Using an open-source dynamic routing tool for sustainable, flexible, and cost-effective last mile distribution in Zambia

ZAMMSA

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Background: 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.

What Problems Does the Dispatch Optimizer Solve?

Reduce cost and time of deliveries while maintaining service standards by dynamically optimizing delivery routes.

HOW TO GROUP FACILITIES INTO ROUTES?

IN WHAT SEQUENCE TO VISIT FACILITIES?

WHAT TYPE OF VEHICLE TO USE FOR EACH ROUTE?

HOW TO RAPIDLY REFRESH THESE DECISIONS FOR EACH UNIQUE ORDER?

Why Dynamic Route Optimization?

Static Route Planning vs. Dynamic Route Optimization

- Using set routes planned with or without the use of route optimization software
- Even if routes are mathematically optimized, they are done so for one static scenario and reused under changing circumstances
- This makes it difficult to manage changing volumes, late orders, changing circumstances

This is what most countries do today, but there is now the ability to do better.

- Software like the Dispatch Optimizer can allow rapid dynamic adjustments based on changing circumstances and uncertainty
- Can adjust to variability in orders (e.g., different commodity types, quantities, seasonal patterns)
- Can adjust to changes in vehicle and driver availability
- Can optimize late orders separately to find the most efficient dispatch plans while not delaying the on-time orders
- Can adjust as a rainy season impacts accessibility (e.g., split truck routes onto smaller 4x4 SUVs, remove inaccessible facilities)

Open-source software and improving data and IT landscapes have opened options that used to be accessible primarily to corporations able to purchase costly software licenses.

Experience Using DOT in Zambia and Beyond

A Successful Roll-out in Zambia

- **Engagement with local stakeholders**
  ZAMMSA collaborated with USAID's GHSC-PSM project and their 3PLs in Lusaka to coordinate efforts for the application and business processes
- **User-focused design tailored to public health supply chains**
  App developers spent time embedded in ZAMMSA central medical warehouse and 2 hubs, observing operations and collecting requirements for an operational route optimization application
- **Ongoing and expanding operational use**
  ZAMMSA staff use the tool weekly, with all regional hubs and about 1,955 last-mile health facilities in Zambia currently receiving deliveries planned using this tool; working on expansion to every hub in-country

DOT being run in ZAMMSA Lusaka warehouse on October 1, 2021


First optimized dispatch leaving Mansa hub on June 3, 2022

Transforming Transportation and Warehouse Planning

BEFORE	AFTER
• Transportation planning was done manually, using guess work based on prior experience	• Data-driven decision making that is flexible to changing circumstances
• Sometimes delivered to the same facility on multiple routes for different commodities	• Reduced instances of multiple dispatches to the same facility
• Warehouse sometimes staged orders and the truck was too small or unnecessarily large	• Volumetrics and optimized vehicles ensure the best vehicles are planned for each load
• Consistently increasing commodity categories and volumes in Zambia was making reliance on prior experience risky	• Transportation planners are well prepared to respond to changing or increasing order volumes, even during health crises

Other benefits: Reduced costs and carbon emissions; increased customer satisfaction and employee/3PL

The footprint and features continue to grow, as other countries actively seek to learn from Zambia's example and adopt the tool.




Early 2020

A proof of concept was developed by USAID GHSC-PSM in Excel and tested in Haiti.

October 2021

The Dispatch Optimizer was launched in Zambia's central medical warehouse in Lusaka.

June 2022

Based on the initial success, the tool was adapted and rolled out in Luanshya and Mansa, Zambia.

July 2022

The app was tested in Kenya, including developing new features to address country-specific needs.

2023 and Beyond

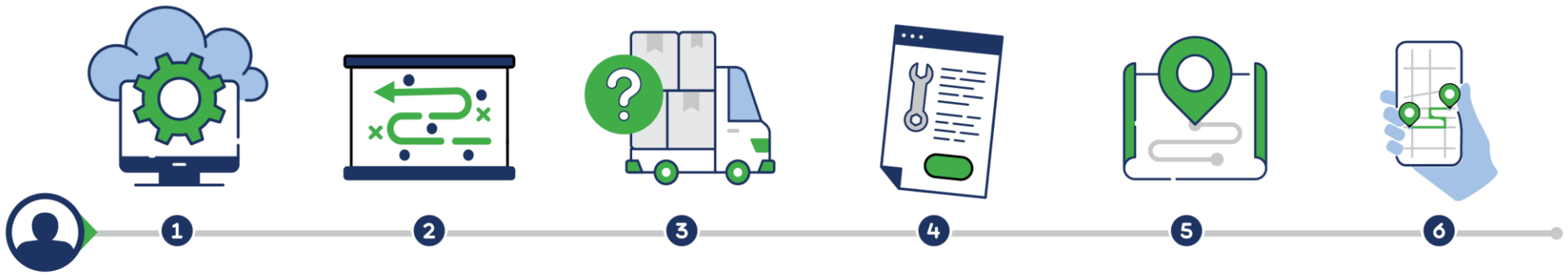
Zambia is expanding to 2 new hubs this year and 3 by end of 2024. New features are improving use.

Mali is also testing use of the app

Technical Solution Details

How to Use the Dispatch Optimizer Tool

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.

The Dispatch Optimizer Application

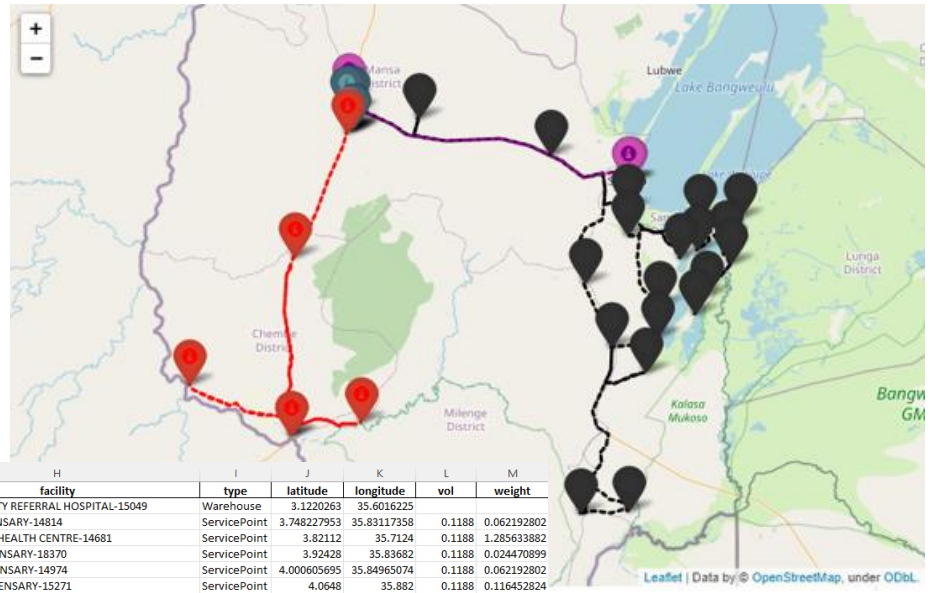
Route maps, details and KPIs can be viewed on the interactive website

Or downloaded in Excel for manual modifications, additional analysis, or sharing plans with warehouse staff and suppliers.

Summary Statistics

4	46	71.1%
Dispatches	Volume (m³)	Utilization

32	1,017	249	20,652
Stops	Distance (KM)	Fuel (L)	Cost (ZK)

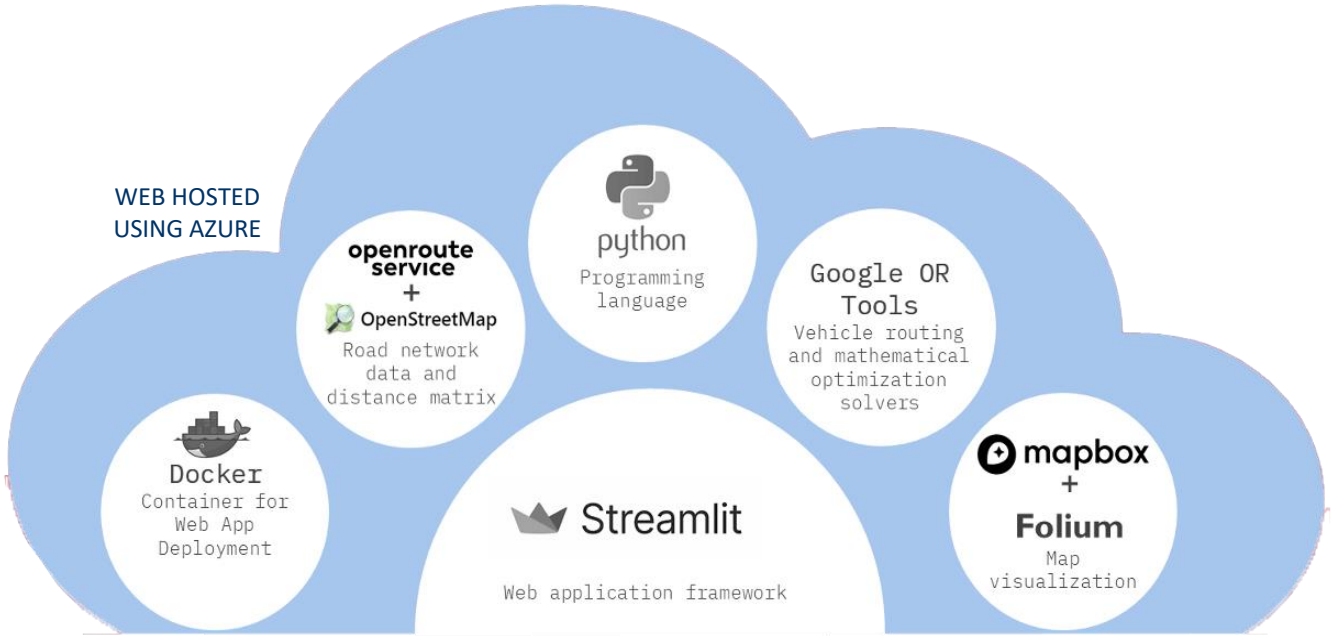


route	stop_no	facility_id	distance	time	fuel_usage	cost	facility	type	latitude	longitude	vol	weight
Dispatch 001	0	915049	0	0	0	21001	LODWAR COUNTY REFERRAL HOSPITAL-15049	Warehouse	3.1220263	35.6016225		
Dispatch 001	1	14814	85.4	1.9	11.1	26123.86	KATABOI DISPENSARY-14814	ServicePoint	3.748227953	35.83117358	0.1188	0.062192802
Dispatch 001	2	14681	19.1	0.6	2.5	5842.69	KANAKURUDIO HEALTH CENTRE-14681	ServicePoint	3.82112	35.7124	0.1188	1.285633882
Dispatch 001	3	18370	33.8	0.9	4.4	10339.42	LOMEKWI DISPENSARY-18370	ServicePoint	3.92428	35.83682	0.1188	0.024470899
Dispatch 001	4	14974	9	0.4	1.2	2753.1	KOKISELEI DISPENSARY-14974	ServicePoint	4.000605695	35.84965074	0.1188	0.062192802
Dispatch 001	5	15271	8.2	0.4	1.1	2508.38	NACHUKUI DISPENSARY-15271	ServicePoint	4.0648	35.882	0.1188	0.116452824
Dispatch 001	6	15310	12.9	0.5	1.7	3946.11	NARIOKOTOME DISPENSARY-15310	ServicePoint	4.1442	35.91058	0.1188	0.005827873
Dispatch 001	7	15096	20.4	0.7	2.7	6240.36	LOWARENGAK HEALTH CENTRE-15096	ServicePoint	4.282512268	35.89751138	0.1188	0.097883598
Dispatch 001	8	15062	23.8	0.7	3.1	7280.42	LOKITAUNG SUB COUNTY HOSPITAL-15062	ServicePoint	4.26233	35.75434	0.2148225	0.72899468
Dispatch 001	9	14636	11.9	0.5	1.5	3640.21	KACHODA DISPENSARY-14636	ServicePoint	4.30986	35.68339	0.1188	0.005827873
Dispatch 001	10	20184	0.7	0.2	0.1	214.13	KAALEM DISPENSARY-20184	ServicePoint	4.32244	35.67673	0.1188	0.321408471
Dispatch 001	11	14637	61.6	1.5	8	18843.44	KAERIS DISPENSARY-14637	ServicePoint	3.983218482	35.47965856	0.1188	0.232905649
Dispatch 001	12	15186	0	0.2	0	0	MILIMA TATU DISPENSARY-15186	ServicePoint	3.983090047	35.47960491	0.1188	0.014596812
Dispatch 001	13	18099	61.2	1.5	8	18721.08	NADUNGA DISPENSARY-18099	ServicePoint	4.265958	35.236588	0.1188	0.067346081
Dispatch 001	14	14604	57.2	1.4	7.4	17497.48	KAALENG HEALTH CENTRE-14604	ServicePoint	4.503042	35.403972	0.1188	0.014596812
Dispatch 001	15	20660	29.9	0.8	3.9	9146.41	NARENGEWOI DISPENSARY-20660	ServicePoint	4.684603382	35.574369	0.1188	0.116452824
Dispatch 001	16	14975	25	0.8	3.2	7647.5	KOKURO HEALTH CENTRE-14975	ServicePoint	4.670741	35.712821	0.1188	0.023214167
Dispatch 001	17	14854	89.4	2	11.6	27347.46	KIBISH GK DISPENSARY-14854	ServicePoint	5.2901962	35.8215793	0.1188	0.023214167
Dispatch 001	18	14540	1.8	0.3	0.2	550.62	GSU DISPENSARY (KIBISH)-14540	ServicePoint	5.2813671	35.8245604	0.1188	0.062192802
Dispatch 001	19	15054	42.8	1.1	5.6	13092.52	LOKAMARINYANG DISPENSARY-15054	ServicePoint	5.01779	35.59455	0.1188	0.058226412
Dispatch 001	20	14996	9.8	0.4	1.3	2997.82	KOYASA DISPENSARY-14996	ServicePoint	4.9912	35.5112	0.1188	0.067346081
Dispatch 001	21	14643	27.8	0.8	3.6	8504.02	KAIKOR HEALTH CENTRE-14643	ServicePoint	4.92123332	35.34123	0.151443	0.052928301
Dispatch 001	22	15092	32.5	0.9	4.2	9941.75	LORUTH DISPENSARY-15092	ServicePoint	4.84831	35.1641	0.1188	0.011607084
Dispatch 001	23	15059	175.9	3.8	22.9	53807.81	LOKICHOGIO (AIC) HEALTH CENTRE-15059	ServicePoint	4.205532917	34.34719425	0.261185	0.386451765
Dispatch 001	24	15081	2	0.3	0.3	611.8	LOPIDING SUB COUNTY HOSPITAL-15081	ServicePoint	4.20529	34.35938	0.2376	0.37315681
Dispatch 001	25	22215	69.8	1.6	9.1	21351.82	NATUKOBENYO HEALTH CENTRE-22215	ServicePoint	3.818459358	34.63018959	0.1188	0.124385603
Dispatch 001	26	25417	22.4	0.7	2.9	6852.16	NAREGAE DISPENSARY-25417	ServicePoint	3.75483	34.750505	0.1188	0.232905649
Dispatch 001	27	25411	12.9	0.5	1.7	3946.11	NALEMSEKON DISPENSARY-25411	ServicePoint	3.726557	34.8116917	0.1188	0.232905649
Dispatch 001	28	14579	8.8	0.4	1.1	2691.92	KAAPOKA HEALTH CENTRE-14579	ServicePoint	3.7301981	34.843963	0.4802495	1.581429354
Dispatch 001	29	915049	118	2.9	15.3	36096.2	LODWAR COUNTY REFERRAL HOSPITAL-15049	Warehouse	3.1220263	35.6016225		

Collaborating with and Contributing to Open-Source Technology

- Tool built on top of open-source tools, as shown in the graphic – including OpenRouteService from co-panelist organization HeiGIT
- Deployed on Azure cloud and users access it like any website
- Source code is available for download on GitHub (link below)
- Tool can be adapted for other types of health commodity distribution or service delivery, such as for community health workers conducting home visits

The system architecture emphasizes intuitive user experience and analytical rigor



https://github.com/ghsc-psm/Dynamic-Optimization-Routing

Want to Learn More?

Visit the QR Code on the Screen to…

READ more about the Dispatch Optimizer Tool

WATCH a video about the Dispatch Optimizer Tool

EXPLORE the Dispatch Optimizer Tool's source code

EMAIL for more details

Thank You!