Tanzania National Tuberculosis and Leprosy Program.
*Assumption.

Table 2. Adult Antiretroviral Therapy

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	3.0%	10%	3.64%	50%
Arusha	1.3%	10%	14.52%	50%
Kilimanjaro	1.7%	10%	14.76%	50%
Tanga	3.5%	10%	5.88%	50%
Morogoro	3.9%	10%	3.54%	50%
Pwani	4.9%	10%	5.36%	50%
Dar es Salaam	8.2%	10%	5.86%	50%
Lindi	3.6%	10%	4.94%	50%
Mtwara	2.8%	10%	6.26%	50%
Ruvuma	5.0%	10%	4.36%	50%
Iringa	13.5%	10%	3.82%	50%
Mbeya	7.3%	10%	5.12%	50%
Singida	2.4%	10%	3.24%	50%
Tabora	5.6%	10%	2.90%	50%
Rukwa	4.1%	10%	2.44%	50%
Kigoma	0.8%	10%	4.68%	50%
Shinyanga	7.0%	10%	1.76%	50%
Kagera	3.1%	10%	4.26%	50%
Mwanza	4.6%	10%	4.08%	50%
Mara	4.9%	10%	3.22%	50%
Manyara	1.6%	10%	4.00%	50%
Unguja North	0.8%	3%	5%*	50%
Unguja South	0.8%	3%	5%*	50%
Town West	0.5%*	3%	5%*	50%
Pemba North	0.3%	3%	5%*	50%
Pemba South	0.3%	3%	5%*	50%

Resources:

Ministry of Health and Social Welfare, National AIDS Control Program. July 2009. *HIV/AIDS/STI Surveillance Report: Report number 21*. Tanzania.

Project for Supply Chain Management. April 2011. *Tanzania National ARV Quantification.* Supply Chain Management Systems.

Tanzania Commission for AIDS (TACAIDS), Zanzibar AIDS COMMISSION (ZAC), National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), and Macro International Inc. 2008. *Tanzania HIV/AIDS and Malaria Indicator Survey 2007-2008.* Dar es Salaam, Tanzania: TACAIDS, ZAC, NBS, OCGS, and Macro International Inc.

*Assumption.

Table 3. Pediatric Antiretroviral Therapy

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	0.26%	0.50%	100%	100%
Arusha	0.11%	0.50%	100%	100%
Kilimanjaro	0.15%	0.50%	100%	100%
Tanga	0.30%	0.50%	100%	100%
Morogoro	0.34%	0.50%	100%	100%
Pwani	0.42%	0.50%	100%	100%
Dar es Salaam	0.71%	0.50%	100%	100%
Lindi	0.31%	0.50%	100%	100%
Mtwara	0.24%	0.50%	100%	100%
Ruvuma	0.43%	0.50%	100%	100%
Iringa	1.18%	0.50%	100%	100%
Mbeya	0.63%	0.50%	100%	100%
Singida	0.21%	0.50%	100%	100%
Tabora	0.49%	0.50%	100%	100%
Rukwa	0.36%	0.50%	100%	100%
Kigoma	0.07%	0.50%	100%	100%
Shinyanga	0.61%	0.50%	100%	100%
Kagera	0.27%	0.50%	100%	100%
Mwanza	0.40%	0.50%	100%	100%
Mara	0.42%	0.50%	100%	100%
Manyara	0.14%	0.50%	100%	100%
Unguja North	0.07%	0.15%	100%	100%
Unguja South	0.07%	0.15%	100%	100%
Town West	0.04%	0.15%	100%	100%
Pemba North	0.03%	0.15%	100%	100%
Pemba South	0.03%	0.15%	100%	100%

Resources:

Ministry of Health and Social Welfare, National AIDS Control Program. July 2009. *HIV/AIDS/STI Surveillance Report: Report number 21*. Tanzania.

Project for Supply Chain Management. April 2011. *Tanzania National ARV Quantification.* Supply Chain Management Systems.

Tanzania Commission for AIDS (TACAIDS), Zanzibar AIDS COMMISSION (ZAC), National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), and Macro International Inc. 2008. *Tanzania HIV/AIDS and Malaria Indicator Survey 2007-2008.* Dar es Salaam, Tanzania: TACAIDS, ZAC, NBS, OCGS, and Macro International Inc.

*Assumption.

Table 4. HIV-Positive Births for Preventing Mother-to-Child Transmission (PMTCT)

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
National	4.51%	10%	80%	100%

Resources:
Ministry of Health and Social Welfare, National AIDS Control Program. July 2009. *HIV/AIDS/STI Surveillance Report: Report number 21*. Tanzania.
Project for Supply Chain Management. April 2011. *Tanzania National ARV Quantification.* Supply Chain Management Systems.
*Assumption.

Table 5. HIV-Positive Pediatrics Not Yet on Antiretroviral Therapy (ART)

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
National	0.18040%	0.400%	80%	100%

Resources:
Ministry of Health and Social Welfare, National AIDS Control Program. July 2009. *HIV/AIDS/STI Surveillance Report: Report number 21*. Tanzania.
Project for Supply Chain Management. April 2011. *Tanzania National ARV Quantification.* Supply Chain Management Systems.
*Assumption.

Table 6. HIV Rapid Test Kits

Region	Treatment Tate 2010	Treatment Rate 2020*
National	14%	15%

Resources:
USAID | DELIVER PROJECT documents.
*Assumption.

Table 7. Malaria Rapid Test Kits

Region	Treatment Rate 2010	Treatment Rate 2020*
National	8%	10%

Resources:
USAID | DELIVER PROJECT documents.
*Assumption.

Table 8. HIV Positive Adults Receiving Prophylaxis

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	3.04%	10.00%	18.50%	100%
Arusha	1.29%	10.00%	18.50%	100%
Kilimanjaro	1.75%	10.00%	18.50%	100%
Tanga	3.50%	10.00%	18.50%	100%
Morogoro	3.86%	10.00%	18.50%	100%
Pwani	4.88%	10.00%	18.50%	100%
Dar es Salaam	8.19%	10.00%	18.50%	100%
Lindi	3.59%	10.00%	18.50%	100%
Mtwara	2.76%	10.00%	18.50%	100%
Ruvuma	4.97%	10.00%	18.50%	100%
Iringa	13.52%	10.00%	18.50%	100%
Mbeya	7.27%	10.00%	18.50%	100%
Singida	2.39%	10.00%	18.50%	100%
Tabora	5.61%	10.00%	18.50%	100%
Rukwa	4.14%	10.00%	18.50%	100%
Kigoma	0.83%	10.00%	18.50%	100%
Shinyanga	6.99%	10.00%	18.50%	100%
Kagera	3.13%	10.00%	18.50%	100%
Mwanza	4.60%	10.00%	18.50%	100%
Mara	4.88%	10.00%	18.50%	100%
Manyara	1.56%	10.00%	18.50%	100%
Unguja North	0.80%	3.00%	18.50%	100%
Unguja South	0.80%	3.00%	18.50%	100%
Town West	0.50%	3.00%	18.50%	100%
Pemba North	0.30%	3.00%	18.50%	100%
Pemba South	0.30%	3.00%	18.50%	100%

Resources:

Ministry of Health and Social Welfare, National AIDS Control Program. July 2009. *HIV/AIDS/STI Surveillance Report: Report number 21*. Tanzania.

John A. Crump, Habib O. Ramadhani, Anne B. Morrissey, Wilbrod Saganda, Mtumwa S. Mwako, Lan-Yan Yang, Shein-Chung Chow, Susan C. Morpeth, Hugh Reyburn, Boniface N. Njau, Andrea V. Shaw, Helmut C. Diefenthal, John F. Shao, John A. Bartlett, and Venance P. *Maro*

Invasive Bacterial and Fungal Infections Among Hospitalized HIV-Infected and HIV-Uninfected Adults and Adolescents in Northern Tanzania

Clin Infect Dis. (2011) 52(3): 341-348 doi:10.1093/cid/ciq103

*Assumption.

Table 9. Malaria Treatment

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	13.19%	6.59%	51.0%	100%
Arusha	0.34%	0.17%	28.6%	100%
Kilimanjaro	0.88%	0.44%	39.1%	100%
Tanga	14.20%	7.10%	65.5%	100%
Morogoro	15.98%	7.99%	73.6%	100%
Pwani	43.64%	21.82%	59.2%	100%
Dar es Salaam	0.93%	0.47%	56.1%	100%
Lindi	74.17%	37.08%	73.4%	100%
Mtwara	53.86%	26.93%	83.5%	100%
Ruvuma	36.66%	18.33%	72.9%	100%
Iringa	2.73%	1.36%	59.8%*	100%
Mbeya	2.49%	1.24%	59.8%*	100%
Singida	9.79%	4.89%	56.7%	100%
Tabora	12.20%	6.10%	54.7%	100%
Rukwa	17.54%	8.77%	63.4%	100%
Kigoma	28.91%	14.46%	72.3%	100%
Shinyanga	20.73%	10.36%	57.2%	100%
Kagera	38.27%	19.14%	56.3%	100%
Mwanza	21.39%	10.69%	67.0%	100%
Mara	38.88%	19.44%	58.8%	100%
Manyara	1.00%	0.50%	46.9%	100%
Unguja North	10.40%	5.20%	8.1%	100%
Unguja South	13.38%	6.69%	8.0%	100%
Town West	5.24%	2.62%	24.7%	100%
Pemba North	9.83%	4.92%	9.1%	100%
Pemba South	10.59%	5.29%	19.7%	100%

Resources:

Tanzania Commission for AIDS (TACAIDS), Zanzibar AIDS COMMISSION (ZAC), National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), and Macro International Inc. 2008. *Tanzania HIV/AIDS and Malaria Indicator Survey 2007-2008.* Dar es Salaam, Tanzania: TACAIDS, ZAC, NBS, OCGS, and Macro International Inc.

National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011. *Tanzania Demographic and Health Survey 2010*. Dar es Salaam, Tanzania: NBS and ICF Macro.

*Assumption.

Table 10. Malaria Intermittent Preventive Treatment in Pregnancy (IPTp)

Region	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	37.30%	100%
Arusha	50.75%	100%
Kilimanjaro	52.15%	100%
Tanga	58.25%	100%
Morogoro	51.75%	100%
Pwani	52.55%	100%
Dar es Salaam	44.70%	100%
Lindi	52.25%	100%
Mtwara	61.50%	100%
Ruvuma	44.05%	100%
Iringa	42.25%	100%
Mbeya	32.10%	100%
Singida	52.00%	100%
Tabora	32.70%	100%
Rukwa	37.55%	100%
Kigoma	44.05%	100%
Shinyanga	36.85%	100%
Kagera	56.85%	100%
Mwanza	41.60%	100%
Mara	55.00%	100%
Manyara	44.80%	100%
Unguja North	75.30%	100%
Unguja South	80.25%	100%
Town West	63.10%	100%
Pemba North	60.00%	100%
Pemba South	61.90%	100%

Resources:

National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011. *Tanzania Demographic and Health Survey 2010*. Dar es Salaam, Tanzania: NBS and ICF Macro.

*Assumption.

Table 11. Malaria Bed Nets (coverage of households)

Region	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	76.0%	100%
Arusha	59.2%	100%
Kilimanjaro	58.4%	100%
Tanga	70.4%	100%
Morogoro	56.8%	100%
Pwani	80.3%	100%
Dar es Salaam	85.8%	100%
Lindi	79.0%	100%
Mtwara	76.1%	100%
Ruvuma	77.0%	100%
Iringa	60.6%	100%
Mbeya	69.3%	100%
Singida	47.1%	100%
Tabora	82.3%	100%
Rukwa	78.4%	100%
Kigoma	69.0%	100%
Shinyanga	92.9%	100%
Kagera	75.8%	100%
Mwanza	90.8%	100%
Mara	92.3%	100%
Manyara	78.1%	100%
Unguja North	93.1%	100%
Unguja South	92.5%	100%
Town West	82.5%	100%
Pemba North	94.1%	100%
Pemba South	88.8%	100%

Resources:

National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011. *Tanzania Demographic and Health Survey 2010*. Dar es Salaam, Tanzania: NBS and ICF Macro.

*Assumption.

Table 12. Diarrhea

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	33.59%	49%	53%	80%
Arusha	17.36%	49%	53%	80%
Kilimanjaro	6.77%	49%	53%	80%
Tanga	20.23%	49%	53%	80%
Morogoro	47.12%	49%	53%	80%
Pwani	25.89%	49%	53%	80%
Dar es Salaam	4.30%	49%	53%	80%
Lindi	40.42%	49%	53%	80%
Mtwara	12.39%	49%	53%	80%
Ruvuma	24.46%	49%	53%	80%
Iringa	27.39%	49%	53%	80%
Mbeya	32.09%	49%	53%	80%
Singida	3.75%	49%	53%	80%
Tabora	39.64%	49%	53%	80%
Rukwa	49.38%	49%	53%	80%
Kigoma	13.00%	49%	53%	80%
Shinyanga	64.51%	49%	53%	80%
Kagera	20.68%	49%	53%	80%
Mwanza	7.99%	49%	53%	80%
Mara	39.58%	49%	53%	80%
Manyara	18.60%	49%	53%	80%
Unguja North	26%*	49%	53%	80%
Unguja South	26%*	49%	53%	80%
Town West	26%*	49%	53%	80%
Pemba North	26%*	49%	53%	80%
Pemba South	26%*	49%	53%	80%

Resources:

National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011. *Tanzania Demographic and Health Survey 2010*. Dar es Salaam, Tanzania: NBS and ICF Macro.

Pediatric figures used. 49% for prevalence rate for 2020 represents 14% with 3.5 episodes per year.

*Assumption.

Table 13. Leprosy

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010*	Treatment Rate 2020*
Dodoma	0.005%	0.001%	100%	100%
Arusha	0.000%	0.001%	100%	100%
Kilimanjaro	0.001%	0.001%	100%	100%
Tanga	0.011%	0.001%	100%	100%
Morogoro	0.026%	0.001%	100%	100%
Pwani	0.020%	0.001%	100%	100%
Dar es Salaam	0.013%	0.001%	100%	100%
Lindi	0.027%	0.001%	100%	100%
Mtwara	0.036%	0.001%	100%	100%
Ruvuma	0.007%	0.001%	100%	100%
Iringa	0.001%	0.001%	100%	100%
Mbeya	0.003%	0.001%	100%	100%
Singida	0.003%	0.001%	100%	100%
Tabora	0.015%	0.001%	100%	100%
Rukwa	0.016%	0.001%	100%	100%
Kigoma	0.015%	0.001%	100%	100%
Shinyanga	0.005%	0.001%	100%	100%
Kagera	0.004%	0.001%	100%	100%
Mwanza	0.006%	0.001%	100%	100%
Mara	0.002%	0.001%	100%	100%
Manyara	0.001%	0.001%	100%	100%
Unguja North	0.006%	0.001%	100%	100%
Unguja South	0.006%	0.001%	100%	100%
Town West	0.003%	0.001%	100%	100%
Pemba North	0.003%	0.001%	100%	100%
Pemba South	0.003%	0.001%	100%	100%

Resources:

Ministry of Health and Social Welfare. *Annual Health Statistical Abstract Tanzania Mainland 2008*. January 2008. Health Information and Research Section.

*Assumption.

Table 14. Treatment of Acariasos, Trichuriasis and Hookworm

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
National	38.50%	38.50%	87%	100%

Resources:

National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011. *Tanzania Demographic and Health Survey 2010*. Dar es Salaam, Tanzania: NBS and ICF Macro.

Mazigo et al., *Co-infections with Plasmodium falciparum, Schistosoma mansoni and intestinal helminths among schoolchildren in endemic areas of northwestern Tanzania*. Parasites & Vectors 2010, 3:44

*Assumption

Table 15. Asthma

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
National	24%	24%	8%*	40%

Resources:

Berntsen, S., Lødrup Carlsen, K. C., Hageberg, R., Aandstad, A., Mowinckel, P., Anderssen, S. A. and Carlsen, K.-H. (2009), *Asthma symptoms in rural living Tanzanian children; prevalence and the relation to aerobic fitness and body fat.* Allergy, 64: 1166–1171. doi: 10.1111/j.1398-9995.2009.01979.x

Mugusi F, Edwards R, Hayes L, Unwin N, Mbanya JC, Whiting D, Sobngwi E, Rashid S. *Prevalence of wheeze and self-reported asthma and asthma care in an urban and rural area of Tanzania and Cameroon.* Trop Doct. 2004 Oct;34(4):209-14.

*Assumption

Table 16. Vitamin A (Supplement)

Region	Treatment Rate 2010	Treatment Rate 2020*
National	61%	100%

Resources:

National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011. *Tanzania Demographic and Health Survey 2010*. Dar es Salaam, Tanzania: NBS and ICF Macro.

*Assumption

Table 17. Diabetes Mellitus

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
National	2.60%	3.45%**		100%

Resources:

IDF. Diabetes atlas (4th Edition). Brussels: International Diabetes Federation, 2009. http://www.diabetesatlas.org/

*Assumption

** with an increase of prevalence per year of 0.085%thereafter

Table 18. Preventative Therapy for Hookworms

Region	Treatment Rate 2010*	Treatment Rate 2020*
Dodoma	96%	100%
Arusha	100%	100%
Kilimanjaro	98%	100%
Tanga	95%	100%
Morogoro	89%	100%
Pwani	85%	100%
Dar es Salaam	84%	100%
Lindi	86%	100%
Mtwara	92%	100%
Ruvuma	94%	100%
Iringa	90%	100%
Mbeya	92%	100%
Singida	91%	100%
Tabora	89%	100%
Rukwa	96%	100%
Kigoma	95%	100%
Shinyanga	92%	100%
Kagera	98%	100%
Mwanza	93%	100%
Mara	93%	100%
Manyara	85%	100%
Unguja North	90%*	100%
Unguja South	90%*	100%
Town West	90%*	100%
Pemba North	90%*	100%
Pemba South	90%*	100%

Resources:

Ministry of Health and Social Welfare. *Annual Health Statistical Abstract Tanzania Mainland 2008*. January 2008. Health Information and Research Section.

*Assumption.

Table 19. Pediatric Respiratory Infections

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	37.38%	37.38%	71%	100%
Arusha	17.82%	17.82%	71%	100%
Kilimanjaro	4.71%	4.71%	71%	100%
Tanga	11.19%	11.19%	71%	100%
Morogoro	17.78%	17.78%	71%	100%
Pwani	11.46%	11.46%	71%	100%
Dar es Salaam	1.81%	1.81%	71%	100%
Lindi	19.64%	19.64%	71%	100%
Mtwara	18.90%	18.90%	71%	100%
Ruvuma	24.51%	24.51%	71%	100%
Iringa	9.69%	9.69%	71%	100%
Mbeya	12.73%	12.73%	71%	100%
Singida	0.57%	0.57%	71%	100%
Tabora	11.99%	11.99%	71%	100%
Rukwa	5.04%	5.04%	71%	100%
Kigoma	2.89%	2.89%	71%	100%
Shinyanga	11.14%	11.14%	71%	100%
Kagera	7.10%	7.10%	71%	100%
Mwanza	2.57%	2.57%	71%	100%
Mara	9.99%	9.99%	71%	100%
Manyara	14.26%	14.26%	71%	100%
Unguja North	12.06%*	12.06%	71%	100%
Unguja South	12.06%*	12.06%	71%	100%
Town West	12.06%*	12.06%	71%	100%
Pemba North	12.06%*	12.06%	71%	100%
Pemba South	12.06%*	12.06%	71%	100%

Resources:

National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011. *Tanzania Demographic and Health Survey 2010*. Dar es Salaam, Tanzania: NBS and ICF Macro.

*Assumption.

Table 20. Sexually Transmitted Infections

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	0.473%	0.473%	60%	100%
Arusha	0.047%	0.047%	60%	100%
Kilimanjaro	0.963%	0.963%	60%	100%
Tanga	1.405%	1.405%	60%	100%
Morogoro	0.398%	0.398%	60%	100%
Pwani	0.092%	0.092%	60%	100%
Dar es Salaam	0.697%	0.697%	60%	100%
Lindi	0.359%	0.359%	60%	100%
Mtwara	0.678%	0.678%	60%	100%
Ruvuma	0.786%	0.786%	60%	100%
Iringa	0.669%	0.669%	60%	100%
Mbeya	1.195%	1.195%	60%	100%
Singida	0.383%	0.383%	60%	100%
Tabora	0.121%	0.121%	60%	100%
Rukwa	0.136%	0.136%	60%	100%
Kigoma	0.599%	0.599%	60%	100%
Shinyanga	0.562%	0.562%	60%	100%
Kagera	0.244%	0.244%	60%	100%
Mwanza	0.582%	0.582%	60%	100%
Mara	0.188%	0.188%	60%	100%
Manyara	0.10%*	0.10%	60%	100%
Unguja North	0.10%*	0.10%	60%	100%
Unguja South	0.10%*	0.10%	60%	100%
Town West	0.10%*	0.10%	60%	100%
Pemba North	0.10%*	0.10%	60%	100%
Pemba South	0.10%*	0.10%	60%	100%

Resources:
Ministry of Health and Social Welfare, National AIDS Control Program. July 2009. *HIV/AIDS/STI Surveillance Report: Report number 21*. Tanzania.
*Assumption.

Table 21. Vitamin A (for measles)

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	0.00000%	0.0174%	100%	100%
Arusha	0.00106%	0.0030%	100%	100%
Kilimanjaro	0.00755%	0.0030%	100%	100%
Tanga	0.00000%	0.0030%	100%	100%
Morogoro	0.00167%	0.0030%	100%	100%
Pwani	0.04207%	0.0030%	100%	100%
Dar es Salaam	0.02132%	0.0030%	100%	100%
Lindi	0.01911%	0.0030%	100%	100%
Mtwara	0.10311%	0.0030%	100%	100%
Ruvuma	0.04791%	0.0030%	100%	100%
Iringa	0.00271%	0.0030%	100%	100%
Mbeya	0.01016%	0.0030%	100%	100%
Singida	0.00000%	0.0030%	100%	100%
Tabora	0.02303%	0.0030%	100%	100%
Rukwa	0.01878%	0.0030%	100%	100%
Kigoma	0.00519%	0.0030%	100%	100%
Shinyanga	0.00516%	0.0030%	100%	100%
Kagera	0.01973%	0.0030%	100%	100%
Mwanza	0.00693%	0.0030%	100%	100%
Mara	0.00613%	0.0030%	100%	100%
Manyara	0.02288%	0.0030%	100%	100%
Unguja North	0.0174%*	0.0030%	100%	100%
Unguja South	0.0174%*	0.0030%	100%	100%
Town West	0.0174%*	0.0030%	100%	100%
Pemba North	0.0174%*	0.0030%	100%	100%
Pemba South	0.0174%*	0.0030%	100%	100%

Resources:

National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011. *Tanzania Demographic and Health Survey 2010*. Dar es Salaam, Tanzania: NBS and ICF Macro.

*Assumption.

Table 22. Vitamin A (Supplement)

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	0.00000%	0.0174%	100%	100%
Arusha	0.00106%	0.0030%	100%	100%
Kilimanjaro	0.00755%	0.0030%	100%	100%
Tanga	0.00000%	0.0030%	100%	100%
Morogoro	0.00167%	0.0030%	100%	100%
Pwani	0.04207%	0.0030%	100%	100%
Dar es Salaam	0.02132%	0.0030%	100%	100%
Lindi	0.01911%	0.0030%	100%	100%
Mtwara	0.10311%	0.0030%	100%	100%
Ruvuma	0.04791%	0.0030%	100%	100%
Iringa	0.00271%	0.0030%	100%	100%
Mbeya	0.01016%	0.0030%	100%	100%
Singida	0.00000%	0.0030%	100%	100%
Tabora	0.02303%	0.0030%	100%	100%
Rukwa	0.01878%	0.0030%	100%	100%
Kigoma	0.00519%	0.0030%	100%	100%
Shinyanga	0.00516%	0.0030%	100%	100%
Kagera	0.01973%	0.0030%	100%	100%
Mwanza	0.00693%	0.0030%	100%	100%
Mara	0.00613%	0.0030%	100%	100%
Manyara	0.02288%	0.0030%	100%	100%
Unguja North	0.0174%*	0.0030%	100%	100%
Unguja South	0.0174%*	0.0030%	100%	100%
Town West	0.0174%*	0.0030%	100%	100%
Pemba North	0.0174%*	0.0030%	100%	100%
Pemba South	0.0174%*	0.0030%	100%	100%

Resources:

National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011. *Tanzania Demographic and Health Survey 2010*. Dar es Salaam, Tanzania: NBS and ICF Macro.

*Assumption.

Table 23. Maternal Health

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	63%	100%	100%	100%
Arusha	77%	100%	100%	100%
Kilimanjaro	88%	100%	100%	100%
Tanga	84%	100%	100%	100%
Morogoro	82%	100%	100%	100%
Pwani	78%	100%	100%	100%
Dar es Salaam	95%	100%	100%	100%
Lindi	78%	100%	100%	100%
Mtwara	58%	100%	100%	100%
Ruvuma	84%	100%	100%	100%
Iringa	85%	100%	100%	100%
Mbeya	91%	100%	100%	100%
Singida	71%	100%	100%	100%
Tabora	85%	100%	100%	100%
Rukwa	64%	100%	100%	100%
Kigoma	54%	100%	100%	100%
Shinyanga	76%	100%	100%	100%
Kagera	51%	100%	100%	100%
Mwanza	75%	100%	100%	100%
Mara	61%	100%	100%	100%
Manyara	80%	100%	100%	100%
Unguja North	74%*	100%	100%	100%
Unguja South	74%*	100%	100%	100%
Town West	74%*	100%	100%	100%
Pemba North	74%*	100%	100%	100%
Pemba South	74%*	100%	100%	100%

Resources:

Ministry of Health and Social Welfare. *Annual Health Statistical Abstract Tanzania Mainland 2008*. January 2008. Health Information and Research Section. Used percentage of births at health centers.

*Assumption.

Table 24. Hypertension and Related Heart Diseases

Region	Prevalence Rate 2010	Prevalence Rate 2020*	Treatment Rate 2010	Treatment Rate 2020*
National	35%	35%	30%	100%

Resources:

Mensah, GA. *Epidemiology of stroke and high blood pressure in Africa.* Heart 2008; 94: 697-705.

Mensah, GA. *Ischaemic heart disease in Africa.* Heart 2008; 94: 836-843.

Addo, Juliet, et al. *Hypertension In Sub-Saharan Africa: A systematic Review*. Hypertension. 2007; 50;1012-1018.

*Assumption

Table 25. Vaccines

Region	Treatment Rate 2010	Treatment Rate 2020*
Dodoma	77.30%	100%
Arusha	88.40%	100%
Kilimanjaro	94%	100%
Tanga	72%	100%
Morogoro	78%	100%
Pwani	92%	100%
Dar es Salaam	92%	100%
Lindi	65%	100%
Mtwara	91%	100%
Ruvuma	81%	100%
Iringa	93%	100%
Mbeya	69%	100%
Singida	81%	100%
Tabora	42%	100%
Rukwa	67%	100%
Kigoma	67%	100%
Shinyanga	62%	100%
Kagera	90%	100%
Mwanza	75%	100%
Mara	80%	100%
Manyara	72%	100%
Unguja North	84%	100%
Unguja South	85%	100%
Town West	77%	100%
Pemba North	79%	100%

Pemba South	68%	100%

Resources: National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011. *Tanzania Demographic and Health Survey 2010. Dar es Salaam, Tanzania: NBS and ICF Macro.*

Ministry of Health and Social Welfare. *Annual Health Statistical Abstract Tanzania Mainland 2008*. January 2008. Health Information and Research Section. Used percentage of births at health centers.

*Assumption.

Appendix C

Composition of Medical Zones

Medical Zone	Region	District
Dar es Salaam	Dar es Salaam Morogoro Pwani Pemba Zanzibar	Ilala Kinondoni Temeke Kilombero Kilosa Morogoro Rural Morogoro Urban Mvomero Ulanga Bagamoyo Kibaha Kisarawe Mafia Mkuranga Rufiji
Dodoma	Dodoma Singida	Bahi Chamwino Dodoma Kondoa Kongwa Mpwapwa Iramba Manyoni Singida Rural Singida Urban
Iringa	Iringa Ruvuma	Iringa Rural Iringa Urban Kilolo Ludewa Makete Mufindi Njombe Mbinga Namtumbo Songea Rural

Medical Zone	**Region**	**District**
		Songea Urban Tunduru
Mbeya	Mbeya Rukwa	Chunya Ileje Kyela Mbarali Mbeya Rural Mbeya Urban Mbozi Rungwe Mpanda Nkasi Sumbawanga Rural Sumbawanga Urban
Moshi	Arusha Kilimanjaro Manyara	Arumeru Arusha Karatu Longido Monduli Ngorongoro Hai Moshi Rural Moshi Urban Mwanga Rombo Same Babati Hanang Kiteto Mbulu Simanjiro
Mtwara	Lindi Mtwara	Kilwa Lindi Rural Lindi Urban Liwale Nachingwea Ruangwa Masasi Mtwara Rural Mtwara Urban Newala Tandahimba
Mwanza	Kagera Mara Mwanza	Biharamulo Bukoba Rural Bukoba Urban

Medical Zone	**Region**	**District**
	Shinyanga	Karagwe Muleba Ngara Bunda Musoma Rural Musoma Urban Rorya Serengeti Tarime Geita Kwimba Magu Misungwi Mwanza City Sengerema Ukerewe Bariadi Bukombe Kahama Kishapu Maswa Meatu Shinyanga Rural Shinyanga Urban
Tabora	Kigoma Tabora	Kasulu Kibondo Kigoma Rural Kigoma Urban Igunga Nzega Sikonge Tabora Urban Urambo Uyui
Tanga	Tanga	Handeni Kilindi Korogwe Lushoto Muheza Pangani Tanga

Appendix D

Sources of Health Model Changes

Disease Condition	Changes Made	Source(s)
Diarrhea (Rotarix vaccine)	Prevalence rate	1. Pawinski, Robert, et al. *Rotarix in Developing Countries: Paving the way for inclusion in National Childhood Immunization Programs in Africa.* Journal of Infectious Disease. 2010; 202(S1):S80-S86. 2. Atherly, Deborah, et al. *Rotavirus Vaccination: Cost-effectiveness and impact on Child Mortality in Developing Countries.* Journal of Infectious Disease. 2009 200S28-38.
Contraceptive prevalence rate (CPR)	CPR rate	Moreland, Scott, Ellen Smith and Suneeta Sharma. *World Population Prospects and Unmet Need for Family Planning*. Futures Group. April 2010.
Male circumcision	New HIV infections and new item to requirements list (MC kit)	USAID | Health Policy Initiative. *The potential Cost and Impact of Expanding Male Circumcision in Tanzania*. September 2009.

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USAID | DELIVER PROJECT
John Snow, Inc.
1616 Fort Myer Drive, 11th Floor
Arlington, VA 22209 USA
Phone: 703-528-7474
Fax: 703-528-7480
Email: askdeliver@jsi.com
Internet: deliver.jsi.com