Moving Beyond the Speed-Price Tradeoff

Today's shoppers want more than low prices. Advances in inventory and sales analytics make it possible to deliver products both cheaply and quickly.

By Jason A. Acimovic, Michael K. Lim, and Ho-Yin Mak

[**Bio**] Jason A. Acimovic (@JasonAcimovic), is an assistant professor of supply chain management at Penn State University's Smeal College of Business. Michael K. Lim is an associate professor of operations management at Seoul National University Business School. Ho-Yin Mak is an associate professor in management science at the University of Oxford's Saïd Business School. Comment on this article at http://sloanreview.mit.edu/x/xxxx.

Key words: Distribution, online retail, supply chain, logistics, data analytics

In the early days of online retailing, e-commerce retailers fulfilled consumer demand from a small number of large-scale warehouses that carried a similar catalogue of items. Retailers stocked inventory for low-volume products in as few locations as possible while maintaining service levels that met customer expectations. It was a way to keep inventory costs low and take advantage of the economies of scale that accompany large fulfillment centers. Since consumers were willing to wait for their deliveries, proximity and speed were less important than cost savings.

But the online retail market has changed. Today's shoppers want more than low prices--they also want the products they order delivered quickly. To achieve same-day delivery, retailers are experimenting with new business and operations models, including using third parties (such as local city-specific delivery services), crowdsourcing (such as paying individuals by the task to shop for and deliver groceries), self-service (such as setting up physical lockers from where customers retrieve their packages), and even flying drones (whereby unmanned aerial vehicles can deliver packages in less than 30 minutes). At the same time, many retailers such as Amazon, Nordstrom, and Macy's have recently redesigned their distribution networks. A growing number of omnichannel retailers are using their physical store networks to fulfill online orders (for example, shipping online customers' orders from physical stores and allowing online customers to pick up their packages at physical stores), while online-only retailers are adding warehouses, particularly near major urban markets.

Supply-chain network design has traditionally been based on the tradeoff between cost and response time. Historically, if you wanted something right away, you expected to pay significantly more for the retailer's expense of maintaining local inventory or deploying high-speed shipping. Lately, however, the terms of competition have changed.

In response to increasing consumer demands for faster deliveries without added cost, more companies are implementing IT solutions that enable access to real-time sales data and inventory data across the whole enterprise. Real-time sales and inventory information, coupled with advanced analytics (such as recently developed network-wide fulfillment algorithms) enables networks to accommodate fluctuations and changes in the business environment quickly, a quality we call distribution agility. The result: retailers can treat their whole distribution footprint as a single entity as opposed to a group of individual depots.

We recently studied the impact of proximity and agility in supply chain network design, examining how online retailers can benefit by restructuring their distribution networks to move beyond scale-based network design. In addition, we studied ways in which companies with agility enhanced networks can leverage centrally controlled systems through better fulfillment and replenishment algorithms. Through this research, we found that scale and responsiveness don't need to be in direct conflict with one another. In fact, the ability to deliver on-the-fly fulfillment and network-wide replenishment means that retailers can offer faster delivery times without driving up costs much and can even improve their resiliency against risks of disruptions.

Incorporating agility into the distribution system is a three-step process that involves rethinking network design; planning for information centralization; and building inventory and pricing into order-fulfillment decisions.

1. Rethink network design.

Implementing distribution agility begins with redesigning your physical distribution network and the information network that supports it. In both centrally-managed systems that can respond immediately to new information (so-called agile) and traditional systems, the network design has important implications for both the cost and performance as they relate to customers. Consider Amazon. Since 2013, growing demand for rapid delivery has led it to open 43 small-scale delivery stations and 53 hubs in the United States to augment a distribution network of 101 fulfillment and 29 sorting centers. Traditionally, expanding a network this way undermines the scale economics. But real-time stock visibility across the network and intelligent product replenishment and fulfillment significantly mitigates the cost of this trade-off.

When physical stock is distributed, information about supply and demand needs to be centralized. Having a real-time information system that incorporates data on sales by time and location, inventory availability, and replenishment schedules, helps a retailer to satisfy and predict demand on the fly. Some companies are already making use of this

capability. China-based Cainiao Logistics, in which Alibaba Group holds a majority position, for example, is a leader of online retail distribution in China, executing more than 50 million deliveries per day. Its real-time big-data algorithms determine the optimal fulfillment routes by assessing inventory availability at different warehouses, traffic, and weather, as well as provide couriers with better forecasts of demand spikes. By leveraging massive data sets from disparate sellers, selling platforms, and third-party logistics firms, Cainiao Logistics' centralized decision process increases efficiency throughout the selling network.

2. Plan for information centralization

As the size and complexity of the network grows, the likelihood of stock-outs at any particular node is likely to increase, leading to dynamics that drive costs higher. To minimize the downsides, the data analysis system should be able to make forecasts and manage inventory.

Forecasts should include a variety of elements: hourly demand, information about the time sensitivity of orders (how fast customers want items delivered), road traffic, labor requirements and uncertainty in realized capacity, product return information, and customer price sensitivities. Inventory management can be complicated, partly due to the fact that there is a high degree of uncertainty over lead time (the time between when a retailer places a replenishment order with a vendor and when the order arrives at a warehouse). Not only is demand random, but a stockout during the period when an item is on order at one fulfillment center can overload demand at a second fulfillment center, causing a domino effect of stockouts across facilities. Algorithms that examine the network as a whole can mitigate these problems by predicting the cascading stock-out patterns that might occur across the network and ordering accordingly.

3. Build inventory and pricing into order-fulfillment decisions

The final step is to enable flexible operations that consider inventory and pricing across the entire organization at the same time. For example, should you send the last game console in a given warehouse to a customer nearby who requested a five-day delivery window? Or should you send the five-day customer the console from farther away at slightly higher cost, because there is a chance that a future customer might request the local unit via a one-day delivery window? An agility-enhanced distribution system should be able to make such decisions quickly and estimate the value of a specific item in a specific warehouse at a given moment in time, given current system-wide inventory levels.

There's another lever managers can use when a store has too much inventory. Traditionally, when inventory exceeds demand, retailers are under pressure to mark prices down to maximize revenue. However, in agility-enhanced networks where pricing and fulfillment decisions are made jointly, online orders can be fulfilled from overstocked stores, reducing the need for markdowns.

An Outmoded Conflict

Traditionally, retailers could not offer both low prices and fast delivery: no free lunch was also fast. The core benefit of embedding agility into a retail distribution network is that it mitigates the traditional conflict between responsiveness and efficiency. At the same time, it enables retailers to keep prices low while meeting consumers' preference for faster delivery.

In the broader supply chain context, the concept of agility could extend beyond retail, for instance, to manufacturing. The benefits of this approach are visible at LEGO, which recently completed a large-scale redesign of its supply chain. With most of its manufacturing base concentrated in Europe, LEGO often faced challenges fulfilling volatile holiday demand in North America and Asia due to long manufacturing and shipping lead times. To overcome this bottleneck, the company added new plants in China, Mexico, and Hungary, to be closer to key markets. To take full advantage of the improved market proximity, LEGO made further efforts to enhance its distribution agility. By improving its forecasting analytics, LEGO was able to dynamically allocate manufacturing capacity between different products and parts, which is analogous to dynamically allocating customer orders to warehouses in a retail setting.

A secondary benefit of embedding agility in the distribution network is that it makes networks more resilient. Scale-based networks can have serious difficulty recovering from disruptions. The failure of any node or link can effectively shut down a substantial portion of network capacity. Agility provides protection against risks from both market factors (such as material cost inflation or labor strikes) and non-market factors (such as weather). We have found that, whereas scale-based strategies can only adapt to fluctuations by adjusting the distribution network's design, agility-enhanced strategies can make adjustments at the planning and operations levels. Increased network density provides a natural hedge against disruptions in that it limits the impact to a smaller service area. With agility-enhanced networks, there's less need for major adjustments even when inventory cost factors fluctuate.

Related Research

- J. Acimovic, S. C. Graves, "Making Better Fulfillment Decisions on the Fly in an Online Retail Environment," Manufacturing & Service Operations Management 17(1):34-51. https://doi.org/10.1287/msom.2014.0505
- J. Acimovic, S. C. Graves, "Mitigating Spillover in Online Retailing via Replenishment," Manufacturing & Service Operations Management 19(3):419-436. https://doi.org/10.1287/msom.2016.0614
- M. K. Lim, H.-Y. Mak, Z.-J. M. Shen, "Agility and Proximity Considerations in Supply Chain Design," Management Science 63(4):1026-1041. https://doi.org/10.1287/mnsc.2015.2380