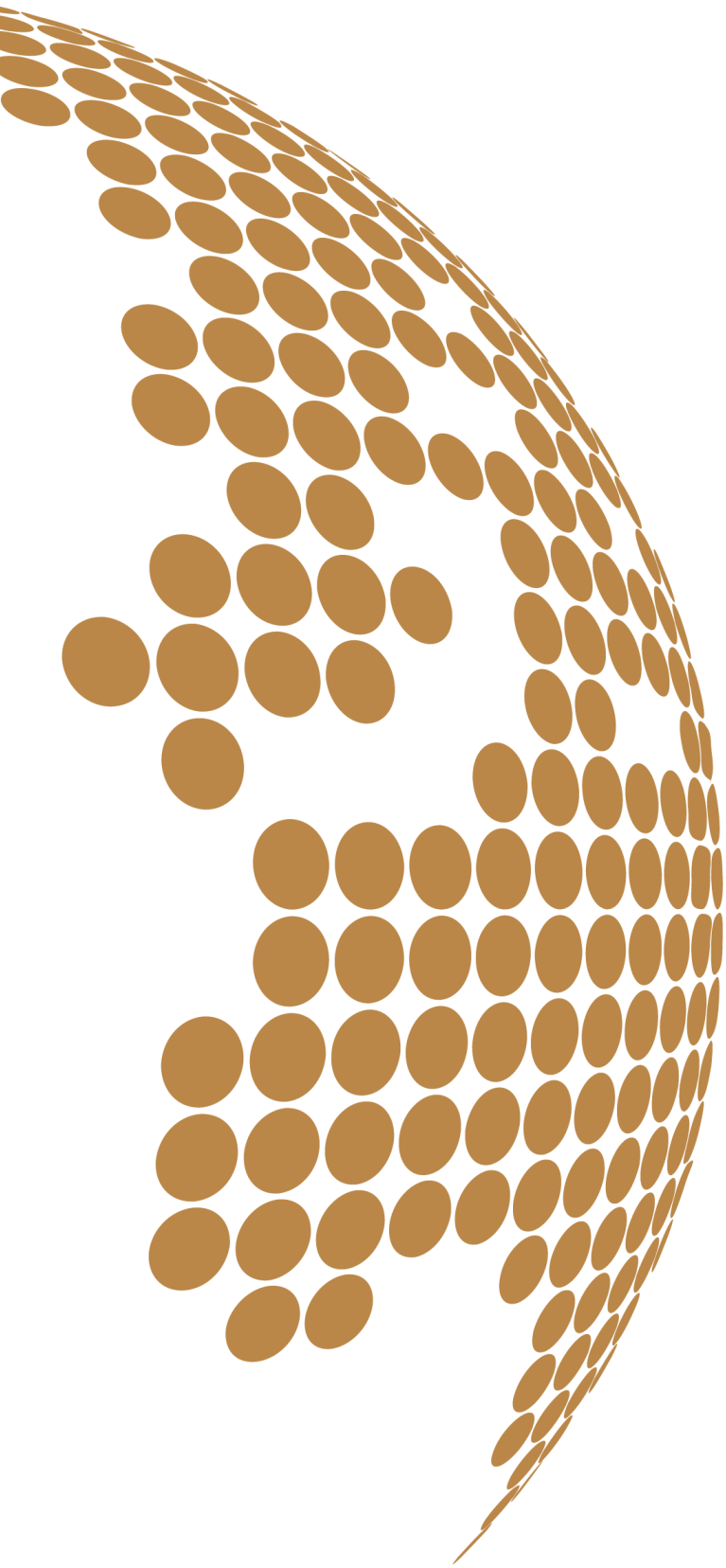

MIT CTL ROUNDTABLE SUMMARY REPORT

MANAGING GLOBAL SUPPLY CHAINS: BUILDING END-TO-END RELIABILITY

29 NOVEMBER, 2012
MIT CAMBRIDGE, MA

MIT Center for Transportation & Logistics

This report was prepared by the MIT CTL Global Transportation Reliability Initiative research team (Dr. Chris Caplice, Dr. Basak Kalkanci, and PhD Candidate Lita Das) and included notes taken at the roundtable by Working Knowledge.

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Table of Contents

Introduction

This document is a summary of the discussion conducted at the Roundtable *Managing Global Ocean Transportation* that was held by the Center for Transportation & Logistics (CTL) at the Massachusetts Institute of Technology (MIT) on 29 November 2012.

Over forty supply chain and freight transportation practitioners and researchers participated in this highly interactive session. The group was comprised of shippers, carriers, third parties and MIT faculty and student researchers. The attendees were hand picked by the CTL research team to best represent the breadth of the global ocean transportation industry. This led to very interesting and open-ended discussions with experts from across the field. The attendees engaged in interactive discussions pertinent to maritime transportation, which included the following topics:

1. Effect of variability in transit times and port dwell times of container shipments on inventory policies of the shippers
2. Procurement strategies and long term vs. short term annual contracts
3. Contingency planning related to recent developments such as the East Coast port strike and natural emergencies like Hurricane Sandy
4. Shipper-carrier relations focusing on carrier scorecards and incentives

The remainder of this document is organized into 5 sections. The first section presents the research of the MIT CTL team based on several datasets from leading shippers and logistics providers. The research results relate to the first topic mentioned above. The next three sections summarize discussions for topics 2, 3 and 4. These discussions include results of the numerous electronic polls conducted during the roundtable prevalent to various practices and opinions on the above-mentioned topics.

The final section discusses the future challenges that are potential topics of research for the MIT CTL team.

1. Research Results

The event began with an overview of research conducted in the last year at CTL on the issue of ocean freight transit time variability. The researchers addressed three key areas concerning both the amount of transit time variability and the business implications of this variability. First, they looked at the causes and amount of variability using data from various shippers and freight forwarders. Second, they examined how actual distributions of transit times observed in the data affect the amount of inventory the shippers may have to carry, particularly compared to the common methods/assumptions shippers use to calculate their inventory levels. Third, they looked at the potential business impact of reducing transit times or reducing transit time variability. Overall, they found strong evidence of variability, showed that actual transit time variability can have complex impacts on needed inventories, and that reducing transit time *variability* can matter more than reducing overall transit times.

1.1. Investigation of Global Trade Transit Variability: An Initial Look at the Container Shipments

Dr. Basak Kalkanci first reported on the analysis of the port-to-port transit and destination port dwell times of 72,000 container shipments into the US from various locations in the world. The data came from a major freight forwarder. Port of Los Angeles had the highest volume of container shipments in this data set; therefore the initial analysis was focused on this port (and later extended to the ports of Long Beach, Seattle and Tacoma). The researchers used a regression model to capture the impact of different factors on the delays in transit. The factors included in the model were carrier, origin country of the container, destination city the container is headed to, whether the container is picked up by truck or train, the day of the week and the month that the container arrived at the Port of Los Angeles. A congestion variable was also included, which corresponded to the total number of containers that arrive on the same port on the same day normalized by the maximum number of containers handled by Port of Los Angeles in the data set.

Three major factors were found to influence the dwell time in the Port of LA. The first factor was inland transportation mode: rail-borne containers spent less time in port than truck-borne containers. Second, shipments to more distant cities generally sat in port longer than containers bound for nearer cities. Third, and most interestingly, there were significant differences between the ocean carriers in terms of port dwell times. As observed by Figure 1, all other factors being equal, the average dwell time of a container can be approximately 60% higher if it is carried by Carrier S instead of Carrier C. This is an indication that although the port-to-port transportation is the carriers' core competency and often what they are evaluated on, collecting data on the carrier's port-to-port transit times provides at best only a partial picture of the carrier's performance. The researchers identified two possible explanations for the differences between the carriers: carriers with their own terminals performed better than those without, and carriers with access to multiple terminals performed still better.

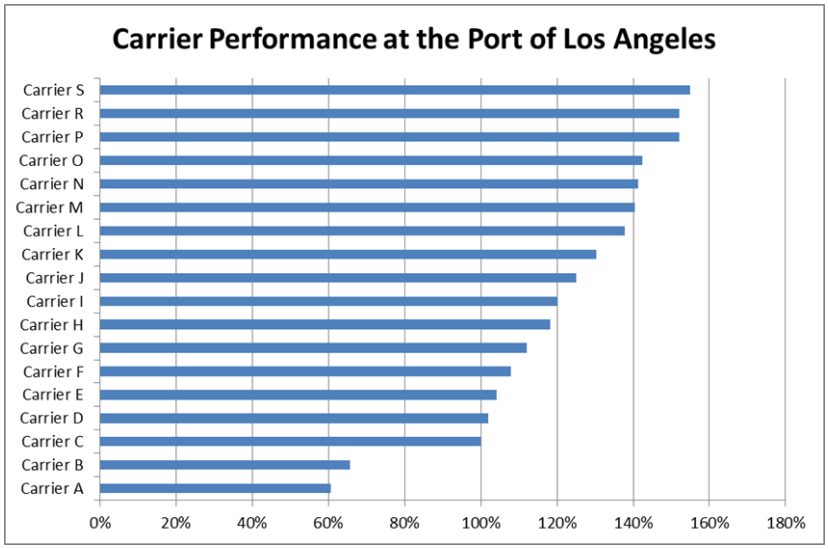

Figure 1. Effect of carriers on the port dwell time of a container at the Port of LA. The figure suggests that the dwell time of a container can be approximately 60% higher if it is carried by Carrier S instead of Carrier C (all other factors being equal).

Next, Dr. Kalkanci presented observations on the trade lane performance across the different data sets they obtained from the shippers. Questions about the research quickly revealed the challenges of collecting, cleaning, and analyzing ocean freight data. Efforts to collect data from various shippers demonstrated that shippers had limited information on their origin-side delays. Most shippers had information only on their port-to-port transit times and perhaps dwell times at the destination port. Combined data from the shippers shows that the destination dwell time at US ports can be quite different: some of the larger ports such as Los Angeles and Long Beach are clustered in the upper right corner of Figure 2 indicating high variability and dwell times while smaller ports tend to have lower variability. Shipper data on the port-to-port performance of different trade lanes also show that there is a significant amount of variability per lane as well as across different lanes (Figure 3). This adds another layer of complexity in operations for the shippers since the items are often needed at the same time, but are shipped from different origins.

Research outlined in Section 1.4 shows that whether considering variability in a trade lane is worthwhile for a shipper depends on its coefficient of variation (CV). This corresponds to the standard deviation of the transit time divided by the average transit time on a particular lane. This measure also provides a common ground to compare the performances of different trade lanes in a shipper's supply chain. Dr. Chris Caplice, Executive Director of CTL, asked shippers about their coefficient of variation of transit times on their most common shipping lanes. The most prevalent response, with 36% of the shippers, was a CV between 0.2 and 0.4. Only 16% had a CV under 0.2. Declining percentages of shippers experience higher levels of CV, with only 12% having CVs between 0.8 and 1.0. These responses are later used in Section 1.4 for a discussion of the link between transit times and their implications on inventory policies of the shippers.

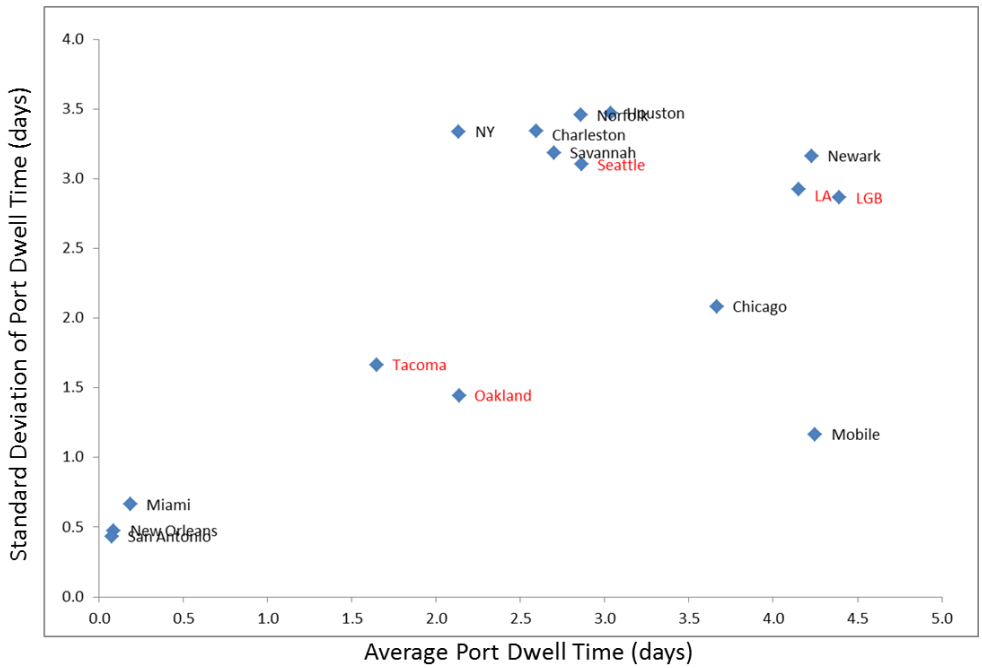

Figure 2. Destination average port dwell times and standard deviations for selected US ports in combined shipper data set. West Coast ports are colored in red.

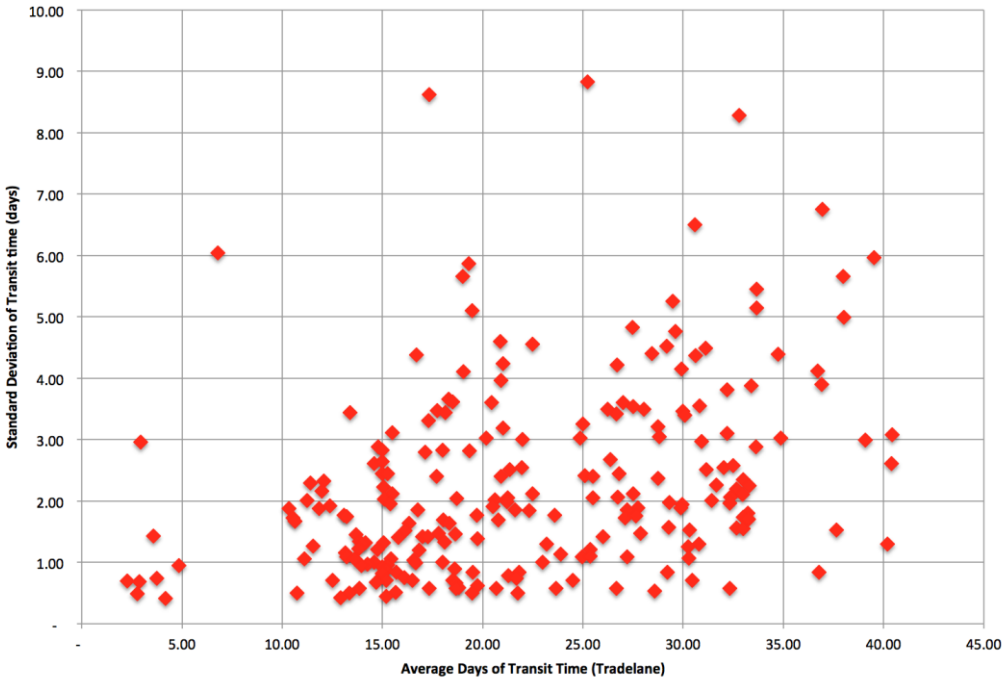

Figure 3. Port-to-port average transit times versus standard deviation for selected trade lanes in combined shipper data set

1.2. Does the Transit Time Distribution Matter? Impact of Bimodal Transit Time Distributions

Doctoral Candidate Lita Das then reported on the impact of the shape of the transit time distribution. The variability of transit time impacts a company's safety-stock -- the chance of a delay in shipping translates into a need to hold more inventory. A common approach to calculate the value of safety stock inventory is to ignore variability by simply assuming an average (deterministic) transit time. A more sophisticated theoretical approach as suggested in the literature uses what is commonly referred to as the Hadley-Whitin formula with an inherent assumption that the transit time follows the Normal distribution. However, research shows that ignoring the actual distribution of the transit time can have grave implications on the safety stock calculation. An optimal calculation of safety stock would entail calculating demand over variable lead-time by using actual (or historical) demand.

A poll revealed that 46% of participants see a Log-normal distribution of transit times. Another 36% of participants said that they typically observe Normally distributed transit time. And 18% said they typically had bimodal transit times, which means that shipments are more likely to be quick or to be late and less likely to fall in some intermediate time.

Multimodality (more frequently bimodality) in transit time was also observed in the data available to the researchers. While being present in 12% of retailers' container shipment data, bimodality accounted for about 60-85% of shipments by others. Instances of multimodality in transit times observed from a shipper's data are shown below.

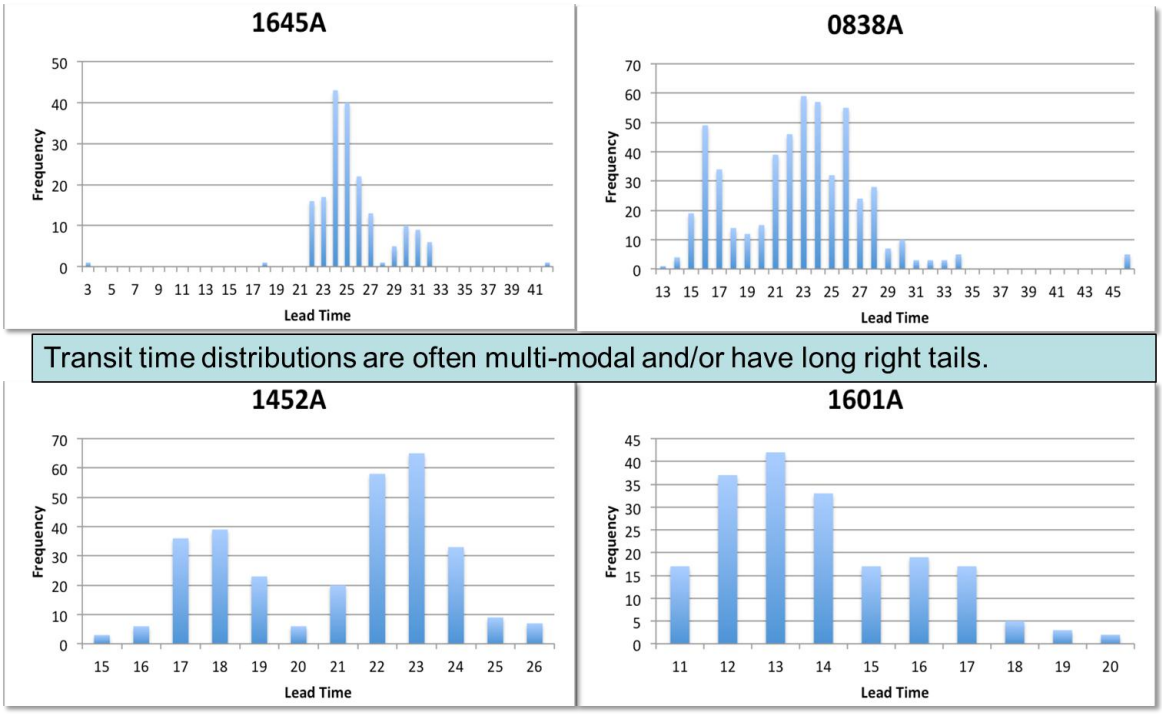

Figure 4. Bimodality in transit time distributions for a shipper (a major US manufacturer)

The relatively large frequency of existence of bimodality in the data convinced the researchers to examine its impact on inventory (on safety stock). Using a mixture of two Normal distributions different *levels* of a bimodal distribution were created. Levels can loosely be defined as the distance between the two modes in a bimodal distribution. An example of such a mixture distribution is shown in the Figure 5 below. The horizontal axis represents lead-time in days and the vertical axis is the resulting probability of occurrence corresponding to each lead-time value.

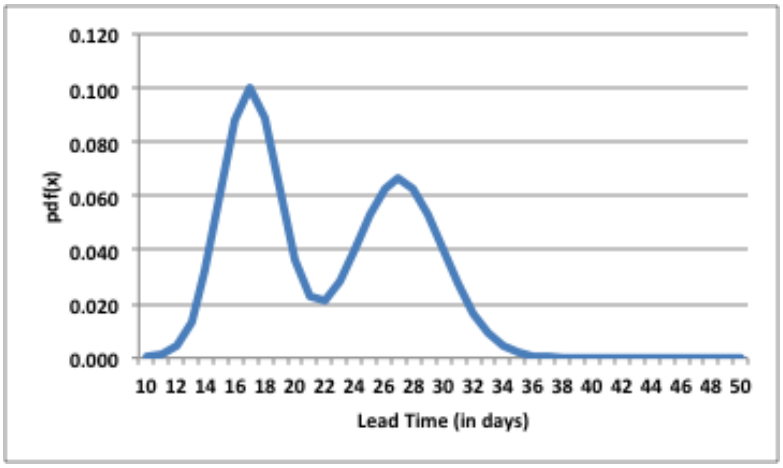

Figure 5. A bimodal distribution created by mixture of two Normal distributions

Simulations are used to calculate the optimal safety stock for the bimodal distribution. Then, the optimal safety stock is compared against the safety stock calculated using Hadley-Whitin equation. Percentage change in safety stock (PSS) is given by the ratio of the difference between the safety stock values calculated by using Hadley-Whitin equation and the optimal value from simulation to that of the value calculated by using Hadley-Whitin equation.[1]

Results (summarized in Figure 6) show that Hadley-Whitin equation can either underestimate or overestimate safety stock values. The figure plots the simulation results of percentage change in safety stock obtained by increasing the *levels* (or increasing difference between the modes of the two normal distributions) of bimodality created from the mixture of two Normal distributions. The difference between the two modes of the Normal distributions used in the mixture, for the plot shown, ranges from 0 to 28 units. Although the plot shows the result of one set of simulation experiment, running the simulation repeatedly and plotting the results yields the same shape for the plot.

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[1] Hadley Whitin Equation is given by:

$E(\text{Demand over LT}) = E(L)E(D)$; $\sigma_{(\text{Demand over LT})} = \text{sqrt}(E(L)\,\sigma_D^2 + (E(D))^2\,\sigma_L^2)$

where: $E(L)$ = Average lead time ; $\sigma^2(L)$ = Variability of lead time; $E(D)$ = Average demand during one period; $\sigma^2(D)$ = Variability of demand during 1 period; and sqrt = Square Root

Hadley-Whitin underestimates safety stock below a certain level of bimodality and later overestimates as compared to the optimal value. The impact of such distributions is neither consistent nor intuitive. By using both examples in the data as well as simulated cases, it was found that the Hadley-Whitin formula can either overestimate or under-estimate the needed safety stock by as much as 31%. This in turn means that there is no easy fix for determining safety stock if the actual distribution of transit times is ignored. The CTL research team is currently investigating the reasons why this might be the case and how the shippers may improve their safety stock calculations given bimodality.

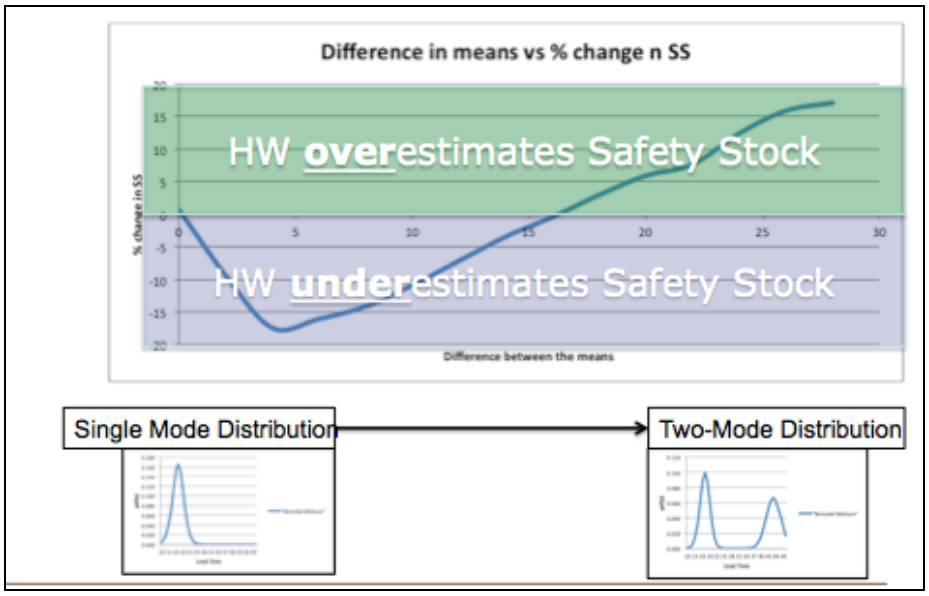

Figure 6. Percentage change in safety stock using Hadley-Whitin equation versus optimal safety stock

There could be a number of reasons for occurrence of bimodality on transit time distributions. Delays such as bumping of ocean freight at the origin port or weekend delays in offloading freight at the destination port could create bimodality. A common characteristic among many (but not all) lanes that do not have unimodal transit times from the available data is that the shipments on the same lane are operated by different carriers. Therefore different mean transit times and the difference in the performance of different carriers may provide an explanation for bimodality. This could also be explained by the fact that some companies handle both high-value and low-value products and use different service levels of shipping that have different transit times on the same lane. Finally, a switch to slow steaming might have resulted in bimodality in transit time distribution. This is possible because the carriers now have the added flexibility to adjust their speeds at their will. In other words they can choose to speed up or slow down to fulfill the requirement of faster transit times or lower fuel costs. The range of speed can thus account for cases of bimodality (or non-unimodality) in the lead-time distribution.

Given that ERP systems assume transit time is a constant, most businesses use the simplest model of using deterministic transit time. Few people think about the variation (and end up assuming a Normal distribution), and fewer still think about the shape of the distribution. Yet the shape of the distribution does impact the results. In particular, bimodal distributions cannot

be accurately approximated by a normal distribution. There is no simple correction for calculating an optimal value of safety stock.

1.3. How much Is It Worth to Reduce Unreliability? Quantifying the Value of Transit Time Reliability in Global Supply Chains

One of the questions raised during last year's roundtable was "How much is it worth to reduce unreliability in my global ocean transportation network?" To be able to answer this question, MIT researchers quantified the reduction in inventory levels that can be achieved by changing transit time variability. For this work, they simulated a year in the life of a global supply chain using data from two large retailers. To achieve realistic results, actual transit time data from a set of large retailers was used for a total of over 300,000 container shipments across more than 200 trade lanes. Seasonality in sales is a big factor in retail inventory calculations; hence, actual sales data from public sources is used to capture the demand pattern over the course of a year.

The researchers calculated what the weekly order-up-to levels should be given the transit times and sales pattern within the course of a year. Then, they simulated five different scenarios: reducing the transit time by 3, 5, or 7 days; or reducing the standard deviation of transit time by either 1 or 3 days. Figure 7 shows the results of this analysis for a particular trade lane.

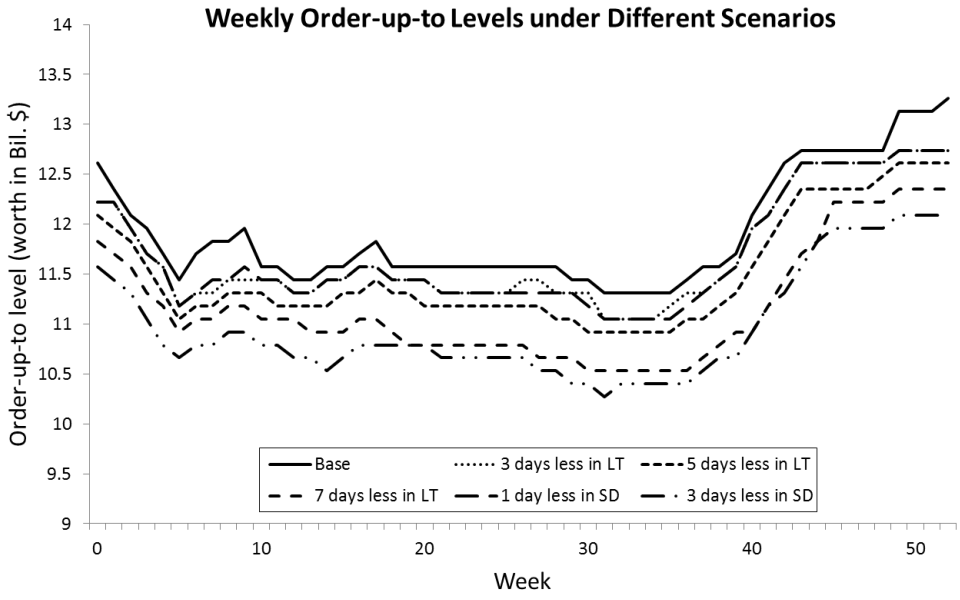

Figure 7. Weekly order-up-to levels under different scenarios for a trade lane

		3 day reduction on average	5 days reduction on average	7 days reduction on average	1 day reduction in standard deviation	3 days reduction in standard deviation
Retailer 1	Average	3.5%	5.9%	8.0%	2.6%	7.7%
	Min	0.5%	2.0%	4.9%	0.0%	5.2%
	Max	8.1%	9.6%	9.9%	9.2%	10.9%
Retailer 2	Average	3.0%	5.0%	6.7%	3.3%	9.3%
	Min	1.2%	2.0%	32.3%	0.9%	7.4%
	Max	6.2%	9.7%	9.6%	5.1%	11.0%

Table 1. Average percent reduction in inventory under different scenarios compared to the base scenarios for retailer 1 and 2 (averaged over the origin-destination pairs)

As expected, the reduction in lead-time and standard deviation both contribute to a reduction in inventory levels. A more gradual increase is observed in the percentage reduction when the variability is reduced (2.6% to 7.7% in retailer 1 and 3.3% to 9.3% for retailer 2). Overall, the greatest savings occurred by reducing the standard deviation by three days (approximately 8 and 9% for retailers 1 and 2 respectively). That produced a comparable to or greater reduction in inventories than did a 7-day speed-up of shipping. In short, *consistent transit times mattered, possibly more than fast transit times*.

The researchers also examined how the characteristics of a route affect the amount of reduction in inventory. They found that reducing the average lead-times pays off more when the transit times are short and consistent. In other words, if the transit times are highly variable, the shippers may not benefit as much from reducing days from their supply chain. Moreover, reducing variability tends to pay off more when the transit times are short and variable.

1.4. Business Case for Lead-Time Variability: When Is It Worth Addressing in Inventory Decisions?

Another key question raised in the last year's roundtable was "When should a shipper worry about transit time variability and address this in inventory decisions?" To answer this question, the researchers compared two possible policies observed in practice against optimal inventory management. Policy I assumes lead time is deterministic and uses the average transit time. Policy II uses the Hadley-Whitin equation described in Section 1.2. This method takes into account the lead-time variability with an inherent assumption of Normally distributed lead-times. Policy I is the most common approach used in practice.

As mentioned above, 46% of participants see a Log-normal distribution of transit times. This is also confirmed with the retailer data used in Section 1.3. Therefore, the researchers assumed that the transit times follow Log-normal distribution for this analysis.

A shipper's decision to consider transit time variability hinges on the tradeoff between holding and shortage costs. This number determines the critical ratio, which is a measure of the optimal service level. When polled, the participants fell into three clusters. Almost half (44%) of the participants had a 4:1 or 5:1 trade-off in overage vs. underage costs which corresponds to a critical ratio of around 0.83 to 0.85. About one-third (30%) had 9:1 or 10:1 cost tradeoffs (critical ratios of 0.90 to 0.92), meaning that they were less tolerant of stock-outs. And one fifth (20%) had 2:1 or 3:1 cost tradeoff (critical ratios of 0.66 to 0.75), suggesting they are less willing to hold inventory even at the risk of stockouts.

As the critical ratio increases, Policy I becomes significantly worse than the optimal policy (Figure 8). How the two policies perform depends on the company's critical ratio and the coefficient of variation of lead-time. If the critical ratio is below 0.7, the company is better off ignoring lead-time variability, regardless of how much variability there is. Above that sharp threshold in critical ratio, companies facing some variability should use Policy II. The amount of variability needed to trigger using Policy II asymptotically declines from a CV of 0.2 at a critical ratio of 0.7 to a CV of 0.05 as critical ratio approaches 1.

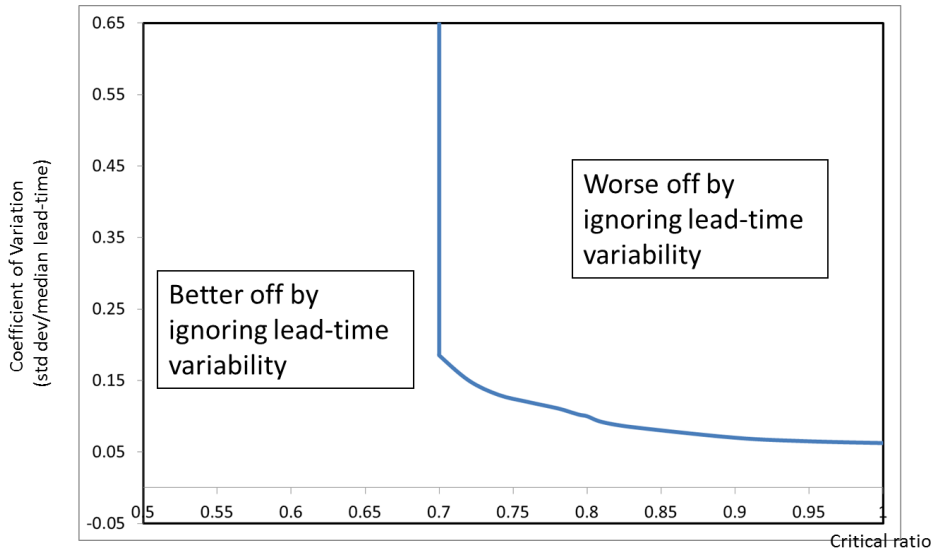

Figure 8. Regions where it is better/worse to ignore lead-time variability

To summarize, research results demonstrated that there is significant variability in global ocean transportation networks. Many factors (even the transportation mode out of a port or specific ocean carrier) contribute to this variability, as shown by transactional shipment data. Variability is closely tied to shippers' inventory costs, and shippers may benefit from reducing variability, even more than from reducing days from their supply chain. However, shippers must be cautious about making direct assumptions on the inventory impacts of variability since the impact depends on the specific inventory policies a shipper uses and even the characteristics of the transit time distribution.

2. Procurement Practices

After the research presentation, the remainder of the day consisted of discussions on three sets of topics. The first discussion covered procurement practices, especially the duration and nature of ocean freight contracts. Shippers' and carriers' duration of contracts was seen as a key indictor of whether ocean shipping is a commodity or whether the companies value long-term relationships with concomitant higher investments in service levels.

2.1. Pros/Cons of Long-Term Contracts

The session on procurement began with a poll on companies' contract durations. The vast majority (80%) of participants used annual contracts. Only 8% have two-year contracts and a mere 4% have contracts longer than two years. The remaining 8% have contracts with less than annual renewals. The widespread use of annual contracts led to debates over why shippers and carriers don't have longer-term contracts and whether ocean freight is a commodity.

Although most companies had annual contracts, some of these contracts were in the context of longer-term legal frameworks or relationships. Shippers might use the same carriers for years or even decades on end but renegotiate the rates annually. As such, the companies have a form of longer-term contract consisting of pre-agreed terms and conditions that gets rolled from year to year. Yet rates are reset each year and sometimes even within the year.

In theory, long-term contracts could be written by including index-driven rate terms or surcharges to reflect the fair fluctuations in the carrier's cost of ocean freight. Yet these types of contracts were surprisingly uncommon. This type of contract requires agreeing on an index. In some cases, the divergent dynamics of different oil price indexes (e.g., WTI vs. Brent) complicate the process. In other cases, a common index such as the Consumer Price Index might have systematic discrepancies due to the differences between consumers and industrial organizations. Even if both shippers and carriers agree on an index, they still have sticky negotiations on the floor value, trigger points, and incremental cost factors.

The group discussed the ideal properties of a good index. First, a good index must be aligned to the carrier's true cost structure so that the index-adjusted rate is both competitive and sustainable. Second, the index must come from a trustworthy source; for example, some worried that the Chinese government might control the Shanghai Index. Third, the index needs to be timely, because too much lag means the index isn't reflecting the current day's cost structure. The result is that a new index takes years to establish by building a track record of accurate data.

The cost structure of the ocean freight industry (i.e., long-lived assets + volatile fuel costs) and the volatility of the economy conspire to create large fluctuations in the market price of ocean freight. Carriers swing from profit to loss on the whims of freight volume, industry over-capacity, fuel prices, and competitors' willingness to undercut each other. Neither shippers nor carriers seem willing to lock in long-term contracts due to a confluence of the cost structure and price volatility inherent in the industry.

Shippers explained that their CFOs see the Drewry's report and want the latest low price for freight. No shipper wants to pay more for ocean freight than their competitors do. Thus, shipping managers don't want to lock in a high price for ocean shipping. Similarly, ocean carriers go through periods of unprofitability, so they don't want to lock in a low price for ocean shipping. Because shippers don't want to buy high and carriers don't want to sell low, neither side seems willing to agree on a single long-term price.

The discussion led to a debate on whether ocean freight was merely a commodity. The shippers' extensive use of short-term contracts and their emphasis on rate renegotiations suggest that shippers are ready and willing to switch carriers at every renewal. Although all shippers insist on some level of service and some shippers value service more than others, price remained a very salient dimension in procurement decisions.

2.2. Port-to-Port & Door-to-Door Trade-offs

Shippers can contract for ocean freight using any of four segment definitions spanning from door-to-port-to-port-to-door. Almost one third (31%) of companies use port-to-port contracts for most of their freight. Using port-to-port contracts lets the shipper control the landside movements of the freight. And about one quarter (24%) use port-to-door. One third (34%) of companies use a mixture.

Only 3% use door-to-port for most of their contracts yet they had interesting reasons for doing so. Companies use door-to-port to help counter ocean freight variability. Door-to-port lets the company decide on the mode of the final leg when the goods arrived at the port. This lets the company make up time if the shipment was delayed reaching the port or to use an economical mode if the shipment was on schedule or did not need immediate delivery. Exporters also sometimes use door-to-port -- from the domestic door to a foreign port -- because that would allow a local broker at the foreign port use their local knowledge for the delivery leg. Presumably, many importers use port-to-door for similar reasons.

Some 7% of shippers use door-to-door for most of their contracts. Two reasons drove the shipper's use of a full-service contract. The first was for handling sensitive goods such as cold-chain. Door-to-door ensured that a single service provider coordinated all the links of the move and minimized the chance of a lapse in temperature control. The second was that door-to-door enabled the carrier to arrange more efficient drayage. Using door-to-door meant the carrier could craft more efficient chassis usage on the pick-up and delivery ends of the container's journey.

2.3. Bidding Platforms

Bidding platforms were seen as simple price competition. Although they serve a role, the group focused their discussion on more complex approaches to procuring ocean freight by expanding the scope of the bidding process. The first approach was global bidding, which expands the geographic scope of the procurement. The second was consortium bidding, which expands the organizational scope of the bidding to include other shippers.

Global bidding can help companies with global supply chains and global distribution. Rather than bid lane-by-lane or even region-by-region, a global bid supports complex efficiencies in the multitudinous inbound and outbound trips to and from many different places. For example, by using global bidding, a shipper might get a discount for arranging a round-trip for reefers to carry fruit from South Africa to UK markets and chocolate from the UK back down to South Africa. To the extent that a shipper's traffic has loops -- even partial loops -- instead of just a unidirectional flow, then global bidding helps the shipper and the carrier create more efficient ocean freight patterns.

There was a related discussion concerning the use consortium buying, which has not worked well in the trucking industry due to disagreements on terms. One participating company used consortium buying following acquisition by a private equity firm. The newly acquired company said that they benefited from the portfolio effects and would do it again. The different companies in the consortium had different seasonalities, and so the combination provided a flatter volume line.

Although consortium buying sounds good in theory, people wondered what happens when something changes or there's a constraint. If there's a shortage of space, which shipper gets it? Or what if one member pulls out of a backhaul agreement? Consortium buying seems more complicated in transportation than in other commodities. One solution to the conflicts of interest within a consortium is to have a neutral third-party intermediary or administrator.

3. Contingency Planning

In addition to routine shipment-to-shipment variations, ocean freight faces larger events such as port strikes, hurricanes, and major changes in the global balance of transportation infrastructure. Both shippers and carriers need to plan for contingencies around these events. In some cases, planning for contingencies leads to permanent changes in day-to-day operations.

3.1. Potential Port Strikes

The vast majority of the roundtable members (82%) thought there would be an East Coast Port Strike in the next six months. Only 9% disagreed. That near-universal awareness of the threat was leading many companies to create contingency plans and to increase inventories. Retailers were especially concerned about summer season shipments, which start soon. Even as companies prepared for an East Coast disruption, they said the clerk's strike on the West Coast was more of a challenge because it was not expected.

Almost everyone (95%) thought the strike would last one week or less. Most (55%) thought it would last one week. The fragility of the US economy would create tremendous political pressure to solve the disruption sooner rather than later. What really scared people was the duration of the aftermath. The 2002 West Coast Port Lockout was only 10 days long but the recovery took 3 to 6 months. Estimates for the impact on the East Coast were that each day of a strike or lockout would create about one week of disrupted flows and recovery efforts.

The group wondered how long President Obama might wait before invoking the Taft-Hartley Act, which would mandate a return to work for an 80-day cooling-off period. With the election secured, the President is not as dependent on union votes. And with the "fiscal cliff" threat to the economy, there will be strong pressure not to jeopardize an already-fragile economy. Yet Taft-Hartley isn't mandatory, so the risk of a prolonged disruption remains.

The overall port labor situation worried people. Companies thought the timing of the late November disruption on the West Coast and the looming threat of disruption on the East Coast were no coincidence. The potential for a two-coast labor disruption is a nightmare scenario. Some participants worried about a potential merger of East and West Coast port unions, which would create a virtual stranglehold on US trade. Yet others thought this was somewhat unlikely due to the large differences in the contracts on both sides.

Companies were planning for various scenarios of the port disruption and looking at the severity, duration and cost of each scenario. One carrier created a 6,000-line spreadsheet that covered four duration scenarios for the potential duration of the event. They considered "what if" the event lasts 1, 2, 6, or 10 days. They modeled port capacity in Canada, the Caribbean, Mexico, and the Panama Canal. They looked at rail capacity and costs for Mexico and Canada. They concluded that not every ship would find a home nor need one. Although some ships will be diverted, others will be stuck in position and wait out the event.

One of the shippers, a retailer, focused on a single scenario. They looked at the "long pole" case of a 10-day labor disruption. They felt that a shorter disruption wouldn't impact them that much,

and a 1-day event or a 3-day event was the same from their perspective. It was the potential for a longer disruption that worried them. Because of the modest cost of goods, the retailer decided to hold more inventory. Not every company did formal modeling. Some just talked through the implications or ran tabletop exercises.

Congestion due to diversions or during a post-disruption recovery period affects some shippers more than others. When everyone tries to get their freight through the system, the congestion causes costs to rise. That can be problematic for shippers with low-margin goods. They must either eat the added costs or wait until other high-margin freight clears the system and transportation costs revert to pre-disruption levels.

3.2. Most Likely Response: Diversion

Diversion was an especially popular strategy with more than half the group (56%) of which 41% plan to divert to other US ports and 15% plan to go to non-US ports. The strategy worked well for the 2002 West Coast Port Lockout as well as during the 2012 Super Storm Sandy. Companies were considering shifting East Coast shipments to Canada, Mexico, and the West Coast.

The carriers cautioned that the diversion might not be viable due to port capacity limits. None of the diversion options is a very large port, and many have limited spare capacity. For example, Prince Rupert has only one open berth per week. If everyone diverts to other smaller ports in Canada and Mexico, those ports will become instantly congested. The Panama Canal is currently congested on both sides, so diverting from coast to coast seems problematic. Ships might take longer to clear the diversion port than to clear their original East Coast port if the labor disruption is over quickly.

Moreover, even if another port can handle the surge in berthing, the surge in containers might face congestion on the land. It's unclear where the diversion ports will get the needed dray chassis, long-haul trucking, and rail capacity to move the containers from the diversion ports to the final destinations. Some worried that if there's a disruption of East Coast ports, then many chassis and empty containers might get locked behind the port's gates and not be available to service other ports.

The second challenge was that diversion to Mexico or Canada would lead to importation issues at the US border. If the company uses a new international entry point, they will be an unknown importer to customs at that border crossing and may incur added delays. Thus, diversion was no panacea due to the potential for congestion, costs, and delays.

Overall, diversion is a big gamble that hinges on the duration of the disruption. If the disruption were short, it would be better to anchor off the original destination port and wait. It's only if the disruption lasts many days or weeks that sailing to a different port and enduring a longer landside route becomes worth the time and money.

3.3. Other Responses

Several companies used a build-up of inventory to prepare for the recent threat of an East Coast Port disruption. They ramped up production to pre-build replenishment stock. They started building inventories early for the holiday and baking season. They told customers about the issue and recommended early ordering to avoid a later stock-out if there was a disruption. In total, 30% of the participants had already started stockpiling.

Several companies noted that they prioritize freight to determine whether to pre-stock or prepare for diversion. For example, customer-critical items (e.g., pharmaceuticals) and high-margin items will take priority over other items. One company avoids the "everything is important" problem among multiple divisions by working through exactly what is needed and when it is needed. Detailing the exact needs helps plan and sequence the alternative transportation modes and routes.

Perhaps the most unusual response was to reshape demand. A retailer alerted their merchants about the disruption. This led to changes in promotions to shift demand from imported goods to domestically produced alternatives.

3.4. Processes for Handling Contingencies

Communications is a key part of the planning and response, according to two of the retailers. In particular, the companies advocated that the supply chain people take a proactive role in communication to insiders and outsiders on the status and recovery of supply chain disruptions. This helps motivate action at the executive level -- getting around mid-level managers who don't get it. Proactive communication forestalls fears among merchants and customers and reduces an inundation of one-off requests for updates. And creating a single coherent story for the handling of the threat or event helps reduce inconsistent messaging and actions.

Coping with crises motivated some companies to create war rooms or command centers to handle the disruptive events. These special temporary facilities bring people together for the duration of a major disruption. The war room supports the special coordination efforts needed to cope with the emergency and supports communications. One retailer's hurricane relief center had 400-500 people in a conference room working the phones. Another retailer created its command center after the unrest in Egypt and has used it half a dozen times since then to handle other disruptions such as Sandy, the Thai floods, and the Japanese tsunami.

3.5. Post-Strike Impact: Contingency Planning and Permanent Change

Companies are making changes to prepare for a strike or to handle a port disruption, and some of those changes might become permanent. Some companies noted that their customers or retail stores boosted inventories with the threat of a strike and Sandy but have not reduced them subsequently. They wondered if people were discovering other advantages to holding a little more inventory or if a permanent fear of volatility has forced a permanent increase in safety stock.

Likewise, diversions might lead to permanent changes in network structure, just as they did with the West Coast Port Lockout in 2002. One firm noted that the 2002 lockout led them to divert shipments from the port of LA to Mexico, Houston, and other ports where they had never shipped. A large portion of that volume stayed in these new ports. Houston, in particular, significantly increased its volume of container traffic in the wake of the lockout.

Companies mentioned four reasons for making their diversions permanent. First, the diversion route might lower the landside distances to some customers (by serving the interior of the US from more than just the extreme western and eastern edges of the continent). Second, some companies are finding attractive prices at alternative ports. Third, some companies are finding good service at the new locations. Fourth, developing relationships at more ports and border crossings will help the company quickly handle other future disruptions. Although adding lanes does add complexity, working on contingency plans has revealed that some added complexity might be worth it.

Developing relationships was especially useful. Creating and executing contingency plans can create or deepen relationships that provide long-term advantages. One of the reasons one shipper maintains some freight through Mexico is to remain on the known-importer lists, which would help in any future disruption through any other port. As one participant said, “you don't wait until your house is burning down to meet with the fire chief.” Another shipper noted that they got priority service in their primary home port during recent disruptions by virtue of being a long-time customer of the port.

The one potential permanent change that companies worried about was a change in expectations. If companies prebuild supplies to help customers, hold extra inventory, or provide extra services either before, during, or after a disruption, then it raises the bar for that company. The next time there's a disruption, people will expect similar service. Yet these additional services do come with a cost that isn't being directly paid if the contingency or response seems to be "free" to those it helped. To the extent that carriers and shippers continue to experience disruptions, they may need to discuss these costs-of-contingencies, both internally and externally.

3.6. Impact of Sandy and Other Events

The early-fall threat of an East Coast port disruption and Hurricane Sandy provided two dry runs for future potential port disruptions. The threat on the East Coast caused some companies to order early and build holiday inventories before the likely date of a potential port disruption. During Sandy, some diverted freight to other ports, and that strategy worked well with only modest delays. Customers changed behavior and have not changed back.

One of the retailers faced issues with the civil unrest in Egypt. The retailer had 800 containers of seasonal goods coming from the country, which was worrisome. The company created a rich contingency plan with a very large number of options. Their plans encompassed many different ports, some up to 200 miles away from their usual choice. Despite the unrest and a strike in Port Said, the plan worked.

3.7. Panama Canal Expansion

The 2015 opening of the expanded Panama Canal could significantly change the balance of East Coast vs. West Coast shipping and change which East Coast ports handle that region's freight. Carriers wondered if shippers were planning any changes to distribution center networks, but the group was silent. Both shippers and carriers are taking a wait-and-see attitude to the Canal expansion. There are too many unknowns at the moment to commit to changes in network design, lane volumes, strings, and so forth.

First, no one knows the future fee structure for the expanded Canal. If the Panamanians try to extract the greatest possible profits from the Canal, then fewer shippers will want to route traffic that way and fewer carriers will offer strings through the Canal. Moreover, the West Coast ports enjoy extensive rail capacity, which offers strong competition to the new Canal.

Second, no one knows the exact capabilities and capacities of East Coast ports. Will the Bayonne Bridge be raised in time to provide the needed air draft for larger ships? Will other East Coast ports have the channel draft and lift facilities to handle larger ships? Will those ports have the land-side infrastructure to efficiently handle a greater container volume? Some carriers are making plans for changes in tonnage strings, but they won't switch them on immediately. Although many have plans and ongoing expansion efforts, shippers and carriers are waiting for more concrete evidence of capacity and cost effectiveness of using the expanded Canal.

4. Shipper-Carrier Relations

The third discussion section covered shipper-carrier relationships. This discussion focused on the use of scorecards to rate carriers (and shippers) as well as various incentives or penalties related to performance. Many shippers expected reliable service as a prerequisite for doing business, more so than as a value-added activity for which they would pay. Carriers were disheartened at the prevailing role of price in ocean freight decisions. Only a few shippers with high-value, time-sensitive freight and a strong market-facing business strategy seemed to explicitly value and pay for the highest service levels.

4.1. Carrier Scorecards

Some shippers use carrier scorecards to rate carriers on performance, to set service expectations, and to focus on specific areas of improvement. Most participants (54%) agree that carrier scorecards are highly effective, although only 9% strongly agreed with this statement. About one third, (32%) were neutral on the statement and some 14% disagreed. One factor for success was not to overanalyze or over-complicate the process. One retailer previously had 27 KPIs for ocean carriers, but have since simplified and streamlined the process.

Carriers said that scorecards are not as prevalent as they should be. Only larger companies -- the top quarter of customers -- tend to use them. Some carriers also provide self-reported KPIs. This lets all customers, including the smaller ones; see some scorecard-like metrics.

Other companies that have lower volumes don't use formal scorecards due to the administrative overhead and the issue of whether the company will really do something meaningful with the data. Yet even companies that don't have scorecards do notice systemic under-performance. In particular, rolling a container is a big negative mark.

Another model for rating carriers was a point-based tier system, which was used by one of the manufacturers. The model is based on the work of the Procurement Strategy Council and assigns points to carriers to score the importance of the carrier to the company. Key variables include: financial health, the number of lanes of service provided by that carrier, the executive engagement with the carrier, and the ease of replacement of that carrier. The tiering is part of the company's Supplier Relationship Management (SRM) efforts. Other companies also used a tiered system and treated some carriers differently than others.

Companies monitor different types of metrics on their scorecards. One category is schedule variables, such as late shipments and vessel schedule integrity (bid vs. actual transit times). A second category covers the availability of containers, space, and chassis. A third category includes administrative performance such as the use of EDI transactions and the accuracy of billed rates. Finally, some companies assess the financial health of the carrier, such as using the Altman Z-score.

Carrier had opinions, too. Carriers didn't like being blindly rated on delayed transits when the delay was out of their control. They felt that some shippers are fixated on the scorecard numbers without ever asking about causes. Yet one shipper noted that they don't weight the transit time

that highly, but they do strongly weight delays without pre-notification. Others expressed a similar sentiment -- being told an accurate delivery date in advance was much more important that getting any particular transit time.

Some shippers were puzzled by discrepancies in shipping times between submitted bid values versus published schedules. Some of the discrepancies arose from seasonal schedule changes. Moreover, there may be differences between the published schedule at the time of the bid versus the schedule in place over the duration of the contract. Carriers also expressed some frustration with bid formats linked to grand alliances. Some bidding systems prevent the carrier from putting in their actual transit time because the alliance's stated transit time overrides it. If a carrier puts in a different number but another alliance member puts in something else, the larger number may override other values.

A few companies also have a reverse scorecard process -- asking the carrier to monitor and rate the shipper's performance. The most important metrics to carriers are the 8-week and 2-week forecast accuracy. Carriers want accurate estimates of future container traffic. Carriers also care about the timeliness and accuracy of payments. These reverse programs are much rarer than carrier scorecards. Even the largest shippers don't ask for reverse scorecards from all carriers, only the top five or so.

Carriers worried about no-shows. Last-minute cancellations of bookings were disheartening. This led to the question of whether shippers hold 3PLs or vendors accountable for missed shipments. Some shippers do give strong feedback to problems with supply chain partners on the pick-up side of the move.

4.2. Incentivizing Carriers

Dr. Caplice asked the group if "the only carrier incentive that works is continuing business?" This stark view of shippers' abilities to influence carriers resonated with many: 36% agreed and 7% strongly agreed. Only 29% disagreed. Discussions after the poll showed that shippers can influence carriers in other ways, even if the opportunity for business or threat of losing business was the main motivator.

Transparency on the scorecard values and other carriers' performances spurs improvements. One retailer sends a rack-and-stack comparison of carrier scorecard performance every week. Carriers get to see all the scores, so they know where they are competitive and where they need improvement. The shipper uses the same process with other transportation providers, not just ocean.

Penalties and cost recovery schemes were not popular among shippers. One shipper reported having tried them but found that the administrative costs were too high. Another company tried charge-backs for vendors with late deliveries and also found the administrative burden to be high. Moreover, they worried that the penalties were probably recycled into higher costs, so that the company ended up reimbursing for the penalty on other ways. Instead, positive incentives seemed to work better.

One carrier noted that most contracts have no teeth. The contracts tend to be nonbinding on the volume terms with neither strong guarantees by carriers to provide long-term service nor strong

guarantees by shippers to provide a minimum volume of long-term business. Given the dynamics of both the shippers' and carriers' businesses, neither side can commit to a year of guaranteed volume. Although carriers and shippers might certainly modulate their opinion of the relationship if the counterparty fails to meet volume expectations, the failure to meet those expectations seldom has legal or financial consequences. This issue further reinforced the sense that ocean freight contracts are little more than rate agreements.

Several shippers reported using awards to publically recognize high-performing carriers. The shipper typically uses objective data, such as the year's scorecard results, to rank the carriers and pick the best. Because the award is tied to the scorecard performance, and because carriers can see their scorecard performance, they have extra incentive to rise to the top. A "Carrier of the Year" award from a respected shipper provides public evidence that the carrier can meet high standards. Carriers said they like the awards but noted that "at end of day, we are here to haul freight and make money."

Dr. Caplice wondered how carrier performance affects bidding and the price that shippers were willing to pay. Did companies use absolute thresholds to knock out low performers, or did they place a relative value on performance? Did companies assign a specific dollar value to scorecard KPIs or other relationship variables like incumbency?

Some companies saw service as the price of admission to the bid. They filtered carriers in an RFI process. Only the carriers with adequate performance could bid, and then price mattered. The shipper picked the most cost-effective carrier from among those with the required level of service. This creates an indirect pay-for-performance phenomenon because high-service carriers don't have to compete with the lowest-cost, low-service carriers.

Some shippers did provide a more direct pay-for-performance relationship. One manufacturing company has an explicit pay-for-performance program. They evaluate their carriers and give them an A, B C, or D letter grade. Any carrier that achieves "A" service levels in quarters two and three gets a pre-defined per-container bonus on all fourth-quarter shipments.

The third strategy was an informal trade-off of performance and bid-price. Although shippers may not have a codified policy of paying exactly $X more for exactly Y% better service, shippers do use discretion in evaluating bids. Objective performance numbers and subjective assessments create wiggle room. Shippers don't just pick the low-bid. Dr. Caplice noted that in trucking markets, analysis of bidding data suggested that service accounted for about 5-12% of price variations. Despite these three schemes, carriers were disheartened that good service doesn't more directly impact the rates that shippers are willing to pay.

Yet some shippers clearly do value service, at least for some of their freight. Both a retailer and a manufacturer mentioned time-sensitive goods and being responsive to market demands, which drove some focus on service, not just rates. Comments by the participants revealed an astounding number of different seasons in different industries: the back-to-school season, the growing season, the baking season, the patio season, and so forth. The potential that freight must be on time or it becomes unsalable means that service does have value.

5. Future Challenges

All participants at the event -- shippers, carriers, and researchers -- continue to work to improve their results. At the start of the day, all of the participants shared their "wins" and their "challenges." The "wins" reflected obstacles overcome and ongoing improvements in performance. Many of the challenges reflected current-day pressures and future uncertainties that affect many in the room. Other challenges were specific to one group or another.

Many noted that there's always something new happening in the world. Volcanoes, tsunamis, port strikes, floods, TSA mandates, etc. Each year brings surprises. Companies knew the East Coast labor situation was shaky, but they were surprised by the West Coast clerks' strike. Volatile gyrations in the interdependent economies in the US, EU, China, and Japan make the entire global trade picture unsettled.

Carriers face an ongoing challenge of achieving and maintaining profitability. Carriers want to retain customers and turn that volume into profits. They seek to keep utilization high in a volatile economic environment. Yet over-capacity in the industry -- with ever-larger vessels being added to some fleets -- continues to be a challenge. Fuel, being the largest single cost to carriers, remains a concern.

Carriers have some flexibility, but at a cost. If transit time reliability is more important than saving fuel, the captain can race across the ocean until they near the destination port and then slow to a comfortable crawl to coast into the port right on time. This strategy ensures the captain can make up for any delays en route. But speed has a cost because fuel consumption increases with the cube of the speed -- sailing just 20% faster consumes 70% more fuel. If saving costs (e.g., fuel) is paramount for the carrier, then the captain will sail more slowly for the entire journey and be more prone to weather delays or other problems. The point is that ships can tailor their speed over the journey to create shorter transit times, more reliable transit times, or lower costs.

The challenges also varied by geography. One manufacturer noted that non-traditional trade lanes have very high variability. Lanes between Latin America and the EU can have transit times that vary between 23 day and 60 days. Another noted the wide variation in origin ports. The ports in Bangladesh are noted to be pretty problematic, for example.

Shippers cited the ongoing challenges of controlling costs, reducing inventories, and reducing lead-time. They are looking for solutions to avoiding higher ocean rates. Carriers vary in their quest for speed -- some want speed to reduce lead-times and inventories. Others have less time-sensitive goods, so speed isn't important to every shipper or for every type of freight handled by some shippers. Yet every shipper seemed to want more consistency and transparency on transit time. "We don't care if it's slow or fast as long as it's on time," said one manufacturer. Shippers worried about uncertainty over carriers' deployment and capacity. Specific shippers also had specific ocean freight challenges such as over-dimensional freight and EPA inspections.

The researchers pointed to the need for more data, especially clean and comprehensive data. More data would help them better understand how ocean freight performance changes and where it might be improved. Key data needs included:

- multi-year data (to look at the effects of fuel price changes and slow steaming)
- data on contract terms (to see how contractual obligations affect incentives for performance)
- origin-side movement data (to assess origin port dwell)
- rail arrangement (to compare on-dock vs. off-dock rail)

The economic drivers of shippers and carriers push both sides toward continuing improvement. Carriers carry freight to serve their shipper customers and get paid. Shippers ship freight to serve their retail and commercial customers and get paid. Both sides seek efficiencies, competitive advantages, and an economic return on their investments and efforts. Against these simple goals are arrayed the capricious forces of global economic trends, energy prices, natural catastrophes, and man-made disruptions. By understanding the incentives, options, and disturbances in the ocean freight industry, carriers, shippers, and researchers will better understand how to steadily increase performance for everyone.