The Next Step in Planning Efficient Distribution of Health Commodities

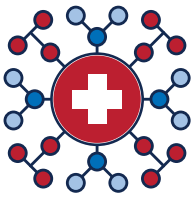
A Tool that Dynamically Optimizes Transportation Routes

In public health supply chains, distributing essential commodities to the community level — the "last mile" — is crucial to ensuring universal access to lifesaving medicines and health supplies. But, many countries face systemic and geographic challenges that put last-mile distribution at risk.

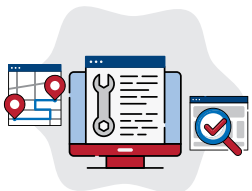
At the warehouse level, distribution managers face the constant challenge of planning transportation routes under tight deadlines while managing a plethora of fluctuating considerations — commodity order volumes, the location of and distance between destination health facilities, vehicle and driver availability, vehicle capacity, road closures, and more. Balancing these variables to plan transportation is an intricate juggling act.

Why is a Dynamic Routing Tool Needed?

As the number of destination facilities grows, the number of possible facility sequences grows exponentially.



If 4 health facilities are scheduled for deliveries, they can be sequenced 24 different ways for a delivery route. But if 22 facilities are scheduled for deliveries, the number of possible sequences grows to 1,124,000,727,777,607,680,000 — that's over 1.1 sextillion!



A dynamic routing tool, such as the **Dispatch Optimizer Tool**, can quickly conduct these complex mathematical calculations that are beyond human capability. This can allow transportation planners the flexibility to reconstruct routes weekly as volumes and conditions change.

Now, countries facing such last-mile distribution challenges have an opportunity to use a type of transportation planning technology — known as a dynamic route optimization tool — that continually adjusts and optimizes transportation routes, thereby helping to ensure that local health facilities receive their commodity orders on time and that limited resources are used efficiently.

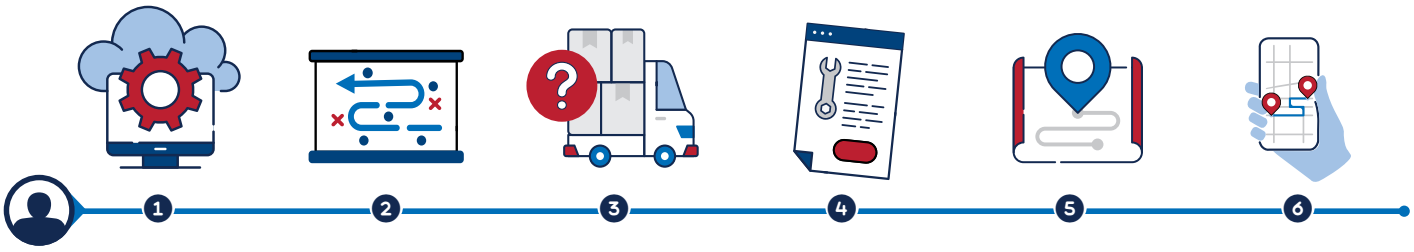
What is dynamic route optimization? How does it differ from static routing?

Most public health supply chains use static routes — meaning the same routes — for each distribution of commodities. Many countries have conducted one-time optimization exercises to make their static routes more efficient and cost effective. Still, these optimizations are conducted for one static scenario and are reused each distribution cycle, making it difficult to adapt to ever-changing circumstances.

But now, public health supply chains can improve transportation planning further by using flexible or dynamic routes. Dynamic route optimization tools allow distribution operations to continually adapt routes to changing factors, such as fluctuations in which facilities place orders, order volumes, vehicle availability, driver availability, or seasonal road conditions. Late orders can be optimized separately to find the most efficient dispatch plans without delaying on-time orders.

Zambia is using a dynamic route optimization tool that shows what is possible.

The Process to Generate Optimized Routes with the Dispatch Optimization Tool



1. User uploads order template; facility details are pre-loaded in the application.
2. User reviews the customers for the order on a map and excludes any as needed
3. User reviews the available fleet and customer vehicle restrictions and modifies, as needed.
4. User selects parameters for the model and clicks a button to run the optimization.
5. Optimization outputs the ideal routes and vehicle assignments and displays them on the website as maps and KPIs.
6. User downloads an Excel file, which includes stop-by-stop route plans for drivers and loading plans for warehouse managers.

Zambia demonstrates why a dynamic route optimization tool is vital for transportation planning

A dynamic route optimization tool developed by USAID's Global Health Supply Chain-Procurement and Supply Management (GHSC-PSM) program is now enabling distribution managers to apply dynamic routing at a low cost. In Zambia, the implementation and use of this tool are showing the benefits to public health supply chains.

To address transportation planning challenges in USAID-supported countries, GHSC-PSM developed a web application called the **Dispatch Optimizer Tool** that helps transportation managers optimize delivery routes to local health facilities. This tool assesses a central or regional warehouse's existing transportation resources and availability, facility order volumes, and destination facility locations, then determines the most efficient resource utilization and routes. Users can also input contextual information for a more complete analysis of external factors, such as weather, road blockages, and security patterns, and adjust routes accordingly.

Dispatch Optimization Tool Inputs and Outputs

INPUTS

- Commodity orders and volumes
- Customer geographical data
- Vehicle sizes and availability
- Transportation costs
- Driving distances between all facilities
- Constraints (e.g., largest vehicle allowed per facility, maximum weight allowed per regulations)

ROUTING

Dispatch Optimization Tool conducts transportation routing optimization

OUTPUTS

- Grouping of facilities into loads
- Loading plan
- Stop-by-stop routes
- Vehicle assignments
- Estimated costs for each load

In 2021, GHSC-PSM worked with the Zambia Medicines and Medical Supplies Agency (ZAMMSA) to pilot test and refine the Dispatch Optimizer Tool and incorporate it into existing warehouse operations. ZAMMSA was facing transportation planning challenges at the time due to reliance on static routes and vehicle assignments for health facility orders that changed in volume from week to week.

Bruce Kamuti

ZAMMSA's Acting Assistant Manager of Outbound Logistics, speaks to the challenges his team faced at the time. "Before we had a transportation planning tool, we planned routes manually and used guesswork based on our previous experience," he explains. "This resulted in inefficiencies, such as requesting too many or too few vehicles or vehicles with cargo sizes that were too big or too small."

Vincent Kabanda

ZAMMSA's Distribution Center Logistics Manager, shares an example of how inefficiencies can arise in planning for cargo space and distribution routes when relying on static vehicle assignments and routes. "For a commodity like HIV test kits, which are ordered in high quantities but their size and volume is relatively low — once we finish packing a truck with test kit orders, we may realize that we only needed an SUV." When it comes to routing, he adds, "we may deliver to the same facility three times when we could consolidate into one delivery with proper planning support."

With GHSC-PSM's Dispatch Optimizer Tool, distribution managers can address these challenges by quickly developing dynamic distribution routes optimized for fluctuating order volumes, resources, destinations, and constraints. When facility orders vary significantly, or a truck breaks down, or a driver is homesick, or a road is washed out during the rainy season, this tool allows supply chain managers to incorporate these changes into their vehicle assignments and route planning and reoptimize the transportation.

Kabanda emphasizes why this is so important.

> **"With the tool, we input the current orders, order volumes, and destination facilities, as well as available vehicles and drivers and any external constraints, and it tells you exactly the cargo space needed and plans the most efficient routes to reach all facilities. This reduces delivery times and multiple movements to the facilities, helping to ensure more timely and cost-effective distributions."**

How GHSC-PSM's Dispatch Optimizer Tool was introduced and rolled out in Zambia

Kamuti led ZAMMSA's collaboration with GHSC-PSM and worked to customize the Dispatch Optimizer Tool to Zambia's particular conditions and needs. GHSC-PSM and ZAMMSA observed operations in ZAMMSA's central warehouses and collected data and requirements, then tailored the tool accordingly and piloted it in the central warehouse in Lusaka in 2021.

The pilot had impressive results, with the tool being used successfully to improve transportation planning and with ZAMMSA users giving positive feedback on the tool's ease of use and effectiveness in optimizing distribution routes. Based on this successful pilot at the central level, ZAMMSA wanted to bring the Dispatch Optimizer Tool to all seven of its regional hubs.

In 2022, ZAMMSA and GHSC-PSM began rollout to the hubs by implementing and piloting the Dispatch Optimizer Tool at the Luanshya and Mansa hubs, extending the tool's coverage. **"Now, ZAMMSA staff at the central warehouse and two regional hubs use the tool weekly for transportation planning and facilitate dispatches to about 650 health facilities,"** Kamuti states.

DOT being run in ZAMMSA Lusaka warehouse on October 1, 2021
Photo by GHSC-PSM.

First optimized dispatch leaving Mansa hub on June 3, 2022
Photo by GHSC-PSM.

The Dispatch Optimizer Tool will be rolled out to Mongu and Mpika hubs next, with the remaining three hubs to follow soon.

ZAMMSA has seen a range of benefits from the Dispatch Optimizer Tool

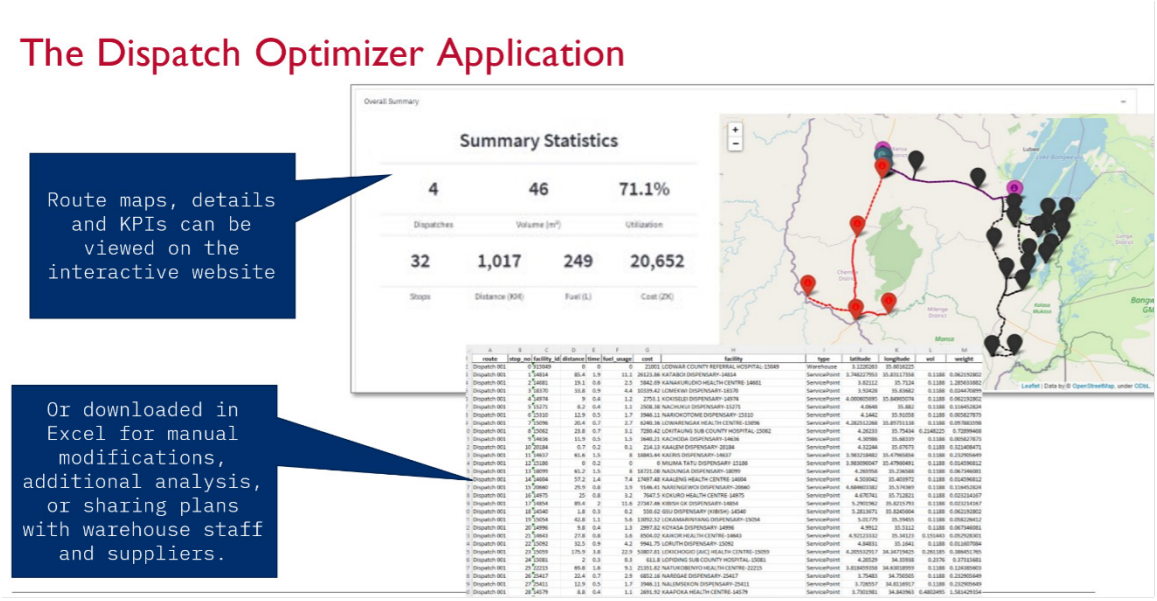
Kamuti and Kabanda have experienced firsthand the improved efficiencies and coordination resulting from using the Dispatch Optimizer Tool. **"The system is easy to use, has multiple benefits, and has impacted our work in a very positive way,"** Kamuti notes.

"we now have an informed pattern of work and a schedule in advance of dispatches."

In addition to optimizing cargo space and distribution routes, which saves time and ensures the best use of resources, the Dispatch Optimizer Tool **"reduces the issue of surprise,"** as Kamuti put it, meaning that **"we now have an informed pattern of work and a schedule in advance of dispatches."** This enables central warehouse staff to reduce surprises for regional hub staff as well, by alerting them in advance of upcoming deliveries to ensure the hubs have enough warehouse space, or to adjust delivery volumes for available space.

In recent years, ZAMMSA has been expanding commodity categories and seeing consistently increasing order volumes, which would have made manual distribution planning exponentially more challenging, **"beyond human guessing,"** Kabanda emphasized. But with the Dispatch Optimizer Tool, ZAMMSA can now respond to order volume increases or order spikes during health crises.

The Dispatch Optimizer Application



To help prevent order entry errors from being processed, the Dispatch Optimizer Tool compares current order volumes to past volumes and flags any significant changes from a particular facility so that ZAMMSA can confirm these changes with the facility or correct any errors.

Beyond the benefits to transportation planning, the Dispatch Optimizer Tool also benefits warehouse planning by improving coordination between the transportation and warehouse teams. The tool creates clear transportation plans that allow for more efficient planning of warehouse operations, and it also creates loading plans so that cartons can be picked, packed, and loaded in the optimal order for each route.

The Dispatch Optimizer Tool is built on an open-source platform to make it affordable

A key reason that low-and middle-income countries (LMICs) often do not have access to transportation planning tools is because of their expensive cost and licensing fees. To address this, GHSC-PSM developed the Dispatch Optimizer Tool by using a variety of open-source software, ensuring that countries would not have to pay any upfront costs or ongoing licensing fees. The only cost to local governments is for hosting the web application through a cloud service provider; in Zambia, this costs about $100 per month for users across three warehouse locations.

Implementing the Dispatch Optimizer Tool requires only a limited data collection period and input and coding support. Initially, countries must collect data to configure the tool, such as geographical data for facilities, so that the tool can generate a distance matrix. To customize the tool's features and deploy it to the cloud, a staff member or consultant with Python coding skills is needed. But, once the tool is up and running, users only need basic Excel skills.

Getting medicines to patients as quickly as possible

"I knew from my hospital experience that I had to step up to the challenge of moving commodities as quickly as possible from ZAMMSA to health facilities for the patients"

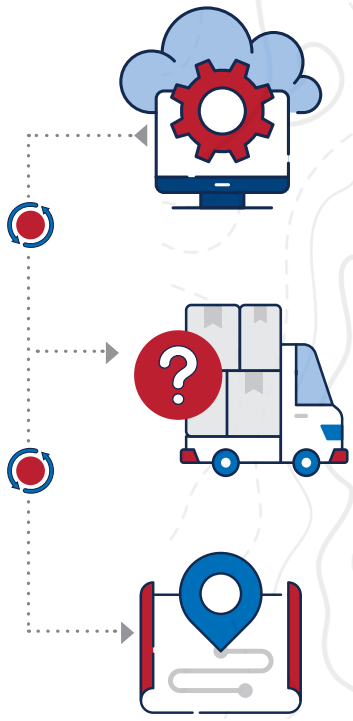
Before joining ZAMMSA in 2018, Kamuti worked in hospitals. Part of his work entailed ordering health commodities for hospital pharmacies and tracking consumption. He reflects, **"I know how I used to struggle when my orders were delayed and how it could put patients at risk for not receiving their medication on time."**

At ZAMMSA, he brought that experience to bear in his work in outbound logistics. **"I knew from my hospital experience that I had to step up to the challenge of moving commodities as quickly as possible from ZAMMSA to health facilities for the patients,"** he states. By leading the implementation and use of the Dispatch Optimization Tool and helping to improve transportation planning, he is doing just that.

LEARN MORE ABOUT THE DISPATCH OPTIMIZATION TOOL

Click here to learn about the Dispatch Optimization Tool

How GHSC-PSM Developed the Dispatch Optimizer Tool and How to Access It



GHSC-PSM first **conducted market research** on 14 commercial, open-source, and build-your-own transportation planning tools to determine what features of these tools were useful and how a tool could be built specifically for public health supply chains in LMICs. The project then used this analysis to develop a solution that is useful for LMICs and has a cost that makes it accessible.

To keep the cost low, the Dispatch Optimizer Tool leverages other open-source data and services, including **OpenStreetMap** and **Openrouteservice API**, to generate the distances between destination facilities for use in route optimization. For the optimization engine, it leverages **Google's open-source OR-Tools API service.** To display the optimized routes on interactive maps for users to view, the tool leverages **Folium**.

Interested in using this tool?

Contact GHSC-PSM at **HSS-AdvancedAnalytics-HQ@ghsc-psm.org** or go to our **GitHub website** to access the source code.