THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF SUPPLY CHAIN AND INFORMATION SYSTEMS

# TRANSPORTATION COST SAVINGS IDENTIFIED THROUGH POST HOC BID ANALYSIS

EMILY ANN WASCHENKO
SPRING 2016

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Supply Chain and Information Systems
with honors in Supply Chain and Information Systems

Reviewed and approved* by the following:

Robert Novack
Associate Professor of Supply Chain Management
Thesis Supervisor

John Spychalski
Professor Emeritus of Supply Chain Management
Honors Adviser

* Signatures are on file in the Schreyer Honors College.

# ABSTRACT

As one of the highest expenditures within the supply chain, transportation has increasingly become a key area of focus for shippers. Across industries, shippers are designing and optimizing their logistics networks to mitigate the rising costs intensified by driver shortages, capacity constraints, fluctuating fuel prices, and other factors. A variety of frameworks and tactics exist to address this challenge, such as optimization-based bidding technology for awarding freight to carriers. Although these enablers support shippers in their cost-savings efforts, they are preliminary in nature and often do not offer post hoc analyses to evaluate performance, conformance, and actual costs. This thesis will seek to fill that void by demonstrating how to conduct a post hoc analysis of freight procurement using bid data from a large consumer packaged goods company. The analysis will introduce three strategies for cost-savings: use of intermodal shipments, carrier consolidation on a per-lane basis, and carrier consolidation on a regional basis. The thesis concludes with recommendations for future research including the incorporation of accessorial charges, and implementation of 57-foot trailers to achieve greater economies of density.

# TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

## ACKNOWLEDGEMENTS

Thank you, Dr. Robert Novack, for your unwavering guidance and support toward my completion of this work. As evidenced by your mentorship throughout my journey at Penn State, you have transcended your role as Thesis Supervisor by furthering my academic and professional growth.

I would also like to thank my counterpart at the company for which this thesis addresses. Your time, insights and knowledge have enabled this work and are sincerely appreciated.

Thank you to the Schreyer Honors College and Smeal College of Business for offering me a quality education, enriching experiences, and enduring network, all of which have prepared me for the road ahead.

Finally, I sincerely thank my mom, dad, and sister, whose love and support continue to encourage me from one chapter to the next.

Chapter 1

## Introduction

Transportation is the lifeblood of business logistics. Simply put, it is the distribution piece of the supply chain, or the means by which goods move from one location to another. Though it is just one piece in the larger picture that includes sourcing, buying, demand fulfillment, and warehousing, transportation is by no means trivial. In 2005, freight transport activities accounted for ten percent of the GDP in the United States (Cristini, 2014). Thus, it should come as no surprise that transportation is often one of the largest expenses for manufacturing companies around the world. Estimates show that transportation "accounts for as much as 30% of the total cost of logistics operations – almost as much as warehousing and inventory together" (Cristini, 2014). Indeed, significant investments are made in the shipment of materials, intermediaries, and finished products throughout the supply chain. These shipments travel amongst a plethora of "nodes" such as raw material suppliers, production plants, finished good warehouses, customer distribution centers, retail stores, and in many cases, the consumers' homes. Worldwide population growth, a shortage of drivers in the trucking industry, and consumer preferences such as next-day delivery are among the many global trends shaping the transportation landscape while increasing the demands on shippers. As manufacturers attempt to keep up with these demands while working to meet the on-time delivery metrics and case fill rate targets agreed upon by their customers, they concurrently find themselves challenged by internal pressures to cut-costs and increase efficiencies in the transportation network.

Due to the enormous spend on such a critical component of the supply chain, logistics professionals may find the task of reducing transportation expenses daunting. Wanting to maintain customer service while avoiding disruption to the network's current state, these individuals may fear taking risks associated with change, or simply do not have the knowledge for where to begin in their transportation network analysis. A Bloomberg survey noted this emerging trend, reporting that although "73% of Supply Chain Managers are undergoing this shift in attitude toward transportation and identifying transportation as their key focus in 2014," implementation of transportation solutions and even *plans* to adopt them are lagging with only twenty-two percent of managers indicating their plan to do so (Cristini, 2014). Nevertheless, small changes in transportation strategy can compound into large improvements and significant payoff. When logistics personnel understand these tactics, they will be less likely to view transportation as a "necessary evil" or cost center, but rather as a source for achieving competitive advantage.

There are many theories and associated strategies on how manufacturers can decrease their transportation costs. This thesis will seek to explore these various approaches, while keeping in mind the differences in strategies based on company size, markets served, industry, and other differentiating characteristics. Following the research on best practices for reducing transportation expense, a post hoc analysis of freight bidding will be conducted using data provided by a large consumer packaged goods manufacturer (disguised as "Company A" for the entirety of this paper). The analysis will pinpoint three techniques to reduce transportation costs, all of which are suggestions for future network bidding. Although these findings emerge from one company's data set, the methodology and techniques are transferable to other shippers, as will be discussed.  The thesis will conclude with recommendations for future analyses to increase cost-savings potential.

## Chapter 2

## Literature Review

Before discussing methods to mitigate the impacts of high transportation costs, it is critical to first examine the history and driving forces behind these rising costs.  Doing so will not only pinpoint the issue at hand, but also help ascertain the future outlook for transportation expenses and thus devise an optimal strategy for post hoc analyses.

### History

In their Supply Chain Quarterly article, "The Real Impact of High Transportation Costs," researchers in the Smeal College of Business at Pennsylvania State University and the Coggin College of Business at University of North Florida trace the recent history of transportation availability and costs.  In the 1990s through the early part of the 21$^{st}$ century, companies prided themselves with "just-in-time deliveries" as transportation services were readily available and low in cost relative to holding inventory.  Since the mid-2000s, however, crude prices (which influence the cost of diesel) have risen in an unpredictable pattern and have been met with a "demand-supply imbalance" of transport services due to the rapid pace of international trade growth.  The availability of transportation service in the United States simply could not keep up with the increase in freight volumes, resulting in congested roads and capacity constraints. Worsening the issue is the growing size of the average ocean container ship that now demands upwards of five times as many inland moves per ship than those generated by ships in the past. Coupled with the limited budget of the Highway Trust Fund (HTF) and lack of investments into the U.S. transportation infrastructure, it is unlikely that shippers will see abolition of these issues, at least not in the near term. As the aforementioned university researchers uncovered, the oil price volatility and capacity constraints will continue to keep transportation costs high, therefore leading us to conclude that "managing transportation costs is more important than ever for preserving margins and profitability as well as improving supply chain performance" (Coyle, et. al., 2014).

## Strategies & Frameworks

The "perfect storm" evolving from these trends led the researchers to highlight three main shifts in supply chain strategies in response to high transportation costs. They deduce that the benefits from these strategies are not limited to transportation, but extend to the broader supply chain and financial dealings "due to lower costs and more productive investments" (Coyle, et. al., 2014). The advantages from each of the three strategies are captured in Figure 1.

*1. A shift from offshoring to nearshoring*

Companies are increasingly procuring their materials and producing their products closer to the point of consumption. While cheap labor and low production costs often justify the decision to offshore, companies consequentially find themselves burdened by long-distance transportation costs, especially in an environment with rising fuel prices. Performing these activities closer to end markets (i.e. near-shoring) not only reduces transportation costs due to short distances traveled, but allows companies to more easily respond to changes in customer demand, resulting in improved customer service, order fulfillment, and inventory positioning.

*2. A shift from product design for marketability and production to design for "shipability"*

In effort to increase shipment density, reduce weight, and avoid the costly shipment of air, companies are turning their attention to smarter product and package design. One such example is the removal of water from cleaning products like Windex, to create concentrated and physically compact products that will be diluted only after arrival at the customers' home. Researchers reference a survey conducted by the Grocery Manufacturers Association that found "1.5 billion pounds of packaging [was] avoided from 2005 to 2010" in the consumer products industry (Coyle, et. al., 2014). As a result, supply chains benefit from freight cost reduction (more products can fit on the same size truck), packaging cost reduction, and improved space utilization due to smarter product configurations.

*3. A shift from lean inventory policies to hybrid lean transport/inventory policies*

When oil prices were much lower (about $25/barrel), "just-in-time" inventory strategies were often employed whereby companies would routinely ship small quantities quickly and frequently. Although this required fewer inventories to be kept on-hand (and therefore translated into lower holding costs), significant investments had to be made in transportation. Those investments became more costly as oil prices increased, therefore spurring many companies to adopt a "hybrid lean transport/inventory" policy where transportation economies of scale (larger, less frequent shipments) could be captured (Coyle, et. al., 2014). Here, researchers introduce two of many methods companies use to implement a successful "hybrid" strategy. "*Shipment consolidation"* is one such technique, where companies leverage third party (3PL) expertise to identify opportunities for consolidating loads along shared lanes and routes. The constraints, costs, and scarcity of over-the-road (OTR) carriers, have prompted many companies to consider another tactic, *"alternative modes of transportation"* such as intermodal rail services, especially for long-distance transportation (Coyle, et. al., 2014). Although intermodal shipments often have increased transit-times, contributing to higher in-transit inventory costs and safety stock levels, many companies see this means as an effective alternative to OTR shipments due to the "freight-cost reductions achieved through improved shipment economies, fewer empty runs, and better vehicle utilization" (Coyle, et.al., 2014).

**Figure 1. Transport-driven shifts in strategies and their connections to the boardroom**

| Guiding Transport and Logistics Principle | Transport-Driven Shift in Supply Chain Strategy | Supply Chain Performance Impacts | | | |
|---|---|---|---|---|---|
| | | Freight costs | Inventory costs | Customer service responsiveness | Space utilization |
| Count the miles | **Sourcing:** Shift toward nearshoring | ● | ● | ● | |
| Don't ship air, don't ship water | **Product and package designs:** Shift toward design for "shipability" | ● | | | ● |
| Consolidate, consolidate, consolidate | **Inventory:** Shift toward lean inventory/transport hybrid | ● | | ● | |
| | | Cost of goods sold (COGS) | Current asset | Sales | Fixed asset |
| | | Return on Capital Employed (ROCE) Impacts | | | |

(Coyle, et al., 2014)

As alluded to in the research of Coyle, et.al., when determining ways to reduce transportation expenses, logistics professionals must keep in mind that transportation and physical distribution decisions depend on the broader supply chain strategy. Opportunities to reduce transportation costs exist in tandem with the other choices made across the network, from the upstream supplier selection to the downstream home delivery process, and everywhere in between. For this reason, "cutting transportation costs" need not be an independent goal, but rather it can emerge as the beneficial or advantageous result of optimization techniques employed elsewhere in the supply chain.

In a 2011 issue of *Supply Chain Quarterly*, Rob O'Byrne, CEO of the Sydney, Australia-based consulting firm Logistics Bureau, supports this broader view, offering seven strategies to cut supply chain costs regardless of industry or company size. O'Byrne claims that these strategies can help companies become more profitable, with annual savings often ranging from $2 million to $10 million across the supply chain. Before investigating his seven tactics, it is critical to first highlight the importance of knowing the company's "cost to serve" its customer base. The type of customer, product, and/or service offered ultimately drives the supply chain design and distribution strategy. Servicing a grocery store with perishable food on a pallet is quite different than delivering a piece of delicate furniture to a customer's doorstep or building materials to a construction site. Indeed, order cycles, lead times, product configurations, special handling requirements, and delivery windows are just a few of the many characteristics that vary in each case. Thus, as O'Byrne reiterates "…it is paramount that you first understand the dynamics of your customer base so that you can design your service offering to meet their needs at a sensible cost. If you fail to identify customer needs correctly, you will supply the wrong service at the wrong cost." O'Byrne's seven suggestions for reducing supply chain costs are listed in Appendix A. Four of these methods – customer service, supply chain network design, outsourcing, and asset utilization – will briefly be examined based on their relevance to this thesis and the scope of the Literature Review.

***Customer service.*** Simply put, O'Byrne urges companies to identify and meet customer needs without paying extra for things they do not want. His examples follow suit, the first of which demonstrates the heavy cost repercussions of servicing customers with "next-day delivery" when in fact, the customer neither requested nor needed it. On the other hand, the *absence* of a customer service policy can be equally detrimental, as illustrated through an auto parts deliverer who chose to deliver to each region on a different day of the week simply for the "ease of transport planning" (O'Byrne, 2011). Finally, O'Byrne warns against use of the "Band-Aid" solution whereby distributors respond to customer complaints with free delivery rather than addressing the underlying problems, consequentially setting itself back thousands of dollars as a result.

***Supply chain network design.*** Intelligent network design can prevent headaches and costly adjustments down the road. Suppliers and customers should be thought of as "bookends" that help determine the optimal strategy for *where* and *how* inventory should flow across the network to reduce total "touches" (O'Byrne, 2011). As O'Byrne emphasizes, "Inadequate network design can lead to excessive handling, too many stock locations, and poor utilization of distribution centers. The results are high distribution costs and poor customer service." O'Byrne's 5-step approach to reducing touches is outlined in the "Supply chain network design" section of Appendix A.

***Outsourcing.*** Eighty-five percent of companies outsource at least some portion of their supply chain operations, with warehousing and transportation being the most common (O'Byrne, 2011). Although cost savings is not a guarantee, the expertise of third parties can often lead to greater efficiencies and better-informed management of various supply chain functions. Transportation savings are most likely to be captured if "service specifications" are clearly communicated between the two parties such as delivery schedules, shipment volumes, product handling requirements, and temperature or hazardous controls (O'Byrne, 2011).

***Asset utilization.*** Smarter utilization of assets, such as avoidance of idle vehicles, can have significant payoff. Two examples provided by O'Byrne include the decision of a bakery to spread its early-morning deliveries throughout the course of a day to prevent idle trucks, and ultimately decrease the size of its fleet. Asset utilization strategies are also viable for the retail industry as exemplified by retailers who work with their outsourced delivery fleet to transition away from paying "truck rates" (a flat delivery rate from a distribution center to store, regardless of how full the truck) to a "pallet rate" to maximize efficiency while reducing costs (O'Byrne, 2011).

## Transportation Bidding

Another strategic means toward reducing transportation costs is through optimizing the bidding process where shippers award volume to carriers for each lane in their network. Freight procurement, often perceived as a time consuming, complex, and even "disruptive" process to the supply chain, should not be underestimated. Its impact on cost and quality has spurred extensive research from scholars and industry experts alike.

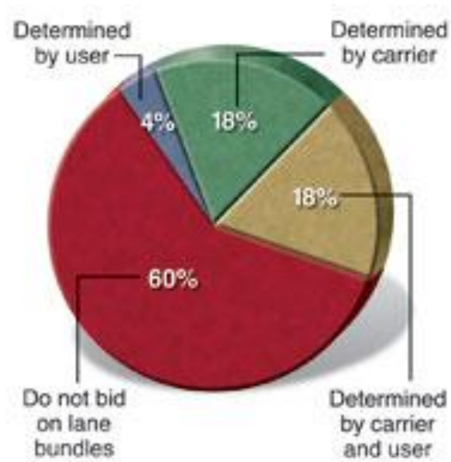
As defined by researcher Matthew James Harding at the Massachusetts Institute of Technology, a lane is "the lowest level of shipment aggregation which can be loosely defined as the geographic representation of origins, destinations and service and equipment requirements" (Harding, 2005). As Harding emphasizes, the service, equipment and contract types do not always characterize the lanes before bidding, but rather emerge with the individual carrier's bids. The latter is the case for this thesis's data set; bids with various modes of transportation (dry-van, rail, etc.) appeared for the same lane. As a result, line haul charges can vary greatly across bids for the same lane, due to the offering of different transportation modes. Analysis of these variances provides an opportunity to reduce costs through arriving at the optimal mode-mix.

Researchers have concluded that there is no shortage of "optimization-based bidding technology" that can help shippers improve their networks, both from a cost and capacity perspective. This technology, as Harding highlights, "enables shippers to address a large number of competing objectives by allocating capacity considering hundreds of thousands of rates, and capacity limitations at various network levels including lane, facility and system-wide" (Harding, 2005). Depending on the degree of certainty in volume levels, some shippers will "hone" their origins and destinations to the most descriptive level (i.e. physical addresses of facilities), while others will define their lanes with more broad origins and destinations (on a more regional level) in hopes of obtaining the most favorable rates from carriers (Harding, 2005).

Chris Caplice, Vice President of Chainalytics and Yossi Sheffi, professor at Massachusetts Institute of Technology, add to this discussion on transportation procurement, reiterating that optimization-based techniques are widespread and benefit shippers by accounting for system-wide constraints that exceed the capabilities of traditional (lane-by-lane) bidding models. These constraints include thresholds set to achieve a minimum number of carriers by location, or to award minimum volumes to individual carriers (Caplice and Sheffi, 2003). Optimization-based techniques are also more sophisticated than lane-by-lane methods in their ability to address the "*interdependency* problem" that arises when carriers' true costs are dependent upon the additional lanes they are awarded (Caplice and Sheffi, 2003). The holistic approach to the network therefore enables optimization-based techniques to increase the likelihood of carriers achieving economies of scope, where "the total cost of a single carrier to serve a given set of lanes is lower than the cost of multiple carriers serving these same lanes" (Caplice and Sheffi, 2003).

Lane bundling, whereby shippers award carriers groupings of lanes, is one way to arrive at the aforementioned economies of scope. Shippers can often seize lower rates through the carrier's commitment to transport the collective volume on multiple lanes. The "Combined Value Auction (CVA)" is one such optimization approach that enables this process by providing carriers with added visibility into the shipper's network. Better-informed carriers can then proceed to place bids that (1) improve their asset utilization, (2) lessen their chance of over- or under-committing, and (3) align with the shipper's fluctuating needs (Grossardt, 2002). Dave Blanchard, a supply chain scholar and Senior Editor of *IndustryWeek*, reiterates the bundling advantages through his emphasis on the carrier's ability to "complement its current portfolio" while increasing the likelihood of "yielding a lower total bid than the sum of the individual lanes" (Blanchard, 2007). Despite the foreseen upside, data from the Supply Chain Consortium suggests that many companies are not yet employing this tactic when awarding freight volumes (see Figure 2).

**Figure 2. Usage of lane bundles in freight bidding**



Contributing to the discussion on best practices, are the insights from Chris Ferrell, Principal Consultant at Tompkins International. Ferrell offers twelve pertinent suggestions based on a Supply Chain Consortium survey of "manufacturers, wholesalers and retailers on their freight bidding policies and processes" (Ferrell, 2007). Recommendations include bidding on a regular, pre-determined basis, engagement of bidders in the process (to identify potential lane bundles, mode-mixtures, and/or opportunities for dedicated fleets), and feedback loops (for tracking actual carrier performance relative to what was agreed upon) (Ferrell, 2007). Researchers also suggest the incorporation of new providers in the bidding process to keep rates competitive. Concurrently, existing carriers are encouraged to widen the geographic scope of their bids beyond their "historical base" to strengthen the carrier-shipper relationship and keep up-to-date with any new carrier market penetration (Ferrell, 2007). Finally, Ferrell highlights the importance of implementation planning in conjunction with awarding bids. Indeed, affected locations (origins and destination) should offer input on any decisions related to "carrier capacity commitments, timing, and coordination of service provider turnover" (Ferrell, 2007). As with many supply chain alternations, collaboration and transparency are essential toward the successful implementation of any change.

## Discussion

As evidenced by the insights offered in the aforementioned literature, there are many methods to address rising transportation costs. Consideration of strategies such as outsourcing, nearshoring, increasing the "shipability" of products, and intelligent network design are all contributive steps toward arriving at a cost-effective supply chain. While these approaches are valid, they are preliminary in nature and perhaps most easily implemented during the initial design phase of the supply chain or as bids are awarded. Much of the current literature highlights these proactive strategies and available technologies, but neglects to provide substantial insight on how shippers can conduct post hoc analyses of their network decisions. This thesis will seek to fill this void, proceeding with a retrospective analysis of one such optimization technique – awarding freight volumes to carriers.

# Chapter 3

## Background

As previously introduced, Company A is a large consumer packaged goods company with an extensive and complex transportation network. This is due in part to the diversity in both the product offerings and customer base. As such, transportation modes are wide ranging, including refrigerated vans ("reefers"), dry vans, intermodal carriers, dedicated fleets (operating in a concentrated region), and brokerage loads. There are a number of different providers (carriers) *within* each of these modes, and some carriers offer their service *across* modes. For example, Company A may award volume to a carrier for both intermodal and dry-van moves, and sometimes for the same origin-destination pair. Additionally, many carriers transport loads across move types, such as from a plant to distribution center (DC) and from a DC to customer. Due to the heavy shipment volume and efforts to achieve economies of scale, truckload quantities are favored over less-than-truckload ("LTLs").

In total, Company A's network is comprised of over 50 carriers, over 350 origins, over 2400 destinations, and over 3100 lanes. Out of the three "move types" (material, interplant, and customer) as defined in Appendix C, customer moves received the highest awarded volumes, followed closely by interplant moves, and finally material shipments. The size and complexity of the transportation network is further illustrated through distance and volume statistics, separated by mode of transport in Table 1. All of these figures are calculated from winning bid data from freight procurement that will be discussed in the next section.

### Table 1. Descriptive Analysis by Transportation Mode

| Mode of Transport | Annual Volume (TL) | Volume (%) | Approx. Miles in Network* | Average Miles** | StdDev of Miles** | Min. Miles** | Max. Miles** |
|---|---|---|---|---|---|---|---|
| Over-the-Road (OTR) | 607,248 | 76% | 1,316,614 | 492 | 425 | 1 | 2914 |
| Dedicated | 119,213 | 15% | 71,587 | 147 | 85 | 1 | 990 |
| Intermodal (IM) | 75,818 | 9% | 199,260 | 1346 | 711 | 418 | 2792 |

*Total miles aggregated from lanes in bidding process (not annual traveled)
**values give on a "per move" basis (i.e. from single origin to destination)

## Objectives & Scope

As highlighted in the conclusion of the Literature Review, companies across industries often experience issues conducting a retrospective analysis of their freight procurement processes. While the optimization techniques seek to award volume in the most sensible, efficient, and cost effective manner, there is a lack of post hoc methodologies to evaluate the outcomes. Opportunities for greater efficiencies or cost savings could be missed. For this reason, Company A has provided historical bid data across all lanes ranging from two years ago to nine months ago. This Excel file used for analysis consists of over 53,000 rows, each corresponding to an individual bid that was placed by one carrier for one lane. To differentiate and distinguish the bids, eighty-five columns provide both qualitative and quantitative measures. Columns such as supplier name, awarded volume, miles, move type, and mode of transport are among the fifteen columns identified as most useful for this analysis. For a full listing of the relevant columns and their corresponding descriptions, see Appendix C. The impending methodologies and analysis will reference this data through these column names.

Using Company A data as an example, the following three chapters each detail a methodology and corresponding analysis for how shippers can evaluate post hoc bid data to detect cost savings opportunities. Intermodal utilization, carrier consolidation by lane, and regional carrier consolidation will be introduced while keeping the underlying economies of density, economies of scope, and cost savings objectives in mind. Insights from these methodologies can then be incorporated into future bidding strategies to obtain the projected benefits.

# Chapter 4

## Intermodal Utilization

The goal of this first analysis was to identify which lanes, from a cost perspective, are optimal candidates for transitioning shipments from over-the-road to intermodal. The analysis was first conducted on “interplant” data (between Company A sites), followed by “customer” data (outbound shipments from DCs to customers). Due to the slight differences in approach, the methodologies and results will be discussed separately.

## Methodology – Interplant

The methodology commenced with the concatenation of the Lane ID, Lane Code, and Lane Name to group together all the bids that were part of the same bidding session. This led to a single, unique identifier referred to as “lane.” The lanes were then filtered to only those with distances greater than 500 miles, and designated as "interplant." The scope was narrowed as such in order to focus on those lanes with the greatest likelihood for transitioning from over-the-road to intermodal shipments. Rail shipments are often more sensible for long-distance shipments than for shorter moves. Additionally, the tradeoff between lower costs and longer transit times suggests that rail moves may be less optimal for customer shipments since these moves often demand short lead times and tight delivery windows. Thus, the scope of this first analysis was "interplant" moves within the company, where scheduling and production planning can more easily accommodate these longer transit times.

Once filtered to interplant lanes with distances greater than 500 miles, the lanes where less than eighty percent of volume was awarded to an intermodal bidder were identified. Of these remaining lanes, the ones receiving at least one intermodal bid were noted, to calculate the cost savings if most or all the volume was shifted from over-the-road transportation to rail. The lanes receiving no intermodal bids were eliminated from this analysis since the cost savings could not be identified due to the absence of an intermodal line haul charge.

Cost savings for the remaining lanes were then calculated through a series of steps. Since some lanes had multiple winning bidders, the allocation of volume across winning bidders was multiplied by the respective line haul charges and summed together to obtain the total cost. The minimum line haul charge was then identified out of all the intermodal bidders for that lane. Any volume currently being shipped over-the-road at a more expensive line haul charge than that of the intermodal bidder's offering was then multiplied by this lower rate, and subtracted from the current charge to obtain a cost savings value for that particular lane. In some instances, intermodal carriers were awarded a portion of the total volume on a particular lane albeit not offering the lowest line haul charge when compared to other intermodal bidders. These winning intermodal bidders did not undergo the same hypothetical cost savings calculation as the aforementioned winning dry-van and reefer carriers since the volume was already awarded as intermodal.

## Findings – Interplant

There are 123 interplant lanes with a distance of over 500 miles. Of those 123 lanes, 26 lanes (summing to 19,821 miles and 33,120 truckloads) received no intermodal bids, thus resulting in over-the-road transport of all volume. One lane awarded *some* volume to its lone IM bidder, however it still awarded twenty-five percent of the volume (700 trucks) over-the-road. Had the full volume (2800 loads) been awarded to the intermodal bidder, the company could have saved $88,079 (700 previously DV shipments * $125.83 savings per shipment). Even better, this intermodal shipment has a total transit time of 2 days per shipment for both the intermodal and dry van modes of transport. Thus, the equitable transit times serve to refute the commonly held assumption that intermodal shipments always incur longer transit times for the sake of lower costs.

Of the 123 interplant lanes with distances over 500 miles, 88 lanes saw less than eighty percent of their volumes awarded to an intermodal bidder. Sixty-two of those lanes (over seventy percent) did, in fact, receive at least one intermodal bid. To highlight the cost implications of shipping over-the-road versus rail, the bids for these 62 lanes underwent the aforementioned line haul calculations. Almost half of these lanes (25 in total) exhibited cost savings potential of up to $5,716,664, as summarized in Table 2.

**Table 2. Projected Intermodal Savings for Interplant Lanes**

| | Average | Minimum | Maximum |
|---|---|---|---|
| **Days Added to Transit Time** | 1.88 | 0 | 6 |
| **Savings per Lane** | $228,667 | $2,499 | $1,341,607 |
| **Savings per Lane (%)** | 12% | 1% | 41% |
| **Miles per Lane** | 1,285 | 564 | 2,653 |

| | |
|---|---|
| **Total Annual Savings** | $5,716,664 |

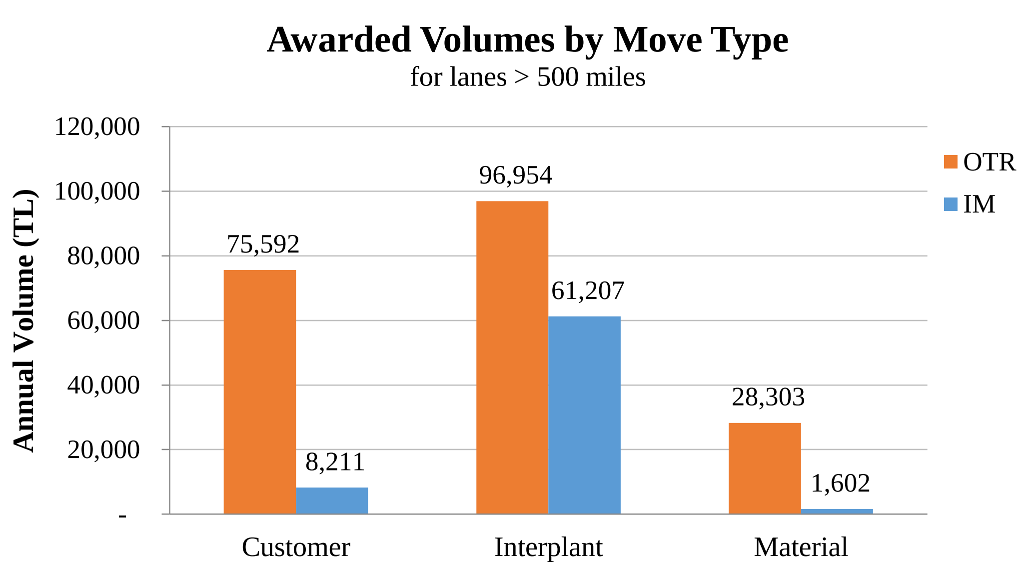
Calculations based on 25 lanes exhibiting potential IM savings while meeting the following criteria: >500 miles, <80% IM, ≥ 1 IM bid

**Methodology – Customer**

Given many customers' high expectations for on-time deliveries, supplier responsiveness, and high quality service, shippers often hesitate to send freight via rail. Nevertheless, as concluded through the interplant lane analysis, switching to intermodal moves does not always imply an increased transit time. For this reason, cost savings for a switch to intermodal moves were calculated for Company A's outbound lanes to customers. A similar approach to that of the interplant lanes was taken towards these customer lanes, albeit a few threshold changes.

The minimum lane distance of 500 miles remained consistent, however, the percentage of awarded intermodal volume was lowered from eighty percent to seventy-five percent for the scope of customer lanes. As depicted in Figure 3, less than ten percent of total customer volume was awarded to intermodal carriers, whereas over thirty-eight percent of total interplant volume was awarded as such. Therefore, the minimal intermodal utilization on customer lanes prompted the threshold to be lowered. As a result, more lanes could undergo the cost savings analysis.

**Figure 3. Awarded Volumes by Move- and Mode-Type**



In sum, the "in scope" lanes for this analysis were (1) customer move types, (2) at least 500 miles from origin to destination, (3) less than seventy-five percent of total volume as intermodal, and (4) had at least one intermodal bid. Consistent with the interplant methodology, line haul charges offered by the lowest IM bidder were utilized to calculate cost savings for the change in mode on the given lane. Lanes that had already been assigned IM carriers for a portion of volume only underwent dollar savings calculations for the volume that was awarded to non-IM carriers.

## Findings – Customer

There are 648 customer lanes with a distance of over 500 miles. Of those 648 lanes, 412 lanes (summing to 309,707 miles and 49,401 truckloads) did not receive any intermodal bids and therefore had all volume awarded to OTR carriers. One hundred seventy-three lanes received at least one intermodal bid but saw less than seventy-five percent of their volume designated as intermodal. These lanes underwent the cost savings analysis whereby OTR volume was hypothetically shifted to IM. The results of this analysis are summarized in Table 3, where 73 lanes were found to have potential savings.

**Table 3. Projected Intermodal Savings for Customer Lanes**

| | **Average** | **Minimum** | **Maximum** |
|---|---|---|---|
| **Days Added to Transit Time** | 1.75 | 0 | 4 |
| **Savings per Lane** | $27,760 | $18 | $348,902 |
| **Savings per Lane (%)** | 15% | 0.2% | 38% |
| **Miles per Lane** | 1,109 | 513 | 2,914 |

| | |
|---|---|
| **Total Annual Savings** | $2,026,481 |

Calculations based on 73 lanes exhibiting potential IM savings while meeting the following criteria: >500 miles, <75% IM, ≥ 1 IM bid

In absolute terms, the projected cost savings for customer lanes is less than that of the interplant lanes (comparing Table 2 and Table 3). Interestingly, however, the average transit time added as a result of the shifts is slightly lower for customer lanes at just 1.75 days. Indeed, 30 of the 73 lanes (over forty percent) showed 0-1 days of increased transit time. Acknowledging that this slight increase in transit time might still be met with some resistance, further examination of lanes with zero increase in transit times ensued. Seven lanes were identified with steady transit times and approximate savings per lane of $10,451 or about nineteen percent.

Chapter 5

# Carrier Consolidation by Lane

## Methodology

The second cost savings analysis involved carrier consolidation within lanes. Shippers can often obtain lower rates if they award more volume to a carrier traveling between the same origin and destination. Thus, the underlying goal for this methodology is to increase economies of density. The methodology commenced with filtering the master data set to only the winning bids. A pivot table was then created from the winning bid data to obtain the summary statistics outlined in Table 4.

**Table 4. Carrier Usage Overview**

| | |
|---|---|
| **Lanes** | 3195 |
| **Average Weekly Volume (TL)** | 5 |

**Average Carriers per lane:**

| | |
|---|---|
| **All move types** | 1.16 |
| **Material** | 1.13 |
| **Interplant** | 1.82 |
| **Customer** | 1.12 |

The data in Table 4 highlights that an average of at least one carrier per lane was awarded volume across all three move types (material, interplant, and customer). Given the geographic scope of the network and number of lanes, these figures suggest that opportunities for consolidation may exist across the seemingly large portfolio of carriers. In order to calculate potential savings for the aforementioned consolation, any lane whose volume was awarded to just one carrier was excluded from the ensuing investigation. There were 399 lanes, approximately 12.5 percent of all lanes, with two or more awarded carriers. Table 5 provides summary statistics for these 399 lanes.

**Table 5. Carrier Usage on Lanes with >1 Carrier**

| | |
|---|---|
| **Lanes** | 399 |
| **Average Weekly Volume (TL)** | 22 |

**Average Carriers per lane:**

| | |
|---|---|
| **All move types** | 2.32 |
| **Material** | 2.22 |
| **Interplant** | 2.93 |
| **Customer** | 2.13 |

Across all lanes with more than one awarded carrier, an average of 2.32 carriers were awarded volume, while the average weekly volume per lane was twenty-two loads. The 399 lanes were then filtered to just those lanes with more than the average number of carriers (2.3) **and** less than the average weekly volume per lane (twenty-two truckloads), under the assumption that the number of carriers should theoretically follow a direct relationship with the weekly volume, though this is not always the case. The lane must have met both conditions (more than average carriers and less than average volume) in order to undergo the final cost savings calculation. This calculation closely resembles that of the intermodal utilization outlined in Chapter 4. Indeed, the approximate annual cost of each individual lane was determined by multiplying each carrier's line haul charge by the corresponding volume awarded, and summing these values together on a per-lane basis. Any volume that was not awarded to the winning bidder who offered the lowest line haul charge, was multiplied by the difference between the actual line haul charge and the lowest line haul charge offered by a winning bidder. This approach is slightly different from that of the intermodal (IM) utilization where cost savings for

OTR volume were calculated from minimum IM line haul bids *regardless* of whether or not the minimum bidder was a winner. The methodology outlined in this chapter differs in that cost savings were calculated only on the hypothetical shift of volume to another *winning* bidder who offered a lower price point.

## Findings

Narrowing the data as such resulted in thirty-three lanes that, among the lanes with at least two awarded carriers, had below average weekly volumes, and above average carrier counts. Of these thirty-three lanes, twenty-four were outbound lanes to customers, one was interplant, and eight were material. Cost-savings by shifting the volumes to just one carrier are summarized in Table 6.

**Table 6. Carrier Consolidation (Per-lane) Savings Summary**

| | | Calculated Lane Savings | | | |
|---|---|---|---|---|---|
| **Move Type** | **No. Lanes** | **Min.** | **Avg.** | **Max.** | **Total** |
| Customer | 24 | $7,118 | $90,990 | $367,902 | $2,183,762 |
| Interplant | 1 | $64,027 | $64,027 | $64,027 | $64,027 |
| Material | 8 | $6,199 | $85,279 | $288,423 | $682,233 |
| Total | **33** | **$6,199** | **$88,789** | **$367,902** | **$2,930,023** |

In addition to the cost saving potential, awarding volume to a smaller portfolio of carriers could potentially increase the reliability of those select carriers, given that they will have a consistent flow of volume to transport. If only awarded a trivial amount of volume, the carrier may prioritize a competitor's load if it can obtain a more stable stream of inventory to ship. This threat is heightened in situations where the bidders are not held accountable to actually ship the awarded volume due to the absence of contracts. Thus, a more strategic awarding of bids that incorporates the insights brought forth in this chapter could decrease a shipper's dependency on resorting to costly freight auctions during times of tight capacity. Nevertheless, it is important to note that sometimes carriers simply do not have enough capacity to haul additional freight, and hence, may be the reason for originally awarding volume across multiple carriers.

Chapter 6

# Regional Carrier Consolidation

## Methodology

Unlike the previous analysis where potential carrier consolidation was explored on a lane-by-lane basis, this analysis takes a macro level approach toward identifying economies of scope opportunities. "In-scope" subjects for this regional methodology include six of the largest distribution centers (as origins) and their customer shipment destinations aggregated by state. As presented in Table 7, the six identified distribution centers collectively account for approximately fifty-one percent of the awarded outbound volume to customers. Distribution Centers A, B, and C, were ultimately selected for analysis due to their large volumes (approximately thirty-three percent in total) and number of destination states. The overarching goal for this final analysis was to identify opportunities to condense the number of carriers from a single origin to multiple destinations in one state.

**Table 7. Shipment Volumes* by DC**

| DC | Awarded Volume (TL) | Percentage of Total | Destination States |
|---|---|---|---|
| A | 60,057 | 15% | 17 |
| B | 37,384 | 9% | 14 |
| C | 37,302 | 9% | 38 |
| D | 26,767 | 7% | 4 |
| E | 24,496 | 6% | 13 |
| F | 21,471 | 5% | 9 |

*Data includes customer move-types only

To conduct the analysis, three measures – number of carriers, number of customers, and awarded volume – were sought for each "Origin DC to destination state" pairing. To obtain these figures, a series of Excel pivot tables were generated from winning bid data in the master file. The first table included the following: Origin Name (filtered to only those six identified distribution centers), Destination State, Supplier Name, Destination/Customer Name (as a "count"), and Awarded Volume (as a "sum"). Creating this first pivot table eliminated duplicates in "Supplier Name" that would have skewed the output value when doing a "count" of names. A second pivot table was then generated from the output from the first. All inputs were kept the same with the exception of "Supplier Name" which moved from a 'row' to a 'value' (displayed as "count") since duplicates were removed in the first step, therefore leaving only unique values for "Supplier Name" in the new data source. Additionally, since the first table already displayed "Destination/Customer Name" as a number ("count"), these values were displayed as a "sum" in the final table. In all steps, "Awarded Volume" was displayed as a "sum." A sampling of this final output (filtered to just one DC) is provided in Table 8. A similar table was generated for Distribution Center B and C.

**Table 8. Sample Pivot Table Output: DC A**

| Origin Name | Destination State | No. Carriers* | No. Customers** | Awarded Volume*** |
|---|---|---|---|---|
| **DC A** | OH | 4 | 38 | 7637 |
| **DC A** | NC | 4 | 27 | 6241 |
| **DC A** | VA | 4 | 20 | 5710 |
| **DC A** | IN | 4 | 25 | 5645 |
| **DC A** | WI | 8 | 26 | 5591 |
| **DC A** | IL | 4 | 20 | 4100 |
| **DC A** | KY | 5 | 14 | 3974 |
| **DC A** | NY | 6 | 17 | 3838 |
| **DC A** | SC | 5 | 15 | 3661 |
| **DC A** | MI | 4 | 14 | 3547 |
| **DC A** | PA | 4 | 14 | 2986 |

| | | | | |
|---|---|---|---|---|
| **DC A** | IA | 3 | 9 | 2959 |
| **DC A** | TN | 4 | 15 | 2652 |
| **DC A** | MN | 5 | 8 | 1260 |
| **DC A** | WV | 1 | 4 | 144 |
| **DC A** | GA | 1 | 2 | 89 |
| **DC A** | ND | 1 | 1 | 23 |

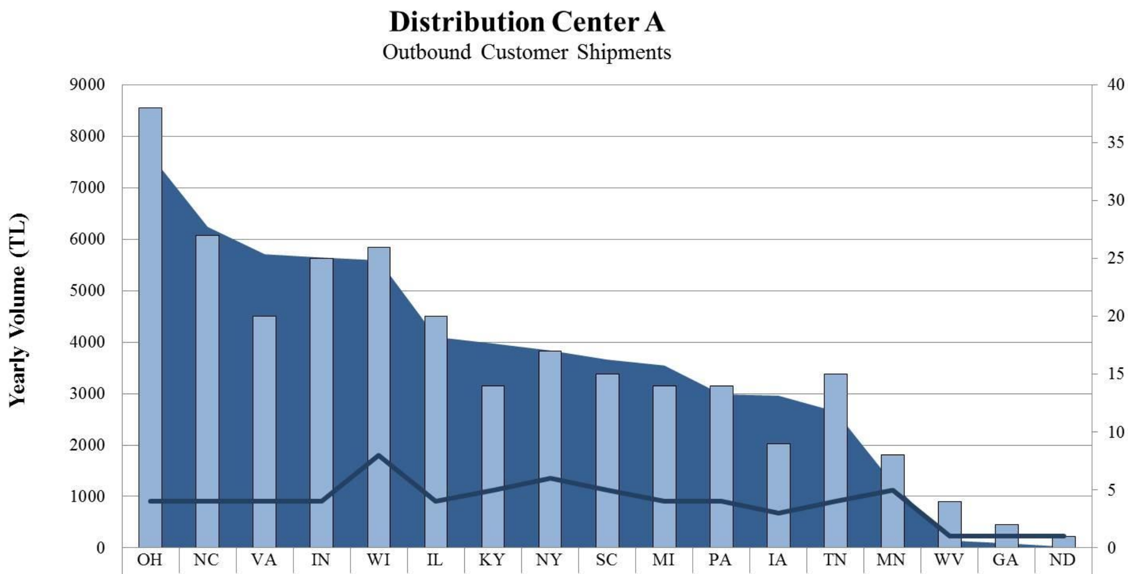
*Supplier Name (count)
**Destination/Customer Name (sum)
***Awarded Volume (sum)

The next step in the methodology was to create three "PivotCharts" (one per data table) to aid in the interpretation of each distribution center's output. Due to the wide range of values, awarded yearly volume was plotted on the primary Y-axis, while number of carriers and number of customers were plotted on the secondary Y-axis. To aid in data visualization, three chart types were utilized: area chart for Awarded Volume, clustered column for No. Customers, and line chart for No. Carriers. Using these three measures, data points for each state were plotted and collectively analyzed.

## Findings

As depicted in Figure 4, Distribution Center A has a direct relationship between awarded volume and number of customers across its seventeen destination states. In other words, the greater the awarded volume, the larger the number of customers, as to be expected. The overlying line depicting the number of carriers, however, does not follow suit. Indeed, customer volume routed to Wisconsin was awarded to twice as many carriers than that of Indiana or Virginia, the next closest states in terms of total awarded volume. There are a number of reasons as to why this could be justified, such as carrier capacity constraints, but the contrast nevertheless lends itself to further investigation. Perhaps Company A's "piecemeal" bidding approach overlooked potential optimization in this region whereby Wisconsin's carriers could have more closely aligned with the portfolio of carriers in the nearby states such as Illinois and Indiana to achieve greater economies of scope. Indeed, utilization of a targeted group of carriers in a region can often help eliminate empty miles and deadheads.

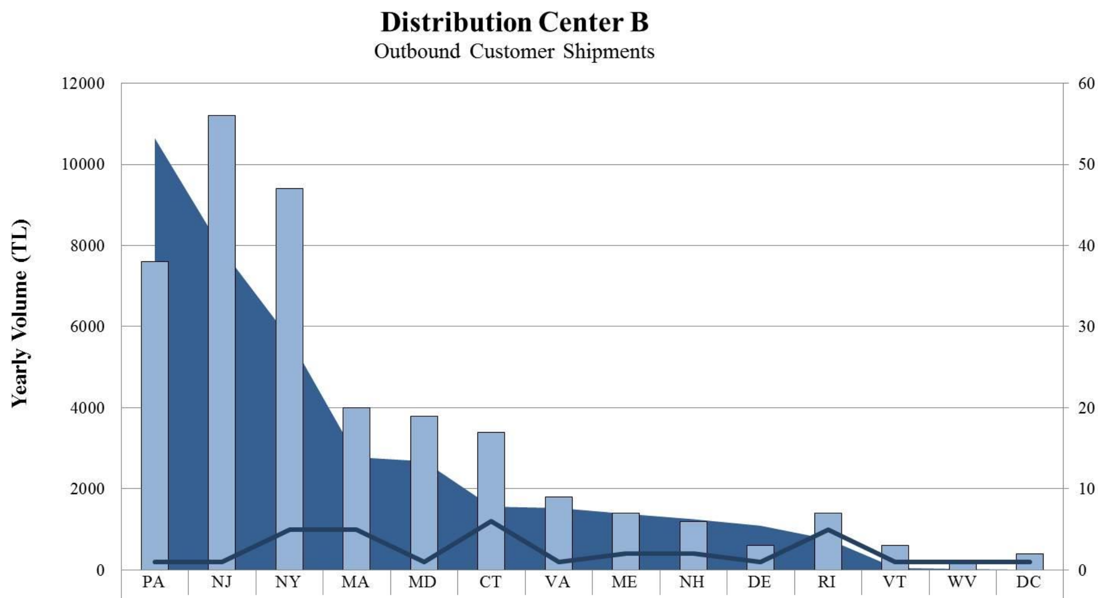
**Figure 4. DC A - Volume, Customer, Carrier Spread**




| | OH | NC | VA | IN | WI | IL | KY | NY | SC | MI | PA | IA | TN | MN | WV | GA | ND |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Awarded Volume | 7637 | 6241 | 5710 | 5645 | 5591 | 4100 | 3974 | 3838 | 3661 | 3547 | 2986 | 2959 | 2652 | 1260 | 144 | 89 | 23 |
| No. Customers | 38 | 27 | 20 | 25 | 26 | 20 | 14 | 17 | 15 | 14 | 14 | 9 | 15 | 8 | 4 | 2 | 1 |
| No. Carriers | 4 | 4 | 4 | 4 | 8 | 4 | 5 | 6 | 5 | 4 | 4 | 3 | 4 | 5 | 1 | 1 | 1 |

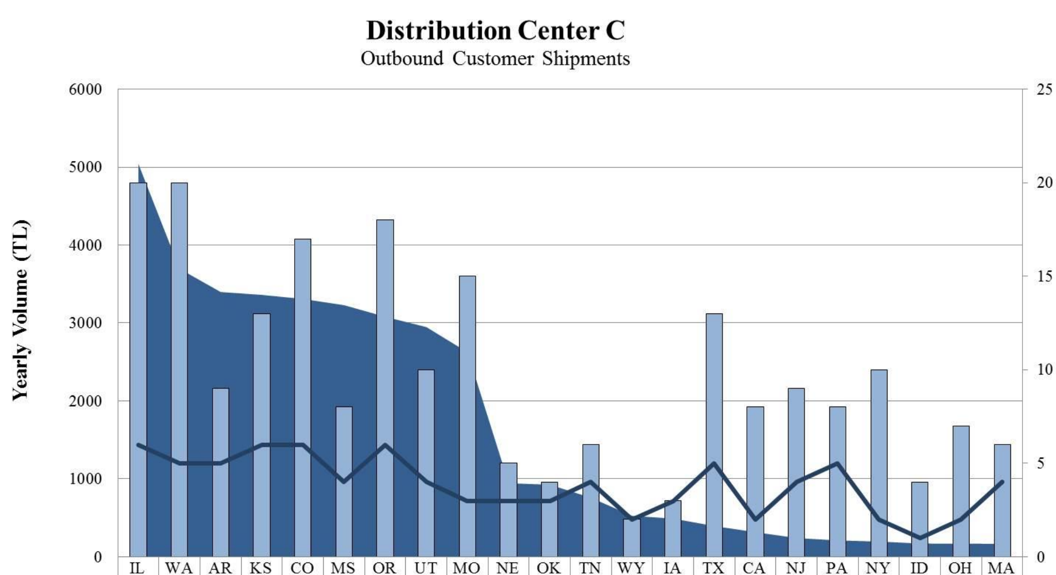
Similar conclusions can be reached from Distribution Center B's outbound shipment data presented in Figure 5. When comparing shipments to Pennsylvania destinations with shipments to customers in Connecticut, one can see that the volume sent to the former is 6.8 times as large, yet the carrier base is one-sixth the size. Furthermore, there are over twice as many customer destinations in PA than in CT (thirty-eight versus seventeen). This heightened disparity lends itself to a close investigation as to whether or not carrier consolidation, similar to the Wisconsin example above, is feasible.

## Figure 5. DC B - Volume, Customer, Carrier Spread




| | PA | NJ | NY | MA | MD | CT | VA | ME | NH | DE | RI | VT | WV | DC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Awarded Volume | 10642 | 7897 | 5707 | 2781 | 2682 | 1564 | 1529 | 1386 | 1254 | 1093 | 761 | 54 | 26 | 8 |
| No. Customers | 38 | 56 | 47 | 20 | 19 | 17 | 9 | 7 | 6 | 3 | 7 | 3 | 1 | 2 |
| No. Carriers | 1 | 1 | 5 | 5 | 1 | 6 | 1 | 2 | 2 | 1 | 5 | 1 | 1 | 1 |

## Figure 6. DC C - Volume, Customer, Carrier Spread (by State)




| | IL | WA | AR | KS | CO | MS | OR | UT | MO | NE | OK | TN | WY | IA | TX | CA | NJ | PA | NY | ID | OH | MA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Awarded Volume | 5041 | 3696 | 3398 | 3361 | 3309 | 3229 | 3080 | 2948 | 2625 | 945 | 926 | 759 | 527 | 491 | 395 | 317 | 242 | 211 | 197 | 171 | 169 | 168 |
| No. Customers | 20 | 20 | 9 | 13 | 17 | 8 | 18 | 10 | 15 | 5 | 4 | 6 | 2 | 3 | 13 | 8 | 9 | 8 | 10 | 4 | 7 | 6 |
| No. Carriers | 6 | 5 | 5 | 6 | 6 | 4 | 6 | 4 | 3 | 3 | 3 | 4 | 2 | 3 | 5 | 2 | 4 | 5 | 2 | 1 | 2 | 4 |

*22 of 38 destination states are displayed (based on largest awarded volumes)

In contrast to the outbound shipment spread for the first two distribution centers, Distribution Center C has a rather asymmetric distribution. Figure 6 highlights the lack of correlation between awarded volumes, number of customers, and number of carriers by state. Perhaps this is due to the vast number of destination states receiving shipments from DC C. Indeed, as highlighted in Table 7, DC C has thirty-eight destination states, over twice as many as DC A. To better comprehend this spread from a macro level, each bid was assigned a region (based on the destination state) in the raw data. "State" was then replaced by "region" in the final pivot table outlined in the methodology section. As displayed in Figure 7, this new distribution, aggregated by region, provides a more sensible picture of how the carriers are allocated. Even so, there is still a large number of carriers in regions with smaller volumes such as the Middle Atlantic and New England. Given that these are neighboring regions with similar volumes, perhaps there is an opportunity to consolidate the carrier base and leverage the same carriers across regions.

**Figure 7. DC C - Volume, Customer, Carrier Spread (Regional)**

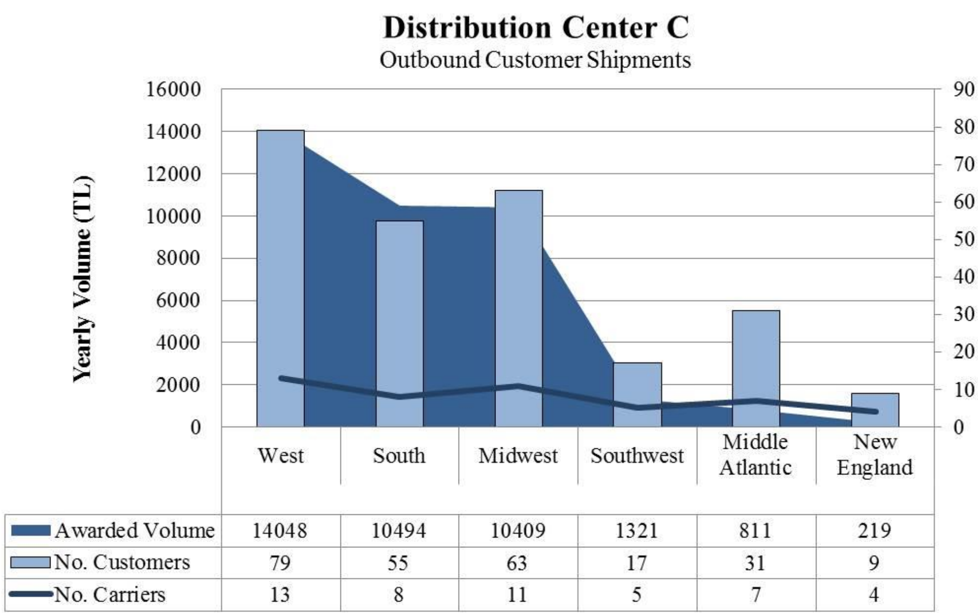


Table 9 highlights this potential through a breakdown of carriers (suppliers) disguised by letters. At the time of awarding volume, eight different carriers were utilized for these regions while only three were utilized across regions (Suppliers A, B, and F). Suppliers D, E, G, and H were each awarded small volumes (about one TL per week) for a minimal amount of customers (one to two). This spread begs the question as to whether the loads can be consolidated and awarded to fewer carriers either within either region or across the two regions. Doing so can increase potential to not only increase carrier reliability and the likelihood of achieving greater economies of scope, but also decrease the transactional costs often associated with carrier proliferation. When trying to optimize how these outbound loads are awarded to carriers, Company A should concurrently consider its carrier base for loads originating in the Middle Atlantic and New England States that are returning to DC C's region. Utilizing a complimentary carrier portfolio for outbound and inbound lanes can increase shipment efficiencies and therefore reduce costs.

**Table 9. DC C - Northeast Shipment Profile**

| | Middle Atlantic | | New England | |
|---|---|---|---|---|
| **Supplier Name** | **No. Customers** | **Awarded Volume** | **No. Customers** | **Awarded Volume** |
| A | 15 | 343 | 3 | 42 |
| B | 7 | 135 | 4 | 84 |
| C | 4 | 114 | | |
| D | 1 | 60 | | |
| E | 1 | 59 | | |
| F | 1 | 58 | 1 | 40 |
| G | 2 | 42 | | |
| H | | | 1 | 53 |

Chapter 7

## Conclusion and Recommendations

The three analyses conducted through this thesis are just a sampling of the many post hoc investigations that can lead to shippers' cost savings. Through intermodal utilization, and carrier consolidation for greater economies of density and scope, Company A could potentially save over $7 million. Although the subject of this research is a consumer packaged goods company with a large network, the methodology is consistent and transferrable to most other networks. Thus, the forthcoming recommendations are written in a generic sense for any shipper who is bidding out this type of network.

A switch in transportation mode from over-the-road to rail can yield significant cost savings. Although this is not a viable option for every lane in the network due to increased transit times, geographic distance from rail, and/or a lack of intermodal bids, the transferrable methodology outlined in this thesis led to the identification of several lanes, both interplant and customer, as worthy candidates. The reduction in line haul charges and little to no transit time increase on many lanes should help alleviate shipper concerns over sacrificing customer service and supply chain responsiveness for the sake of intermodal utilization. Small variations in line haul charges compound into large savings when dealing with a high-volume, widespread network. While large companies shipping long distances are encouraged to consider shifting from over-the-road to intermodal, smaller companies with less volume and geographic scope can look to obtain similar savings by consolidating LTL shipments into truckload economies.

The second and third analyses featured cost savings potential through carrier consolidation on a per-lane, state, and regional basis. When shifting the awarded volume to the lower of two winning bidders on thirty-three identified lanes, an average savings of over $80,000 per lane emerged. Nevertheless, it is important to remember that consolidation might not be feasible in all situations, particularly when carriers simply cannot provide the necessary capacity. When awarding volumes and determining the carrier portfolios on a state and regional level, shippers are encouraged to consider both forward and backward moves to increase efficiencies. By eliminating deadheads and empty miles while increasing the number of round trips, carriers can pass on the savings achieved though greater economies of scope and density. Chris Ferrell, Principal Consultant at Tompkins International, reiterates these benefits:

> *"Leverage volume through a relatively small group of core carriers to yield lower costs and more capacity. As a shipper's volume increases for a carrier, the shipper rises in importance to the carrier. Therefore, the shipper and carrier are able to dedicate more time to developing a deeper, less transactional relationship. This allows for more creative solutions, lower transactional costs, and the ability to move that desperately needed extra load during a peak-season push."* (Ferrell, 2007)

The decision of whether to bid regionally or nationally is an important consideration emerging from this research. On the one hand, "piecemeal" (lane-by-lane) bidding can allow shippers to utilize some of the smaller carriers in a targeted region, who often offer more competitive prices than many of the larger national carriers. On the other hand, shippers may experience difficulty trying to optimize the whole network at once with such a narrowly focused approach. The alternative, national bidding, can assist with such optimization by taking into consideration the entire network. This approach leverages techniques such as lane bundling to significantly reduce costs and increase carrier efficiency through greater economics of scope. Indeed, the ultimate goal of transportation, as precisely stated by George Grossardt of *Inbound Logistics*, “is to increase efficiencies within a carrier's network so that savings can be passed along to the shipper “(Grossardt, 2002). This perspective highlights the importance of taking a collaborative approach toward freight procurement, ensuring that carriers are every bit as involved in the process as shippers. Shippers should undoubtedly strive for this effective communication and alignment, regardless of whether the bidding process is conducted on a regional or national basis.

Shippers with networks of all sizes should also consider the feasibility and benefits of *dedicated fleets*. Although dedicated trucking only accounts for fourteen percent of the truckload market based on 2013 data, the service is nevertheless gaining popularity (Schulz, 2013). As tight carrier capacity continues to plague the transportation landscape, dedicated fleets can guarantee sufficient capacity to their customers (shippers) and, in turn, “smooth out cyclicality in their operations,” permitting carriers to offer lower rates due to this steady flow of demand (Schulz, 2013). Utilization of dedicated fleets can also help to alleviate the aforementioned driver shortage issue, as drivers prefer shorter, more predicable routes located close to home. The mutual benefits highlighted here strengthen the argument that shippers should consider dedicated operations when bidding out the regional moves within their networks.

# Chapter 8

## Limitations and Future Research

When evaluating the outcomes of this thesis and incorporating the findings into future network decisions, one must be aware of some limitations. Many of these limitations serve as suggestions for future research.

At the forefront of these limitations is the absence of accessorial charges in the line haul rates provided by bidders. These charges, as defined by Matthew Harding, include "detention fees, stop charges, pallet charges, and other costs" (Harding, 2005). A shipper's lack of visibility into these fees can result in actual shipment charges that far exceed the perceived amount at the time of bidding. Since these fees vary amongst bidders and are difficult to forecast, optimization of freight procurement becomes even more challenging. What was once determined to be the most cost-effective solution might no longer be optimal given these hidden fees. Carriers' internal cost structures are another important consideration for shippers as they award network volume. However, this insight is often invisible to the shipper, as research published in the Journal of Business Logistics suggests (Caplice and Sheffi, 2003). Future research should include strategies for how to incorporate these accessorial charges and cost structures into the bidding process.

Additionally, shippers should take caution when calculating increased transit times for changes in mode type. Not all trains operate daily, suggesting that non-operational days should be factored into the "Total Transit Time in Days" value. Indeed, when re-evaluating the findings in the first part of Chapter 4, five of the twenty-five interplant lanes that exhibited intermodal cost-savings could incur longer transit times than initially calculated due to limits on the trains' operational availability.

Network changes and redesigns must also be considered in post hoc analyses. While historical data analysis can provide insights for improvement, shippers' networks are often not static as new customers, new distribution centers, and new lanes emerge. Thus, what was deemed "optimal" one year ago might no longer be the best approach given the changing logistics environment. Concurrently, carriers' networks often change over time as new customers and/or capacity are added. Thus, it is in the shippers' best interest to keep up-to-date with their own networks, in addition to the changing capabilities of external partners.

Finally, future research topics should include regulatory conditions and economic costs and benefits relating to the introduction of 57-foot trailers. Shippers with heavy volumes and extensive networks can achieve greater economies of density through the opportunity to increase shipment quantities. Indeed, fixed costs associated with tendering shipments can be spread across more volume, therefore decreasing the per-unit transportation cost. This can reduce the frequency of shipments and ultimately the number of trailers on the road. Implementation of these 57-foot trailers is perhaps most viable on lanes where there is a consistent volume on both the forward flow and backhaul to avoid idle trailers and empty miles. Future research on these trailers should seek to understand the accompanying equipment requirements (such as the need for a quad axel trailer) and differing state laws that could inhibit interstate moves.

As outlined through this thesis, shippers can decrease their transportation expenditures through a number of different ways. Although intermodal utilization and carrier consolidation proved successful in this regard, future research should entail the inclusion of accessorial charges and opportunities for 57-foot trailers.  Doing so will provide a more accurate picture of incurred transportation costs while increasing efficiencies through greater economies.

# Appendix A

## O'Byrne's 7 Ways to Cut Supply Chain Costs

1. **Customer service**: *Give customers what they really want, not just what you think they want.*

2. **Supply chain strategy:** *Objectives should drive strategy, and strategy should drive tactics—not the reverse.*

3. **Sales and operations planning (S&OP):** *Get your process right first, and define your systems after.*

4. **Supply chain network design:** *Keep costs down and reliability up by designing your network to minimize product handling.*

    a. Establish customer service offers (your first "bookend")
        i. Customer locations and lead time
        ii. Service expectations
    b. Establish supply points/lead times (your other "bookend")
    c. Identify current network performance
        i. Facility costs
        ii. Inventory costs
        iii. Transport costs (inbound and outbound)
        iv. Service performance
    d. Test and quantify alternatives for least-cost networks
    e. Consider network transformation, if the benefit will be large enough

5. **Outsourcing:** *Both parties can benefit from a healthy and proactive partnership.*

6. **Asset utilization:** *Get more productivity out of fewer assets.*

7. **Performance Measurement:** *Measure what is strategically important so that you can manage and improve it.*

(O'Byrne, 2011)

# Appendix B

## List of Acronyms

| | |
|---|---|
| CPG | Consumer packaged goods |
| DC | Distribution center |
| DV | Dry van |
| IM | Intermodal |
| LTL | Less than truckload |
| OTR | Over-the-road |
| RDF | Dedicated fleet |
| TL | Truck load |

# Appendix C

## Data File Column Descriptions

Of the 85 columns provided in the initial data file, the following 15 columns are most essential toward the analysis. Descriptions of these columns are as follows:

| Column Name | Description | Calculation |
|---|---|---|
| Lane | Lowest level of analysis consisting of origin and destination | =CONCAT(Lane ID, Lane Code, Lane Name) |
| Supplier Name | Name of carrier associated with the bid | |
| Quantity Available | Total annual loads (truckload) on the lane | |
| Origin Name | Name of lane's start location | |
| Origin State | State of lane's start location | |
| Destination Name | Name of lane's destination | |
| Destination State | State of lane's destination | |
| Miles | Mileage from origin to destination for the lane | |
| Average Weekly Volume | Approximate number of weekly truckloads on given lane | =Quantity Available/52 |
| Linehaul Charge | Carrier's price per shipment, less fuel and accessorial charges | =Price per mile * Miles |
| Move Type | "Customer" = DC to Customer<br>"Interplant" = Plant to DC<br>"Material" = Inbound to Plant | |
| Mode of Transport | Means of transportation such as intermodal, premium intermodal, dedicated fleet, dry van, refrigerated | |
| Transit Time | Total transit time, calculated in number of days | |
| Awarded Volume | Truckloads awarded (out of the Quantity Available) to the bidder | |
| Outlier/Publish/Winning Bid | Denotes whether the bid was an outlier, publishable (i.e. within range), or winner | |

## BIBLIOGRAPHY

Blanchard, Dave. "Best Practices In Freight Bidding." IndustryWeek, 17 Dec. 2007. Web. 27 Feb. 2016. <http://www.industryweek.com/companies-amp-executives/best-practices-freight-bidding>.

Caplice, Chris. and Yossi Sheffi, Y. (2003), Optimization-Based Procurement for Transportation Services. Journal Of Business Logistics, 24: 109–128.

Chatterjee, Lata, and Chiung-min Tsai. "Transportation Logistics In Global Value and Supply Chains." (n.d.): 1-17. Boston University. Web. 16 Jan. 2016. <https://www.bu.edu/transportation/CTS2002G.pdf>.

Coyle, John J., Kusumal Ruamsook, Dawn Russell, and Evelyn A. Thomchick. "The Real Impact of High Transportation Costs." *Logistics*. CSCMP's Supply Chain Quarterly, 2014. Web. 17 Jan. 2016. <http://www.supplychainquarterly.com/topics/Logistics/20140311-the-real-impact-of-high-transportation-costs/>.

Cristini, Marco. "The Role of Transportation in Supply Chain Management." Eyefreight, 07 May 2014. Web. 15 Jan. 2016.

Ferrell, Chris. "The 12 Best Practices of Freight Bidding." Tompkins International, 01 Oct. 2007. Web. 27 Feb. 2016. <http://www.tompkinsinc.com/the-12-best-practices-freight-bidding/>.

Grossardt, George. "Transforming Density into Savings." Inbound Logistics, Dec. 2002. Web. 29 Feb. 2016.

Harding, Matthew James. "Can Shippers and Carriers Benefit from More Robust Transportation Planning Methodologies?" Thesis. Massachusetts Institute of Technology, 2005. Web. 27 Feb. 2016. <http://hdl.handle.net/1721.1/33322>.

O'Byrne, Rob. "7 Ways Everyone Can Cut Supply Chain Costs." *Strategy*. CSCMP's Supply Chain Quarterly, 2011. Web. 16 Jan. 2016. <http://www.supplychainquarterly.com/topics/Strategy/scq201102seven/>.

Schulz, John D. "Transportation Best Practices/Trends: Is Dedicated Carriage the Future of Truckload?" Logistics Management, 01 Mar. 2013. Web. 09 Mar. 2016. <http://www.logisticsmgmt.com/article/transportation_best_practices_trends_is_dedicated_carriage_the_future_of_tr/transportation_trends>.

# ACADEMIC VITA

Emily Waschenko

University Park, PA 16802

emily.waschenko@gmail.com

---

**Education**

The Pennsylvania State University, May 2016
B.S., Supply Chain & Information Systems
Minor in Information Systems Management
Honors in Supply Chain & Information Systems

Thesis: Transportation Cost Savings Identified Through Post Hoc Bid Analysis
Thesis Supervisor: Robert A. Novack

**Related Experience**

The Procter & Gamble Company - Cincinnati, OH
*Supply Network Operations Intern*
May 2015-August 2015

Kimberly-Clark Corporation - Neenah, WI
*Customer Inventory Analyst Co-op*
May 2014 – December 2014

**Honors and Awards**

MIT Supply Chain Excellence Award (2016)
The Traffic Club of Pittsburgh Award (2016)
The Evan Pugh Scholar Award (2015, 2016)
L. L. Waters Award (2015)
GEICO Achievement Award (2014)
Dean's List (2012-2016)

Beta Gamma Sigma Honor Society
Phi Kappa Phi Honor Society

**Memberships/Activities**

Presidential Leadership Academy
Council of Supply Chain Management Professionals (CSCMP)
Students Consulting for Non-Profit Organizations (SCNO)
Global Business Brigades – Ekumfi Adansi Maim, Ghana
Sapphire Leadership Program
Beaver Stadium Blue Out