Better bloodlines: Data modeling improves Red Cross supply chain

Red Cross turned to W. P. Carey students and scholars to see if its warehouses were optimally placed for cost-effective operations. Their research showed that closing underperforming sites and building new ones would both lead to cost savings and improve efficiency for the life-saving nonprofit agency.

By Betsy Loeff
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Every two seconds, someone in the United States needs blood, which means more than 41,000 transfusions happen in this country each year. The American Red Cross Biomedical Division supplies approximately 40% of that blood to more than 3,000 hospitals across the U.S.

Given that whole blood has a maximum shelf life of five weeks, stock and transportation of this inventory must be carefully coordinated. So must provisions necessary for the collection and storage of blood. That’s why Red Cross turned to students and scholars at the W. P. Carey School of Business to see if the organization’s warehouses were optimally placed for cost-effective operations. They weren’t. Data models showed that closing underperforming sites and building new ones would both lead to cost savings and improve efficiency for this life-saving nonprofit agency.

Testing the blood supply chain

Confounding supply chain planning for Red Cross is the unpredictability of demand for blood and blood products, such as red cells, plasma, and platelets. Red Cross is a nonprofit organization that is in the business of responding to catastrophes. While some of the organization's demand is repetitive, much is sporadic and subject to extremes.

Supply Chain Management Associate Professor **Srimathy Mohan** says Red Cross meets the variable need for blood with fixed warehouses and analytics designed to anticipate requirements based on weather patterns and the risks they present. Depending on the time of year, "you'll have a higher propensity for fire in the West versus tornadoes in the Midwest and hurricanes in the East," she explains. Red Cross sends inventory to warehouses to feed the appropriate geographical areas in the appropriate seasons. When some rare event hits in an area where inventory hasn't been prepositioned because of forecasts, Red Cross will simply move the inventory where it's needed.

While data modeling helps Red Cross ensure that vital supplies are where they need to be, the organization is always re-evaluating its supply chain plans. "When people are suffering, you want to provide the maximum amount of service to those in need," says professor and former chair of the Department of Supply Chain Management and current senior associate dean, **Mohan Gopalakrishnan**. This is where humanitarian organizations like Red Cross borrow supply chain wisdom from for-profit companies like Amazon and Walmart, he adds.

"Amazon is constantly looking at where to build the next warehouse," he continues. How big should the warehouse be? How frequently should there be deliveries to it? Gopalakrishnan says such questions are measured against the costs of building the warehouse, operating it, as well as transporting inventory. For Red Cross, it's also a tradeoff between effectiveness — doing the right things — and efficiency — doing things in the right way to minimize time, costs, and misery.

Timely delivery is a crucial factor in blood supply. The blood supply chain contains several steps, including collection from donors, transportation to facilities that turn the blood into products needed by patients, and transport to the hospitals that use those products, explains Gopalakrishnan.

To test its efficiency and effectiveness in warehouse siting, the American Red Cross turned over copious amounts of data to Mohan, Gopalakrishnan, and some of their graduate students. That data included demand points, required inventory, and ship-to locations. With this, the team was given free rein to imagine a U.S. map devoid of any Red Cross warehouses. The team used a "fixed charge" model to evaluate where warehouses should be located, what sites they should serve, and how big they should be. Fixed charge models trade off the fixed costs of building warehouses at specific locations against the variable cost of transporting goods from the located warehouses to the various ship-to-locations. The team used a "fixed charge" model to evaluate where warehouses should go, what sites they should serve, and how big they should be. Fixed charge models look at the fixed costs of building a warehouse itself. The team also used an allocation model, which looks at where sites should be based on ship-to locations and transportation costs.

Needle in a donor pack

To deliver blood supply, Red Cross must also warehouse the items that facilitate blood collection, such as syringes, gloves, storage pouches, and bandages. For simplicity in modeling, the research team consolidated these collection necessities into one item called a donor pack. This minimized what Mohan calls "the curse of dimensionality." She says: "The more variables you throw in, the more complicated it gets in terms of computing resources." Such complexity can delay insights and hinder timely decision-making.

The team also tested variables that might change, a method of validating the model's strength and prediction reliability. "It's always essential that we do 'what-if' analysis. What if the cost per donor pack is $5 instead of $3? What if it goes up to $7? Will that change my location position?" Mohan asks. "We varied the data quite a bit. It turns out the model was more sensitive to the fixed cost of building a warehouse than the variable transportation costs. It was also quite sensitive to demand data."

The scholars found that of the 27 warehouses Red Cross was operating in the U.S., 16 should be closed, two built and the inventory levels of donor packs should be expanded due to the smaller number of warehouses in the newly optimized facility network. Because the total number of warehouses dropped from 27 to 17, fixed costs decreased by 27%, but variable transportation costs increased by 22%. Red Cross stood to slash expenses by 9% overall, but "it was not an easy sell" to organizational leadership, Mohan recalls.

Model behavior

Red Cross management questioned the research team on the factors used in the modeling, and Mohan explains that “Models are simplified views of reality. They are starting points for discussion, not always an ending point.”

Factors also change. This model, for instance, was run long before recent gas-price volatility, and Mohan says the higher prices in gas could change the model’s results. “It’s a constant trade-off between the fixed cost of building a warehouse and the operational cost of moving things around,” she explains.

Input data changes, too. For example, American Red Cross has seen blood donations drop because of COVID-19. “Remember when online sales went through the roof because of the pandemic?” asks Gopalakrishnan. “That made Amazon think it’s not enough to have these massive warehouses to satisfy customer demand. They opened pop-up warehouses that can open for a season and shut down when the season is over.” A similar approach might help the Red Cross team to weather COVID-19 or various storms.

Another COVID-19 input that could shift how a model performs is the public’s tolerance for out-of-stock inventory, Gopalakrishnan adds.

Because data modeling helps managers efficiently handle inventory, Gopalakrishnan sees the increasing need to employ such approaches. “The value of these models will be even more immense because of what people are ready to tolerate or not.”

Mohan and Gopalakrishnan’s work has been published in the *International Journal of Services and Operations Management*, and it’s a way any manager of inventory could use to calculate warehousing costs. “Today’s technology is such that you could take these models and deploy them very quickly,” Gopalakrishnan concludes. “They could be in a toolkit for whatever decision you are making.”