Achieving Transportation Network Efficiency through Consolidation

By: Daniel Piechnik & Olivia Schaufenbuel
Advisor: Matthias Winkenbach

Summary: Many trucks in the US travel well below permitted cube and volume utilization. Consolidating two or more shipments onto a single multi-stop truckload (MSTL) route can increase truck utilization and decrease transportation costs. This report used a set-covering formulation of the Practical Pick-up and Delivery Problem (PPDP) in combination with clustering and an adapted column generation approach to identify consolidation opportunities. The model identified network cost reductions of 11% for a leading digital freight broker.

Daniel Piechnik is a supply chain professional focused on complex supply chain transformation initiatives. He has worked and studied on four continents, and enjoys working with people from varied backgrounds. Prior to MIT, he worked in supply chain consulting at Deloitte Canada.

Olivia Schaufenbuel’s prior experience in advancing the agriculture industry through technology led her to MIT. With an undergraduate degree in Economics and Supply Chain Management, she worked in manufacturing, analytics and planning for Land O’Lakes and will be joining General Mills after graduation.

KEY INSIGHTS

1. On average, a large 3PL can expect to reduce transportation cost by 11% through MSTL consolidation.
2. MSTL consolidation has significant network effects; more shipments in the transportation network drives greater cost savings.
3. Large less-than-truckload (LTL) shipments and partially full truckload (TL) shipments offer the most opportunity for consolidation.

Introduction

GlobalTranz is a third-party logistics solution and technology provider in the transportation industry looking to consolidate shipments for network savings. They match shippers’ and carriers’ demand and supply through their large network without the use of capital-intensive assets such as consolidation centers or physical trucks.

Like all transportation companies, GlobalTranz faces new pressures as trucking demand continues to rise and supply tightens. GlobalTranz must find routes that provide high levels of service and value to customers, a fair return to carriers, and efficiency across the transportation network. At present, GlobalTranz is identifying a small amount of shipment consolidation opportunities manually. However, this process is time consuming and does not yield optimal results.

GlobalTranz needs a scalable and automated solution that prescribes how all TL and LTL orders in the network should be optimally consolidated.

Literature Review

As a third-party logistics provider, GlobalTranz’s objective is to minimize network costs of multi-stop truckload (MSTL) routes with multiple pickup and delivery nodes. In research, this problem is typically classified as the General Pick-up and Delivery Problem (GPDP).

GPDP encompasses both the Vehicle Routing Problem (VRP) and the Practical Pick-up and Delivery Problem (PPDP). The VRP category has received the most attention in literature. It requires orders to be picked up from a central depot and delivered to multiple destinations, but the PPDP category’s formulation does not need the central depots for consolidation. Figure 1 depicts the differences in problem formulation.
Research has identified geographic model’s increase discussion in identifying remaining routes. Each problem applies to shipments with a high ratio of goods, and the model identified a 4.6% route reduction and an 11.1% cost reduction. An example showing how consolidation led to a new set of proposed routes in a single cluster of the network is depicted in Figure 2. The green routes have 3 shipments combined. The yellow routes have 2 shipments combined.

**Discussion**

GlobalTranz’s promising results on potential cost reductions indicate the transportation industry’s typical truckload and less-than-truckload markets have a new rising player: the multi-stop truckload. A lack of analytic know-how among existing 3PLs and insufficient collaboration between shippers, carriers and brokers has previously made it difficult to gather and analyze the data needed prescribe efficient MSTL routes.

MSTL volume will rise as more 3PLs and freight brokers transition to become digital service providers that apply algorithms to implement smart business rules around consolidation. This industry shift will (i) introduce a substitute for large shipments in the LTL hub-and-spoke system; (ii) push brokers and 3PLs to increase their use of analytics and establish analytics as a core competency; and (iii) require collaboration from carrier and shippers to gain real-world acceptance of load sharing.

According to the data, higher-cost LTL shipments (typically those with larger weight, volume, and shipment distance) are prime candidates for consolidation, whereas lower-cost LTL shipments are not consolidated due to an additional stop cost and charges for out-of-route miles. MSTLs act as a substitute for the hub-and-spoke system, so LTL carriers may experience increased competition on lead time and price. However, low-cost LTL shipments will continue to be shipped through the typical LTL hub-and-spoke system.

Shippers will mostly gain freedom and flexibility in their transportation options. Currently, most shippers choose a full truckload for two purposes: 1) isolation of goods; and 2) cost savings. MSTL allows shippers
to indicate their preferences and only pay for the most important features to their business. If sharing a truckload with another shipper for an 11% cost reduction is appealing, the shipper now has a choice between TL or MSTL.

Figure 3 shows that performing a MSTL move is usually more expensive than a TL move alone, but that a MSTL reduces network transportation cost once you consolidate a large LTL shipment with a partially full TL shipment. These savings can be shared between Shipper 1, Shipper 2, the Carrier, and the Freight Broker.

**Figure 3**

**Illustrative savings from consolidation**

**Savings of Multi-Stop Truckloads**

![Diagram showing cost savings from consolidation]

These savings offer a significant business model opportunity for digitally enabled freight brokers because industry dynamics squeeze margins. On the truck supply side, intense competition among asset-based trucking companies drives tight margins, and on the delivery demand side, shippers can shop around on the spot market to find the lowest-cost carrier for a route. Therefore, an intermediary that matches supply and demand needs to capture margin in a competitive market. The model results show transportation network savings of 11%, which means that the freight brokers can improve margins while making efficiency improvements. Alternatively, the freight broker could pass on the value to their shippers and increase their market share over smaller rivals who lack technology and processes that enable MSTL consolidation.

**Conclusion**

GlobalTranz is actively seeking innovative approaches to reduce transportation network cost through consolidation without capital-intensive consolidation centers. By identifying efficient routes for shippers and carriers that neither can identify on their own, GlobalTranz is able to introduce an improved service offering that goes beyond matching supply and demand.

Better routes are needed because the trucking industry faces tighter supply and increased demand. The key lever to balance the two is improving truck utilization without delaying delivery times or hurting service. Multi-stop truckloads accomplish this by consolidating partially full truckload and/or less-than-truckload shipments to fit on a single route. Shippers share the transportation cost while carriers benefit from higher truck utilization.

However, being able to identify these consolidation opportunities quickly and efficiently is computationally expensive given GlobalTranz’s large network of shipments. To reduce the computational power needed, the adapted column generation and clustering approach in Python processes the data and outputs a smaller, feasible number of potential routes for a numerical optimizer to solve.

These potential routes are modeled as a Practical Pick-up and Delivery set covering problem. Based on the initial 18,000 shipment dataset, an 11% cost reduction was identified when considering all shipments across the network.

The consolidation tool in this report emphasizes the importance of building stronger customer and carrier relationships because MSTL requires agreement from carrier and shipper to actualize network efficiencies. Once implemented, innovative consolidation analytics are an important value-added service that logistics leaders, like GlobalTranz, will use to strengthen both shipper and carrier relationships. These research findings prove an opportunity exists to consolidate shipments into a multi-stop truckload and will reduce network cost, decrease carbon emission, and lower lead times, all while maintaining high service.