GUROBI OPTIMIZATION

Delivering Critical Health Services Where They're Needed Most

With support from Gurobi, PATH can efficiently allocate life-saving resources.

PATH
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PATH is a global team of innovators working to accelerate health equity so all people and communities can thrive. They advise and partner with public institutions, businesses, grassroots groups, and investors to solve the world's most pressing health challenges. Better health moves humanity forward.

Industry: International Development
Location: Global
Use Cases: Resource Optimization, Logistics, Location Planning, Supply Chain
Website: www.path.org

Results

■ Satisfied 80-95% of oxygen demand in health facilities

■ Reduced manufacturing lead times by 6-8 months

■ Life-saving oxygen can be made available to thousands of people in less than half the time

PATH is a global nonprofit dedicated to achieving health equity. With more than 40 years of experience forging multisector partnerships, and with expertise in science, economics, technology, advocacy, and dozens of other specialties, PATH develops and scales up innovative solutions to the world's most pressing health challenges. PATH cocreates many of these innovative solutions through digital and data transformation. Recently, they used Gurobi and mathematical optimization to find better ways for key decision-makers to get complex, expensive, and life-saving medical oxygen equipment to communities who need it most.

What PATH Needed

As Supply Chain Management and Data Science Advisor at PATH, Alex Rothkopf is responsible for helping decision-makers understand all their options and identify the best path forward, often with many lives potentially on the line.

But when it comes to evaluating new, innovative solutions, leaders need all the information they can get. As Rothkopf explains, people often have preconceptions of what the results of a given action will be, and they tend to anchor around those assumptions without doing any deeper analysis—often discounting solutions that could turn out to be game changers. That's why he and his team work to provide an unbiased analysis.

"Our work uses quantitative and qualitative evidence to help decision-makers make informed decisions," says Rothkopf. "For more defined problems, we often assist with answering questions like, 'How much should I procure?' or 'Is my allocation of available services/goods efficient and equitable?' And one way to look at that is through optimization."

PATH's researchers can build models and use qualitative information to facilitate better decision-making, but they need a strong, fast, and versatile solver—one that can identify all possible solutions for allocating resources and determine the best choice based on a number of constraints, such as size and cost.

> " I use Python with Gurobi because it gives me the most control and flexibility to adjust the analyses to meet the client's interests or needs. "

Alex Rothkopf
Supply Chain Management and Data Science Advisor, PATH

Streamlining a Supply Chain for Oxygen Generation Plants with Gurobi

Rothkopf had previously used Gurobi as a researcher at the Massachusetts Institute of Technology's Center for Transportation and Logistics when teaching students, as well as for some of his own research. Because of these prior experiences with various mathematical solvers, he knew the Gurobi solver could take on an important project that had significant potential to improve COVID-19 pandemic response efforts.

"For innovative business problems and explanatory models without clear solutions, I use Python with Gurobi because it gives me the most control and flexibility to adjust the analyses to meet the client's interests or needs," explained Rothkopf.

Oxygen infrastructure is a pricey investment. Purchasing a large-scale oxygen generation plant is not only expensive, but it can involve time-consuming assessments of size and configuration to customize a plant to a facility's needs. As well, international shipping requirements—plus the time spent finding and negotiating with a vendor or supplier—can further complicate the process. This analysis and manufacturing time can take anywhere from several months to a year and more.

As Rothkopf explains, during the peak of the COVID-19 pandemic, most low- and middle-income countries lacked access to oxygen supplies, and they didn't have any time to lose, to procure oxygen generation plants. The international global health community realized that production-to-stock or even pre-purchased oxygen generation plants would eliminate a large portion of the lead time and allow countries to respond more quickly to increased oxygen demand. However, many key decision-makers remained reluctant to try a new strategy, insisting that customization based on exact demand was still the way to go. The concern was that a limited set of capacity options would reduce oxygen service at health facilities.

"We were seeing a production system that is inherently make-to-order and proposed to change that to a make-to-stock environment to eliminate the production lead time for the buyer," says Rothkopf. "So, my colleague Elizabeth Griffin and I developed a model that helped us to determine a set of standard oxygen plant capacities. We wanted to demonstrate if we could bring the options down from dozens to three, four, or five and if this standardization would negatively impact health outcomes."

Efficiently Allocating Vital Health Equipment

Using Gurobi, PATH created a mixed integer linear program to discover whether reducing plant options would be a viable option. The results, in Rothkopf's words, were impressive.

By substantially reducing the overwhelming number of oxygen generation plant configurations, PATH proved that lead times could be reduced by six to eight months, while still satisfying 80% to 95% of hospital demand. That means life-saving oxygen supplies could be delivered to thousands of people in less than half the time.

"Using Gurobi, we let the model propose the right size, and it returns the service level, or how well we're matching the estimated demand," explains Rothkopf. "Each decision still needs to be discussed and thought through, of course. But if it means getting rid of six to eight months of lead time, that makes for a good bargain. This is essentially a confirmation that standardization can be an adequate way of approaching the market without a detrimental negative consequence."