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**Workshop on Building
More Resilient
Supply Chains**

April 11–12, 2023
Washington, D.C.

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Workshop on Building More Resilient Supply Chains

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Preface

The recent COVID-19 pandemic highlighted the significant consequences that can result from disruptions in supply chains. The massive disruptions that occurred because of the pandemic were the result of a “perfect storm” from several events. From panic buying to increases in demand for goods and e-commerce from home-bound consumers, to stalled port operations, and labor shortages, disruptions can cause ripple effects throughout the economy and severely impact individual pocketbooks and stress levels related to uncertainty. These events added stress to an already stressed supply chain system. As a result, there was a demand shock on the system leading from increased imports that led to increased congestion that was difficult to quickly address. These significant disruptions to the supply chain raised awareness that more needs to be done to make supply chains more resilient to uncertainty. Redundancies can help make supply chains more resilient, but as this workshop shows, there are other strategies, including stakeholder collaboration and communication, data-sharing, and workforce development initiatives, which can further bolster the success of supply chains.

The Transportation Research Board (TRB), with support from Federal Highway Administration (FHWA), hosted a workshop focused on strategies and innovations to build more resilient supply chains. The Workshop on Building More Resilient Supply Chains was held April 11–12, 2023, at the Keck Center of the National Academies of Sciences, Engineering, and Medicine in Washington, D.C.

The workshop brought together private freight and supply chain professionals, public agency personnel, academics, and other key supply chain stakeholders to explore and learn about building more resilient supply chains. The workshop included presentations focused on key innovations implemented since the pandemic and what vulnerabilities still remain. As a result of the discussions, a central theme emerged that supply chain resilience has a temporal dimension, meaning that the time in which action is taken to address supply chain resilience can occur at several different points in a disruptive event. While some adaptations and innovations to address supply chain resilience can be implemented before a disruption, others are needed during a disruption, and it is still important to consider adaptations and innovations after a disruption. Another theme that emerged is that communication and collaboration are critical when addressing, planning for, and enhancing supply chain resilience.

TRB assembled a planning committee to help organize the workshop program. Joseph Schofer, Northwestern University, chaired the workshop. Committee members provided expertise in supply chain operations, community partnerships and initiatives, stakeholder collaboration, and innovative supply chain management platforms and technologies.

The workshop attracted approximately 80 attendees, including those from businesses and corporations, federal agencies, state departments of transportation, metropolitan planning organizations, universities, consulting firms, and other key stakeholder groups.

TRB thanks Alison Conway, City College of New York, and Monique Stinson, U.S. Department of Transportation, who served as peer reviewers of this document.

This document presents the discussions and presentations from the workshop. The views expressed in the circular are those of the individual workshop participants, as attributed to them, and do not necessarily represent the views of all workshop participants, the workshop planning committee, or TRB.

Contents

In Memory of Tom Palmerlee.....	1
Introduction and Welcome.....	2
Keynote Presentation.....	3
The Supply Chain Issue—How It Was Resolved and How We Can Improve It in the Future ..	3
Panel Discussion Summaries.....	8
What Do We Need from and for Tomorrow’s Supply Chains?	8
What Adaptations Developed in Response to COVID and Other Recent Supply Chain Disruptions Have Taken Root? What Processes Are Worth Sustaining?	17
New Supply Chain Partners: Engaging Local Leaders to Make Supply Chains Work for Communities	21
The Freight Community: Freight Logistics Community Systems Opportunities and Challenges Ahead for Supply Chains	25
Workshop Wrap-up.....	33
Appendix A: Agenda	35
Tuesday, April 11, 2023	35
Wednesday, April 12, 2023	35
Appendix B: Abbreviations and Acronyms.....	36

In Memory of Tom Palmerlee



Thomas "Tom" M. Palmerlee was born on July 21, 1941, in Lawrence, Kansas, and passed away on April 7, 2023, in Washington, D.C. after serving as staff director for this workshop. He was an Associate Director of the Technical Activities Division at the Transportation Research Board (TRB). Prior to joining TRB, Tom was executive director for the University Consortium for Geographic Information Science (UCGIS), and for the Urban and Regional Information Systems Association (URISA). He served as a legislative assistant and legislative director for U.S. Senator Malcolm Wallop of Wyoming. Tom was a Captain in the United States Marine Corps in Vietnam. He joined TRB in 1998 as a Senior Program Officer (SPO) in the Technical Activities Division, eventually supporting 31 groups, sections, committees, task forces, and many conferences and workshops. He also served as TRB staff liaison to 23 Cooperative Research Projects.

As a TRB SPO, Tom Palmerlee was a connector, linking people and ideas to advance data applications in transportation, and to bring diversity to the field. He was a mentor, coach, partner, and friend to hundreds of TRB volunteers and transportation leaders across the nation. His efforts made TRB volunteers work hard, work well, deliver, and enjoy their experience. It was Tom Palmerlee who made their contributions to TRB and transportation worthwhile. He is missed.

Introduction and Welcome

JOSEPH SCHOFER, *Northwestern University, Planning Committee Chair*

The pandemic and other disruptions caused by natural and market factors have led to important innovations in supply chains. The purpose of this workshop is to explore what the industry has learned since the pandemic and how different adaptations and innovations can lead to more resilient supply chains. The workshop will focus on operational and organizational changes, new collaborative efforts, and insights into the future of more durable and sustainable supply chains.

Joseph Schofer welcomed participants to the Workshop on Building More Resilient Supply Chains. Schofer covered the following topics in his welcome:

- Schofer began the workshop by recognizing that April is Supply Chain Integrity Month, so the workshop occurred at just the right time.
- Schofer recognized Jeff Purdy from the Federal Highway Administration (FHWA) for ensuring the workshop came together. He also recognized the planning committee members and TRB staff, including Scott Babcock and Rhonda Levinowsky, for helping to organize the workshop. Schofer also expressed gratitude for Tom Palmerlee's early efforts in planning the workshop. Tom was a dedicated mentor and leader, who was able to get volunteers to strive in TRB efforts, including this workshop. Tom Palmerlee passed away on the Thursday before the workshop.
- Schofer stated that the goal of the workshop is to bring together experts to share what the supply chain sector needs to learn moving forward, as well as some of the things that did not work so well. It is also important to consider what the research needs are moving forward, as research is continually important to develop strategies and solutions to supply chain disruptions. The final goal for the workshop is to determine where needs remain to advance supply chain resilience.
- Schofer expressed his honor to have General Lyons (retired) join the workshop to discuss efforts to reinvigorate the supply chain.

Keynote Presentation

THE SUPPLY CHAIN ISSUE—HOW IT WAS RESOLVED AND HOW WE CAN IMPROVE IT IN THE FUTURE

GENERAL STEPHEN R. LYONS (retired), *White House Supply Chain Disruptions Task Force*

Overview

General Stephen R. Lyons (retired), Port and Supply Chain Envoy, provided an overview of the challenges faced by supply chains during the pandemic and the ways the industry resolved these challenges. After Lyons retired from the U.S. Transportation Command (TRANSCOM), the Biden Administration appointed him to the White House Supply Chain Disruptions Task Force to reinvigorate the nation's supply chains. While at TRANSCOM, he played a critical role in deploying and sustaining the military. Lyons' keynote presentation, detailed below in his own words, provides insights into the adaptations and innovations that the industry has implemented since the pandemic and what the industry can do to build more resilient supply chains.

The Supply Chain Issue

It has been a rough couple of years for trade and supply chains. While not all of the problems that arose during the pandemic have been resolved, it is easier to talk about supply chains this year compared to last year when there were still a lot of bottlenecks and congestion. There were underlying issues affecting supply chains before the pandemic and the pandemic exacerbated many of these issues, but the demand shock that occurred as a result of the pandemic was massive and that created enormous congestion.

To fully understand the supply chain issue, it is critical to consider three key points: 1) what were the root causes of the pandemic-induced supply chain disruptions, 2) what were the consequential impacts on consumers, and 3) what insights can be drawn about how to strategically keep supply chains resilient and reliable?

Root Cause Analysis

The pandemic halted supply chain activities, along with the entire economy. Manufacturing times slowed down as businesses faced COVID outbreaks and other pandemic impacts, such as schools closing. As panic buying ensued, consumers severely lost their confidence in the market and supply chain. This raised significant challenges throughout the supply chain and the economy. It was a shock to the economic system that individuals were woefully unprepared to handle. As a result of the increased uncertainty, people had "staycations" and spent money on home improvements instead of spending money on the travel, retail, and restaurant industries.

Record freight volumes were moving throughout supply chains. However, supply chains had already developed into lean systems, so they were unable to handle the sudden and unexpected shift in demand. While transportation systems possess some inherent resiliency, I don't know of any investors that are willing to fund 30% excess capacity just in case an unpredicted shock might or might not occur in their lifetime. As a result, significant levels of

congestion began appearing throughout supply chains. Once supply chain nodes are at the highest levels of capacity, the only way to recover is to rebalance the market.

Since the pandemic and rebalancing, consumers and supply chain stakeholders are quick to ask if the system is ready for another disruption. They want to know what level of investment is going to ensure that future disruptions do not have as devastating results, even if the pandemic was the type of event that may not happen for another fifty years. Consumers and supply chain stakeholders want to know that the industry is considering and implementing resilience and reliability strategies to avoid future catastrophes.

Consumer Impacts

Due to the level of consumer demand and the congestion across supply chains, some players became very rich and others paid dearly. The Biden Administration got a lot of credit early on in the pandemic due to the executive order to evaluate the nation's supply chains and the prompt creation of the White House Supply Chain Disruptions Task Force. John Porcari began work and began collaborating with key stakeholders. The Bipartisan Infrastructure Law (BIL), the Creating Helpful Incentives to Produce Semiconductors (CHIPS) Act, the Ocean Shipping Reform Act (OSRA), and the Inflation Reduction Act (IRA) changed the focus and highlighted the importance and need to get back to normal. There were other collaborative efforts at play that supported supply chain efforts, such as the Biden Administration's facilitation of the resolution of a 3-year rail labor dispute.

It is important to separate the pandemic demand shock from pre-existing supply chain issues, of which there were plenty. There is currently a lot of attention on freight rates and rightfully so. According to the International Journal of Money and Finance, every time the price of a container doubles, it adds more pressure on the consumer—approximately a 0.7% increase. However, that was not the primary driver of pricing and inflation.

Managing supply chain operations in a chaotic market is critical for a business's reputation. As a result, supply chain managers began to focus on how they were going to calculate delivery times. It is an impossible area to work in when the market is chaotic. As a result, supply chain managers began to stockpile inventory, often paying higher prices to ensure they had the inventory on hand. This resulted in a 6–8% increase in unforeseen costs that had to be passed on somewhere. There is a lot more work that needs to be done to understand how this process played out and what could have been done to mitigate it. Unfortunately, given the complexity of supply chain ecosystems, once you get behind, there are no quick fixes to the gridlock created by bottlenecks. Adding more ships doesn't get them unloaded any faster. Adding more crane operators only works if there is room at the terminal to stage the containers. Railroads can only absorb as much freight as space allows at inland terminals. As distribution centers reached 99% utilization rates, truck chassis became temporary storage units tripling street dwell times and negating the principles of freight fluidity. Once you are buried in freight, restoring fluidity takes time and only occurs when supply and demand are brought back into balance. This occurred in late 2022, largely driven by a softer market that provided the opportunity to catch up.

Strategic Moves Forward

Currently, the market is experiencing softer demand. It is not clear how long it will take to get back to normal. For many years, we have underinvested in our infrastructure. Significant improvements are urgently needed to infrastructure, which can help lead to more resilient supply chains.

There also needs to be recognition and understanding of product sourcing processes and what role our defense strategies play in protecting supply chains, especially with competitors such as China. This is not to say that we should stop sourcing products and components from China, but it may make sense on the margins to evaluate the impacts of sourcing decisions, such as the impacts on pharmaceuticals and processing chips. We need resilience in these critical supply chains.

Visibility is a critical aspect to consider. We need to do better about seeing what is happening throughout the nation's supply chains. There were more than 109 ships in southern California's San Pedro Bay before anyone realized there was a critical issue in the supply chain. The Department of Defense has dependencies in place to make sure the military can navigate the transportation sector at any given point. Sadly, in the maritime sector, the United States has lost its edge. However, what steps are we willing to take to put the United States back in the driver's seat as a port and maritime leader?

There is a lot of potential within supply chains. Vessel speeds are increasing, and we are navigating carbon reduction at a swift pace. The pandemic impacted every mode. It will be a matter of time before supply chains bounce back and we need to think about how these challenges will shape the future of supply chains.

Discussion

After Lyons' keynote address, a variety of attendees posed questions to him. These questions (Q) and answers (A) are detailed below.

Q: It is interesting to hear about your background at TRANSCOM and the dependencies that the DOD (U.S. Department of Defense) has in place for the military. Considering the challenges occurring at our southern borders, if the military is able to ensure that they can move throughout the transportation sector, why can't more be done to move trucks across the border and reduce congestion?

A: It is all about keeping freight in motion. There are challenges with bottlenecks at the border and the need for U.S. Customs and Border Protections inspections. It was exciting to hear about the Canadian Pacific and Kansas City Southern merger, which indicates that there may be a shift to manufacturing in Mexico as opposed to China. The border needs to go through an evolution to move from outdated practices. It is unclear what exactly is causing border congestion, especially from a security aspect.

Q: What can departments of transportation (DOTs) and operating agencies be doing day-to-day to impact supply chain resilience besides the investment in infrastructure?

A: Private sector decision-making at the public policy level. There are some areas on the margin where the government has an interest in making sure that we are not too dependent on one country. There is a need to diversify product sourcing. If countries overseas are manufacturing containers, that is another issue to contend with in the United States. It can be a double-edged sword. It is not always helpful for the government to overstep, but government could implement legislation to drive and motivate private investment. However, we must be very cautious in implementing legislation to fix last year's problems, as they may not be the same problems today.

Q: On a tactical level, as we unwind the complexity of a port area—from the key through the terminal to the near dray and warehousing—how can we best position resources to be of assistance? What have you learned or what is the research need? Do you have any insight?

A: At the port level, we knew there would be a rebalancing eventually. There was concern that there would be a downtrend. We do not want to miss an opportunity to address needs. Different ports have different needs. For example, Savannah looks completely different from Los Angeles/Long Beach. There is a need to look at queue times and determine if there is fluidity. There is still massive room for improvement. Different stakeholders own different parts of the ports, which can add more challenges to the complexity. It is not always the market forces impacting decision-making. At a strategic level, we need to consider energy and consider the end state of the supply chain process. Sourcing is a critical consideration.

Q: There are several initiatives at the federal level, such as the Freight Logistics Optimization Works (FLOW) program. How can we push these efforts down to the state and local levels? What models are available that accomplish that goal?

A: It would be good to get more initiatives happening at the state and local levels. Some states have done better than others. Some models work better than others. However, state-level initiatives really cannot have an impact at the national level, so there are challenges there with motivation. We need to look at the national economy. There are definitely research needs here. For example, we could look at the railroads. Could there be incentives that could encourage them to improve their level of service? There are areas of interest that can drive private incentives and lead to better outcomes for the overall national economy.

Q: Looking to the future, considering the exercises and testing strategies the private sector does, what are the timelines and how far into the future is it worth planning for as it relates to infrastructure needs and disruptive events?

A: There is no definitive answer. There are regional disruptions that happen every day and supply chains are pretty resilient to those events. The military runs tabletop exercises to prepare for military action, but they hope to avoid military action if they can. In general, there are a lot of resiliencies in those cases. One exception relates to cybersecurity. Information technology is consequential and requires a lot of investment to secure. It is a huge ecosystem, and everyone approaches it from a different angle. States and ports are generally trying to plan for ten years out.

Q: Related to the funding of infrastructure at the public and private levels, just-in-time manufacturing systems are great for the private sector, but they can put more strain on the

transportation infrastructure. Since the efficiencies are being realized by the private sector, should the private sector be more involved in infrastructure funding and improving the transportation system?

A: I am in favor of private investment, but there has been some pushback from the private sector receiving federal money—railroads for example—because they do not want the caveats that come with federal money. There is a public good and there needs to be a balance. Maybe funding matches are a solution. I think transportation organizations should compete in the free market. The challenge is that they will, and it is naturally cyclical, but we are on the downside of the cycle right now.

Q: Related to maritime assets and obtaining containers, getting them domestically can drastically increase costs. How can we compete with that type of financial investment requirement and build strategic importance?

A: We cannot just add more containers and chassis. The problem during the pandemic was that it just was not moving. When you are in the position to make investment decisions, what do you base them on? In the maritime space specifically, except for Jones Act ships, there are no ships built domestically. Ships are built in South Korea. However, technology advancements could bring shipbuilding back to the United States, but it has to make sense cost-wise. There is a need to consider what is economically feasible. It is not going to be driven by congestion at the ports but by relations overseas.

Q: What do you need to know about the future that you do not know now? What are the research or data collection needs?

A: I would need another hour to answer that. It would be helpful to have modeling capabilities that can look at supply chain performance and forecasting. We do well from a modal aspect, but not in relation to the entire system. I would like to see more digital twins outside of the boundaries of a terminal or something like that. At that point, you begin to dial variables back and understand the implications. Not just about how long the queue is, but we also need to consider if we are investing to keep pace with economic prosperity. At a strategic level, there is still a lot of work that needs to be done, but we need policy to drive that.

Panel Discussion Summaries

WHAT DO WE NEED FROM AND FOR TOMORROW'S SUPPLY CHAINS?

MATT HAUBRICH, *Iowa Department of Transportation, Moderator*

Overview

This panel discussed how future supply chains can better prepare for supply chain disruptions by addressing impacts on the truckload market and workforce, as well as what innovative methods stakeholders can consider in preparing for challenges within supply chains.

JASON CRAIG, *C.H. Robinson*

C.H. Robinson is one of the nation's largest third-party logistics providers (3PLs) and they deliver several logistics services, including but not limited to truckload, less-than-truckload (LTL), intermodal, ocean, air, and last-mile shipments. C.H. Robinson does not own any freight equipment; instead, they manage the supply chain process. They own a handful of intermodal containers to access some of the rail lines, but they do not own the wheels or any chassis. They move truckload freight, are a forwarder of ocean freight from China to the United States and have a large LTL network in North America.

Market forces, such as supply and demand, have significant impacts on the nation's supply chains. If the market is tight, it can be challenging to find the proper equipment to make deliveries on time (i.e., demand for deliveries is greater than the supply of shippers). If the market is loose, everyone is looking for a load and there are more shippers trying to secure deliveries than there are deliveries available (i.e., demand for deliveries is lower than the supply of shippers). There is generally a lot of focus on the impacts of demand on market forces, but other factors can also have impacts on the market forces, including weather, infrastructure, labor, and the economy. As a result, there are constantly evolving influences on the supply chain system.

The truckload capacity in the United States is highly fragmented and anonymized. Federal Motor Carrier Safety Administration (FMCSA) data can highlight this fragmentation. FIGURE 1 shows the fragmentation of the truckload capacity based on 2021 FMCSA data. In 2021, there were 404,185 for-hire motor carriers and 1,734,680 truck tractors making up the market. There are generally three common structures in supply chains:

- **Direct to Carrier Pool** occurs when shippers work directly with the carriers to make deliveries, generally occurring when shippers tend to be smaller.
- **Core Carrier Program** occurs when shippers bid out deliveries to a core group of carriers, generally occurring when the shipper is larger.
- **Outsourcing** occurs when shippers contract with 3PL companies to identify qualified carriers for the deliveries.

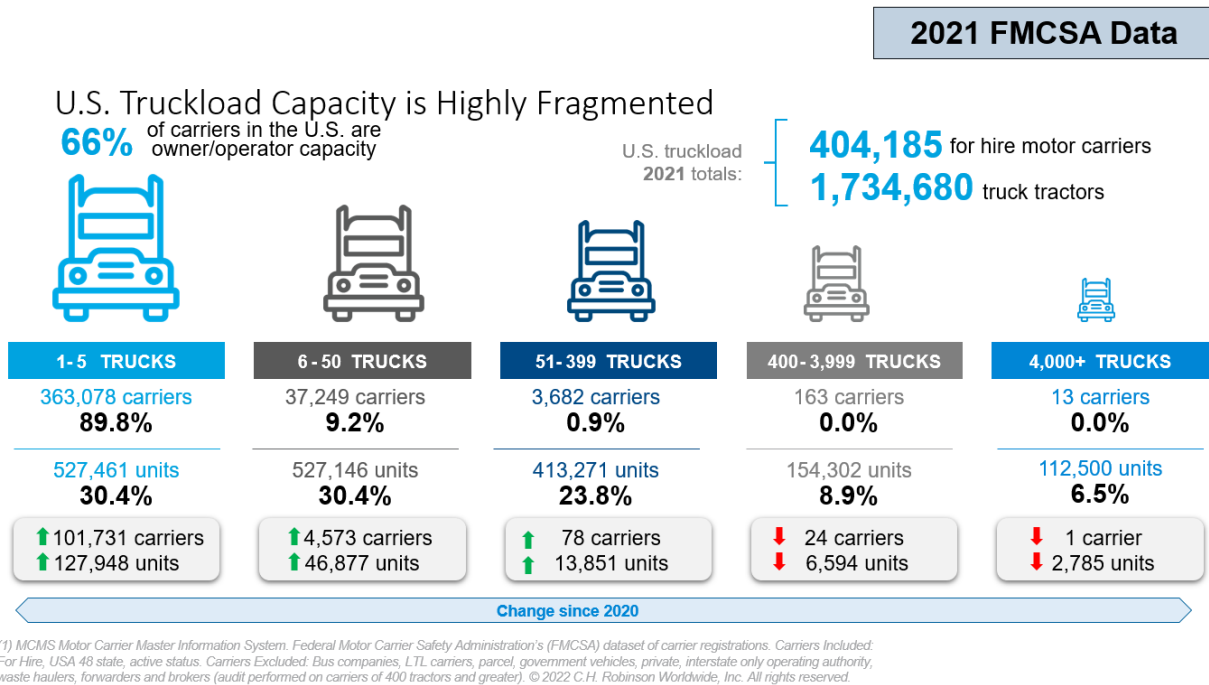


FIGURE 1 2021 U.S. Truckload Market Fragmentation.

There is a cyclical pattern to how the truckload market fluctuates over time. FIGURE 2 shows the cycle that often occurs in the truckload market. As of April 2023, the market had excess supply, which can lead to changes in deliveries or even canceled deliveries. While the market attempts to bring balance, generally prices bottom out. In the past 10–15 years, there have been several trends in the truckload market, including:

- Centralization of supply chain management and an increased focus on best practices, including route guides and automated services.
- Increased importance of supply chain knowledge and understanding in the C Suite, including the creation of Chief Supply Chain Officers and the shift to logistics departments being the primary decision-makers instead of the sales or production departments.
- Increased focus on de-risking within supply chain processes. De-risking is a term being used more and more and one that General Lyons alluded to. It includes “friend-shoring,” looking at where you are sourcing products and not being dependent on one or two sources, and looking at geopolitical and sustainability risks.

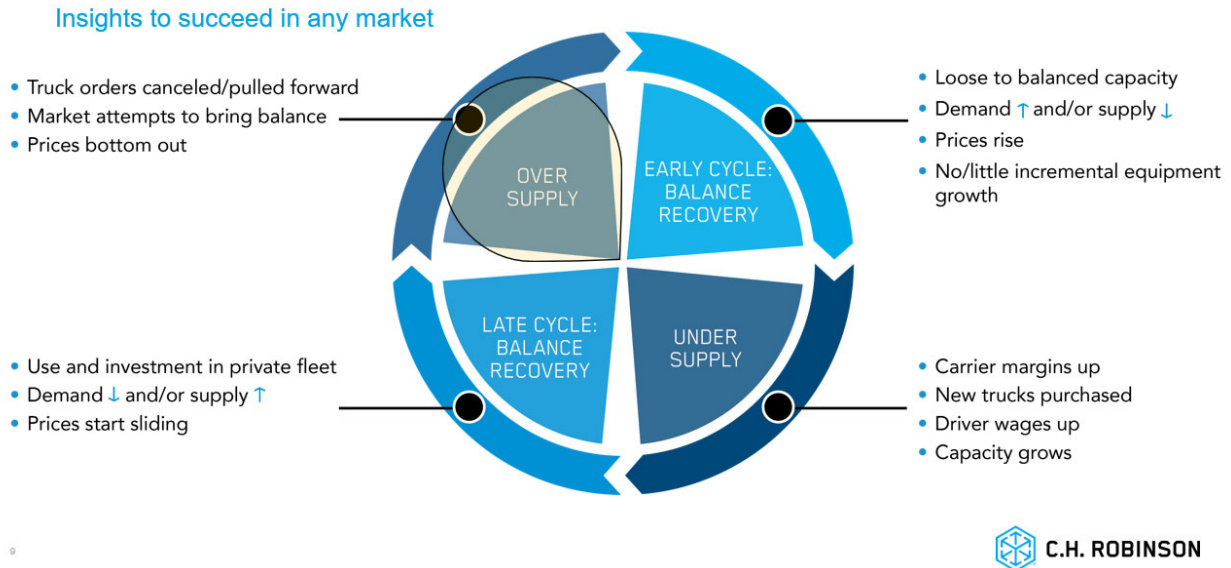


FIGURE 2 Truckload Market Cycle of Impacts.

MIKE STEENHOECK, *Soy Transportation Coalition*

Supply chain processes are complex, which is why using a simple metaphor of a track relay race and the passing of the baton can help explain the complex nature of supply chains. The supply chain can be compared to two of the runners in the relay in the process of exchanging a baton. If the second runner is waiting for the baton exchange and looks back to see the first runner falling on the track, there can be several possibilities of what will occur next. What caused the first runner to fall down? Will the first runner get back up and continue the relay? Or are they injured and unable to get up?

That same uncertainty of not knowing what is happening in the previous leg of the journey has also happened in supply chains. This uncertainty has posed significant challenges throughout the economy. While some of the more cyclical challenges to impact supply chains were known, other challenges impacted supply chains, including the pandemic, weather disruptions, economic conditions, political unrest, energy scarcity, and labor issues. These challenges posed a lot of anxiety in the industry. Many people do not understand what it takes to get products through supply chains, including the time, cost, and distance needed to get goods from point A to point B. Supply chains need to be predictable and reliable in order for shipments to move efficiently.

Resilience in supply chains is critical for efficiency. It is human nature to be reactionary. Another metaphorical way of thinking about resilient supply chains is to consider a sport like boxing, which can be very reactionary. What makes a boxer resilient enough to win a fight? There are three reactionary moves in boxing that can also help in understanding how supply chains can become more resilient.

- **Slipping the punch:** In this move, stakeholders anticipate the problem and can define where the attacks are going to come from. There is a large amount of preparation, forecasting, communication, and innovative design. Supply chain stakeholders cannot put all their eggs in one basket—they have to be forecasting upcoming attacks and conveying that information to whoever else needs to know about the attack. For example, the federal government might know where the punch is coming from for supply chains, but that information may not always make it down to the local stakeholders who need it to make decisions.

- **Taking the punch:** In this move, supply chain stakeholders take a hit, such as with a disruptive event. Supply chain stakeholders have to consider to what extent the preparation for the fight might hurt. Boxers do sit-ups and other training exercises to prepare for the fight. This preparation can lead the boxer to take the hit better so that it does not stop the fight. The same is necessary for supply chain resilience. Are supply chain stakeholders considering innovations, materials, and other methods that can help them prepare to withstand catastrophe? While doing the work and putting in the time to prepare might not be pleasant, it can help prepare the fighter to take the punch and keep fighting.

- **Getting up from the canvas:** Using this common boxing terminology, in this move, a fighter—or in this case the supply chain stakeholder—can leave the fight and go recover. However, an important consideration is how long the recovery will take. For supply chains, it is not just about money. The government can come in and provide support but coordinating that support can take time. It does not do a lot of good if it took too long for help to arrive. That can be the problem with supply chains. If we need to surge up, then we need to do it quickly. Oftentimes, we don't do it that quickly. As a result, it can take even more time to recover. What can supply chain stakeholders do to accelerate and expedite the recovery phase?

Preparing for a fight when it comes to supply chains can be costly and time-intensive, but the best time to respond to a catastrophe is before it occurs, rather than after. Advanced preparation can lead to expedited recovery and long-standing resilience. Stress testing supply chain processes, preventative maintenance, and creative financing are additional methods that can lead to increased supply chain resilience. More redundancy, planning, and preparation can lead to fewer problems in the future. Think of an annual physical with your doctor: The preference is to have a “boring” appointment where the doctor does not identify a lot of issues. Supply chains could stand to be a little more boring.

BOB COSTELLO, *American Trucking Associations*

The industry has been discussing the driver shortage for a long time. However, it ebbs and flows. The driver shortage problem is primarily an over-the-road (OTR), for-hire, truckload problem. While LTL, private fleets, and even local truckload drivers may seem easier to find, these industries are also beginning to see the impacts of the driver shortage. The fact that Walmart is offering a \$100,000 signing bonus highlights that there is a driver shortage problem.

The American Trucking Association supports the Drug and Alcohol Clearinghouse, and it is reducing driver violations. However, drug violations are a critical factor impacting the driver shortage issue. As of January 2023, 120,345 drivers were in prohibited status with at least one violation. Of those drivers, 91,523 are not even attempting to return to driving. If driver drug offenses continue to increase, this will cause continued stress on the labor market. Another factor impacting the driver shortage is accident records. When there is a major commercial vehicle

accident, the lawsuits can be very costly. For this reason, a lot of companies will not hire drivers that have a poor driving record, as it is too risky. It is better for these companies to hire less-experienced drivers that have a clean record. The driver shortage problem is not unique to the United States.

There are additional challenges to the driver shortage, including demographics and lifestyle, truck parking, and waiting times at shippers and receivers, among other factors. Some of the proposed solutions that stakeholders can consider to alleviate the driver shortage problem are as follows:

- **Adding more female drivers.** Female drivers make up approximately 7–8% of the U.S. truck driving industry, which is one of the best in the world. In Europe, females only make up 3% of the industry.
- **Lowering the minimum age for Interstate drivers.** The average age of drivers in training programs is 30–35 years old. This is a direct result of the fact that Interstate truck drivers must be 21 years old in the United States. In Europe, they have lowered the minimum age to 18 years old without a pilot program because they are facing similar driver shortage problems.
- **Addressing congested and inadequate truck parking.** Truck drivers must park by the time their hours of service (HOS) run out. Many truck drivers are parking early—even if they have HOS remaining because they are worried they will not find truck parking when and where they need it. When truck parking is unavailable, it leads to truck driver concerns about where they can safely park. The safety concerns, along with a loss in productivity, are causing drivers to leave the industry because they do not want to wait to make deliveries or face challenges finding safe parking.

Driver pay is expected to continue to increase as a market reaction, but increasing pay alone will not resolve the problem. The industry must address quality-of-life issues. Drivers want to be home more and drive less. In 2021, the industry had a shortage of 80,000 truck drivers. While the truck driver shortage fell to 60,000 in 2023, it is expected to rise to 160,000 by 2031 if the industry does not make some changes.

CHRIS ZOBEL, *Virginia Tech*

Supply chains are complex and face several challenges because they have many interconnected and interdependent networks. The breadth and scope of disruptions on supply chains have been increasing. However, the impacts of these disruptions extend beyond just the physical supply chain. For example, when there is a snowstorm, it is known that the supply chain will recover, but stakeholders also need to consider the downstream impacts. Different solutions need to be available for the different disruptions.

Another aspect that stakeholders need to consider is the impact on communities. For example, the downstream impacts of supply chain disruptions also impact communities, so they too need to be resilient to supply chain disruptions. The pandemic had several supply chain-related impacts on communities, including the loss of access to food, healthcare, and education. The government is responsible for the population's well-being and one way that they could mitigate future disruptions is by considering public-private partnerships to help with humanitarian relief.

Resilience is needed to mitigate and alleviate the impacts on supply chains. Resilience can address the technical, organizational, social, and economic aspects of supply chain disruptions and help them recover. Resilience has several dimensions. What can be done about disruptions and how can resilience be measured? Ultimately, supply chain resilience can be characterized by how much loss occurs as a result of the disruption and how long it takes the supply chain to recover.

Measuring resilience can be challenging, but measuring the demand shock and having access to good data can help evaluate the disruption and prepare better for future events. To assess supply chain resilience and how well the supply chain is functioning, stakeholders must measure impacts over time to evaluate how quickly it can bounce back. It is also important to consider the impacts at the community level because disruptive events can lead to impacts beyond just the supply chain itself, including the social, economic, and health dimensions. There are many different levels that we can consider and try to improve resilience. We can measure the impacts on the supply chains as well as on the communities that are served by the supply chains. The question is how we measure the impact at the community level, which can be tricky because many times these measurements are more qualitative in nature.

There are several strategies and technologies that stakeholders can implement to improve supply chain resilience. Some of the more common strategies to increase supply chain resilience include hardening physical capacity, increasing inventory, relocating production, utilizing more common components, improving supply chain visibility, increasing production flexibility, improving financial and operational capacity, and building redundancy into the supply chain. Technology advancements can also improve supply chain resilience and improve the efficiency of supply chains. Some of these technological advancements include using automated manufacturing, 3D printing, digital platforms and cloud technology, improving real-time data and metrics to increase supply chain functionality, and taking advantage of advanced analytics and machine learning to improve routing, scheduling, and evaluation.

One of the critical needs to improve supply chain resilience is access to more accurate and timely data across different dimensions of supply chains. This data can help provide better visibility, flexibility, and control of supply chains. Access to better data will help stakeholders to get a better handle on the complexities of supply chains and lead to continuous improvement for everyone, including communities.

STEVEN HUSSAIN, *Prologis*

Prologis developed a Community Workforce Initiative (CWI) that aims to bridge customer and community needs. The intent of CWI is to develop a training facility in communities of need to focus on job training efforts in transportation, distribution, and logistics. There are jobs that companies need to fill, and there is a need for appropriate career training opportunities for the people that need them, where the jobs are located. This is especially true since there is a lack of general understanding about the opportunities available in the industry. Prologis has a goal of training 25,000 individuals around the world through CWI for jobs in transportation, distribution, and logistics by the end of 2025.

One of the challenges for jobs in the transportation, distribution, and logistics sector is that it is very complex with stakeholders at all levels. The federal government, state government,

schools, private industry, and other nonprofit partners all need to work together to succeed in developing training opportunities and improving workforce development in communities. The stakeholders can also change from community to community, which can add more challenges.

The stakeholders involved in CWI have several common goals, including enrolling 10,000 learners over 24 months in the Prologis Learning Academy, supporting an average per learner course completion of five courses, and placing 5,000 individuals in quality jobs in the transportation, distribution, and logistics industry over 24 months. To accomplish these goals, CWI is using performance-based funding to implement programmatic activities, digital marketing to drive recruitment, two-way messaging to keep learners connected and motivated, a virtual community of practice to share resources and best practices, and connections to Prologis to foster job placement.

The Prologis Learning Academy is an educational program focused on developing supply chain and logistics training. The Prologis Learning Academy designed the content for a wide variety of users at different reading levels. The training content consists of 24 hours of content divided over eight self-paced sessions. The eight sessions include training on the following topics:

- Introduction to Warehousing and Distribution
- Jobs (in Warehousing)
- Safe Material Handling and Equipment Operation
- Principles of Quality, Sustainability, and Continuous Improvement
- Product Storage, Order Processing, Packaging, and Shipment
- Distribution Inventory Management and Control
- The Role of Transportation in the Supply Chain
- Technology

Within two years, CWI has recruited 17 partner organizations and over 21,000 Prologis Learning Academy learners. It has had 3,500 job placements.

Discussion

As the moderator, Haubrich facilitated a Q&A session, during which participants posed questions to Craig, Steenhoek, Costello, Zobel, and Hussain: These questions (Q) and answers (A) are summarized below.

Q: Related to the Prologis workforce development approach, where are the facilities located and how can stakeholders work on getting individuals to the facilities? Are there opportunities to partner with transit agencies to create transit incentives to help individuals get to jobs?

A: Hussain responded that childcare and transportation are two of the top challenges for the workforce. Prologis is considering opportunities to mitigate these challenges and work with regional transit operators. It is an interesting dynamic because communities want to push warehousing further away from communities, which leads to challenges for logistics providers. Both Hussain and Craig reiterated that there needs to be more consistent collaboration and communication among all of the stakeholders.

Q: When the Mississippi River was low, farmers were unable to get agricultural products out on the inland waterways. What do you tell the farmers to do to prepare for when the river is low and how responsible is the farmer for preparing? What should the federal government be doing about these types of scenarios?

A: Steenhoeck responded that having several options, beyond just option A, can lead to more resilience. When considering the Mississippi River, farmers from across the country that are not located near the river have a lot of envy for those located near it because the Mississippi River is actually quite an efficient maritime highway, but not all farmers are located close enough to reap the benefits. Being located near the Mississippi River can lead farmers to consider fewer alternative options because the river is so competitive, so the farmers are not always considering options B, C, or D. For example, in Iowa when the river was diminished, the farmers had options to drive some 75 miles to soybean facilities. Others had their own storage and could just wait until the river was in better shape. Having several options is critical for supply chain resilience. A lot more farmers are investing in grain bins now, as they have learned lessons from past disruptions. The federal government has a role to play. For example, during the pandemic, there were COVID outbreaks at meat-packing plants that caused disruptions because they were all located in the same place. Having more diversity in the location of processing plants can lead to more supply chain resilience. The federal government can help by encouraging this diversity, but ultimately the responsibility is on the individual.

Q: How can we address labor market needs as it relates to technological advancements, such as autonomous driving?

A: Costello responded that in a big-picture sense, ATA (the American Trucking Associations) refers to automated trucks as *driver-assist*, not *driver-replace*, technologies. Truck drivers will still be needed in automated trucks. For example, planes have been using autonomous technology for a long time, but no one would be willing to get on a plane without a pilot. In the trucking industry, there are tight corners that trucks need to navigate. There may be a time when a driver is able to hit the autonomous button, but the driver will still need to make sure they are available if anything comes up.

Q: As far as truck driver training, how can we change the perspective that you can be young and drive a truck and that it is a well-paying job, especially when communicating with those at the middle and high school levels?

A: Craig responded that one way is to turn the question around and ask what the government can do. For example, trucking rates increased dramatically as new trucks entered the market, and that resulted in increased revenue for local communities. During COVID new groups, such as East African communities near Minneapolis, found that truck driving was a lucrative job with several benefits, including having Fridays off. This resulted in higher numbers of trucks parking on the streets in Minneapolis. The City of Minneapolis banned truck parking on January 1, 2022. Does that indicate that government values truck driving? Government has the option to lead by example, but instead they banned it completely. As a result of the local parking bans, truck drivers started parking 30–40 minutes outside of the city, which adds to the cost of their commutes. This is happening all over the country.

Hussain responded that there are also concerns with the growing discussions of autonomous trucking and that there will not be a need for truck drivers, which is not the case—there is a disconnect from reality when it comes to future workforce needs. Costello reiterated the disconnect in the understanding of workforce needs. Training programs need to develop content correctly for the appropriate audiences. In the trucking industry, everyone starts out making the same amount of money. It does not matter your gender, skin color, or education level. Experience and merit are what determine truck driver’s salary potential.

Q: Considering the conversation about ducking the punch, what perspectives do you all have about what is coming in the future and what is your role in making sure the punches do not land?

A: Steenhoeck responded by using the example of low water conditions in 2021 and stated that the opposite was true in 2019 when it was actually high-water events. We could do a better job of monitoring river conditions and anticipating what could happen. When port operators overload boats and then the water is low, they are getting stranded because there is an information-sharing gap. That would not have happened on purpose. There needs to be better information sharing. There will always be uncertainty, but there are a lot of opportunities to slip the punch. Craig responded that the private sector can also learn from the public sector and take on more scenario planning. There is a need to anticipate problems and create better working teams and communication channels. Zobel reiterated that it is important to keep in mind the cyclical nature that evolves, which stakeholders can use to prepare for future disruptions. There is a need for supply chain industry stakeholders to better understand analytics and interdependencies. Another important thing to remember about resilience is that we do not know what will happen next, so there is a continued need to be prepared for several different types of disruptions.

Q: There has been a lot of discussion in the industry about banning truck parking in local neighborhoods. Industrial areas are also not the safest areas, and yet we wonder why there are not more female truck drivers. Has Prologis considered allowing truck drivers to use its facilities for truck parking?

A: Hussain responded yes, but developers also face challenges when it comes to truck parking development because it can create opposition and other challenges. State policies and local lobbying could help to show that there is a need for truck parking. The burden cannot be on one industry or stakeholder. It requires a little bit from everyone.

Q: Has there ever been any consideration to use truck advertising showing what is in trucks, to make people more willing to accept truck parking?

A: Costello responded that the industry proposed that strategy several years ago, but there were too many concerns about cargo theft.

Summary

Haubrich reflected that this session produced critical information and strategies for addressing supply chain resilience. Schofer summarized that the session was focused on moving the supply chain industry down the road and de-risking the industry. Schofer added that there is a need for more stress testing, forecasting, visibility, breaking down barriers, and dispelling myths.

Implementing strategies can at times lead to one-dimensional thinking. Schofer concluded that there is a need to understand people and decision-making, which is not an easy task.

WHAT ADAPTATIONS DEVELOPED IN RESPONSE TO COVID AND OTHER RECENT SUPPLY CHAIN DISRUPTIONS HAVE TAKEN ROOT? WHAT PROCESSES ARE WORTH SUSTAINING?

ALISON CONWAY, City College of New York, Moderator

Overview

This panel evaluated some of the adaptations that have occurred since the pandemic. It sought to evaluate which ones were worth sustaining. Key considerations discussed by the panelists included international and local impacts, along with policy implications. The panelists highlighted the need for communication and collaboration when planning for supply chain resilience, as well as the need to plan for disruptions before, during, and after the event.

WALTER KEMMSIES, Kemmsies Group

This presentation outlined some of the international impacts affecting supply chains. It is important to consider China's actions and how they impact the supply chain. As a result of its aging population, China is outsourcing more manufacturing to countries that produce goods more cheaply, such as Vietnam, India, and Mexico. The vacancy rate for industrial real estate near the northern border in Mexico is nearly 0% because China has been sending products to Mexican "maquiladoras" (which are assembly plants near the U.S. border) for final production. As a result, China has been able to export products to the United States duty-free. A similar situation occurred with Japan in the late 1980s. In 1987, Japanese companies had a 24% share of the value of U.S. imports (at that time volume data was not available). It took more than seven years to cut that value share of U.S. imports in half when the United States initiated tariffs on Japan. As a result of the tariffs, Japanese businesses moved manufacturing to South Korea and other West Asian countries, such as India and Pakistan. As a result, there are more containerized freight movements on the Suez Canal. These are the macro impacts that trade can have on supply chains.

Supply chains have had to adapt to the globalized market. Target invented the four corners strategy in the 1990s to make sure that not all goods were coming from Northeast Asia. The strategy came about because they could not bring all of their goods through the ports in Los Angeles and Long Beach. Further disruptions, such as weather and labor strikes, have now expanded that strategy to five corners. There is an increased need to be prepared for any type of disruption. The supply chain needs to be flexible and able to adapt to disruptions efficiently.

E-commerce continues to gain a share of retail sales. This matters because most of those goods come from other countries. While there is artificial intelligence software to predict what consumers will purchase and what will be sold, it is more challenging to analyze where it will go. There is a need for a different type of algorithm to analyze where purchases are going once they arrive at a port. Some supply chain stakeholders want to leave products at the port of origin until they need them to keep transportation costs low. The railroads' trend toward "precision scheduled railroading" (which is a planning approach to increase railroad efficiency and reduce

costs) is adding confusion to the mix. These additional challenges make adapting to supply chain disruptions more cumbersome and interdependent.

There were massive increases in imports during the pandemic. As a result, supply chains have adapted to a more fluid process, but there are still capacity challenges. The industry also did not learn to manage its equipment supply very well during COVID. Drewry's, a United Kingdom-based port consulting company, estimated that globally there is an excess of five million containers available to supply world demand. We did not learn equipment management during COVID.

DINECE MENDES, *New York City Department of Transportation*

This presentation outlined some of the local impacts, within cities and urban areas, affecting supply chains. One positive effect of the pandemic was an appreciation for essential workers. However, society has lost a lot of that appreciation because it is now “out of sight, out of mind.”

New York City has a changing landscape and there has been a push to develop a broad mission to advance safety and implement a more responsible movement of freight. One in 15 New Yorkers work in freight-dependent industries. These industries rely on trucks for deliveries. As a result, there is a need to have a lot of redundancies in place because there are a lot of pinch points throughout the city. For example, the George Washington Bridge is a critical pinch point, where disruptions can cause ripple effects throughout various supply chains.

There has also been an increase in urban warehouses. These facilities are typically located in industrial areas but locating them closer to communities could be beneficial for workforce development and accessibility. However, there is also a need to calculate the social costs and public health concerns of moving warehouses closer to communities. There has been elevated friction among the warehousing industry and communities related to concentrated truck traffic and increased emissions, so there is a need to balance tradeoffs.

New York City evaluated regional truck traffic during the pandemic. As closures occurred, truck volumes went down significantly, but they rebounded fairly quickly. The size of the trucks moving throughout the region also changed, as larger trucks were able to navigate easier than before the pandemic. It was extremely important during the pandemic to maintain critical freight networks. Prior to the pandemic, there was only one public truck parking facility in New York City. During the pandemic, New York City installed two temporary truck parking locations, which were successful. However, communities do not always see the benefits of truck parking and the cost of land often makes it prohibitive to implement. As a result of the program, a mayoral task force looked at truck parking and considered the political will to advance truck parking efforts.

There is a need to consider the different actors involved in supply chains, as there are many. Scenario planning is critical and can help in understanding where freight is moving. However, there is also a lack of trust between the public and private sectors, so there is a need to develop better partnerships, build trust, and enhance communication.

THOMAS MADRECKI, *Consumer Brands Association*

Supply chains became critical when individuals could not find products such as toilet paper and baby formula because when items become scarce the issue becomes relevant. The industry should not wait for items to be out of stock to panic and start caring about them. There is a need to think about disruptions beforehand and consider what policy changes are needed to protect the supply chain.

Pre-pandemic, total sales of consumer-packaged goods were around \$1.42 trillion annually, and demand has been steadily climbing. Today, total sales of consumer-packaged goods are just over \$1.8 trillion annually. Demand today sits well above the record panic buying days of the pandemic and supply chains are working again. The stores are able to keep the shelves stocked. It is important to remember that there are a lot of moving pieces throughout the nation's supply chains. There are also political considerations that can lead individuals to want to purchase goods domestically.

There is also a lot of visibility on innovation. There are two prominent examples of innovation that resulted from the pandemic. The first innovation was contactless delivery. While consumers can have fully contactless delivery, throughout the pandemic handoffs across supply chain nodes were still done in person, as there is still a lot of manual processing throughout supply chains. The pandemic highlighted that there is a need to preserve safety and limit human contact. A task force looked at methods to simplify these interactive processes. One possibility is the use of QR codes. By further simplifying these handoff procedures using QR codes, supply chains reduced dwell times by approximately 40 minutes. It may not have been the most advanced technology, but it worked and had immense benefits that have paid off quickly. Highlighting these advancements and showing that they work can also lead to additional automation technologies.

The second innovation was the Freight Logistics Optimization Works (FLOW) program created by the Bureau of Transportation Statistics (BTS). While this program is a much bigger idea, the intent is to create the ability for stakeholders to share supply chain industry data that can transform how we move goods across the economy. The program could act as a stepping-stone for how we address issues throughout the nation's supply chains. Ultimately, it can lead to supply chain stakeholders understanding where capacity limitations are located at any given moment. There is long-term potential and a need to prioritize this program.

At the end of the day, issues in supply chains relate back to sourcing. Stakeholders need to remain constantly grounded in the problem at stake. If the industry is trying to solve the issue of supply chain resilience, then there needs to be a consideration of what that means. There needs to be an appropriate level of expertise at the table that can understand the practical issues and solutions. Supply chains still have underfunded and under-resourced problem areas. There is a need for further investment to address supply chain concerns.

Discussion

As the moderator, Conway facilitated a Q&A session, during which participants posed questions to Kemmsies, Mendes, and Madrecki. These questions (**Q**) and answers (**A**) are summarized below.

Q: There have been a lot of changes occurring in the supply chain. Looking at recent disruptions, what is a key change that has been permanent and accepted by supply chain stakeholders?

A: Kemmsies responded that a lot of companies addressed issues that happened when China suffered supply chain issues due to COVID. It was challenging to shift to new markets, but it showed a lot of companies that they can survive without products that were produced in China. At the micro level, there have also been challenges with mom-and-pop businesses accepting new technology. They liked the paper process. However, with digital processes and technology the information on when deliveries arrive and depart is more accurate and there are new ways to collect data.

Madrecki agreed that there has also been a disconnect with some smaller companies not wanting to go digital and not understanding technology, which is a challenge. One of the more remarkable changes has been the inclusion of supply chain knowledge and expertise in the C Suite. It is now a competitive part of the market. Consumer demand has dictated this change. There have also been changes in how individuals find products, such as through social media. Mendes added that another challenge can be satisfying all stakeholders in a timely manner because often changes do not happen as fast as the private sector needs them to happen. Storytelling can play an important role in how the landscape changes because the trucks do not vote, people do. People need to understand what is happening so the appropriate changes can happen to improve supply chain processes. There needs to be support from all levels of leadership and an acknowledgment that freight is important.

Q: Vulnerable communities are at a disadvantage. How can we use these social vulnerabilities to reinforce discussions about the importance of the supply chain and bridge the gap to advance returns on investment?

A: Mendes responded that one way is to consider how the public sector can partner with the private sector and begin to speak the same language. We need to be better environmental stewards and develop shared goals to improve the quality of life in vulnerable neighborhoods. One solution could be incentive programs, such as New York's Clean Truck Program, which assist in the replacement of diesel trucks with cleaner more advanced trucks. There needs to be a shift in how we think of policy implications and how we can work together. Madrecki added that there is also a need to consider the location of employment centers and their accessibility. Solutions must be multifaceted. Kemmsies reiterated that technology and data can also help advance these efforts.

Q: Have there been any conversations throughout the industry, such as in metro areas like New York City, about setting up distribution points that can feed retail supply because parking is limited at retail locations? How are those things developing?

A: Mendes responded that there have been changes in the types of buildings that companies are purchasing and repurposing, such as vertical warehouses and abandoned malls because space is limited.

Q: Considering how consumer behavior has changed since the pandemic and e-commerce has personalized the supply chain, how can we turn that into votes to make institutional changes?

A: Mendes responded that there needs to be more advocacy for the supply chain industry. A report card could help highlight how supply chains are functioning. There is a disconnect in the public understanding of the importance of supply chains. Madrecki added that in politics, the narrative matters, not necessarily the facts and data. To make a change, people have to believe in the need for change and want to support it. There is a need for a compelling narrative, which the industry has not always done well.

Q: After living through the pandemic and more recently shortages of critical medicines, should companies have been more prepared with redundancies? Have they not learned any lessons?

A: Madrecki responded that there are broader geopolitical challenges at play and there is still a need to identify where the risks are located within supply chains. Companies are shifting their analytical methods and collecting more data, but this also needs to occur at the national level. The nation's supply chains need more support to provide broader redundancies. Kemmsies added that there is also a need for more socially responsible media that is sensitive to how its portrayal of the supply chain crisis could incite panic unnecessarily.

NEW SUPPLY CHAIN PARTNERS: ENGAGING LOCAL LEADERS TO MAKE SUPPLY CHAINS WORK FOR COMMUNITIES

ANNE STRAUSS-WIEDER, *North Jersey Transportation Planning Authority, Moderator*

Overview

Previous sessions have looked at macro- and federal-level impacts on supply chains. Supply chains do not operate in a vacuum. They are there because individuals continue to demand products. The intent of this session is to examine the local-level impacts of supply chains and what the industry can do to help supply chains work for communities.

LILY MACIVER, *Bay Area Air Quality Management District*

The Bay Area Air Quality Management District is a residential community surrounded by ports, railroads, and major freeways. As a result, there are significant impacts from emissions on the local community. The Bay Area Air Quality Management District works with regional and local agencies to address the environmental justice (EJ) impacts of ships, railroads, and other freight generators. Often these impacts are concentrated near low-income neighborhoods that are comprised of people of color. The Bay Area Air Quality Management District seeks to mitigate and redefine the predatory practices that have occurred in the past and continue to occur today.

There are significant health impacts of emissions, especially related to diesel particulate matter that is less than 2.5 microns wide (PM 2.5). PM 2.5 is associated with several respiratory illnesses, such as asthma, chronic obstructive pulmonary disease (COPD), lung cancer, and increased susceptibility to COVID. When PM 2.5 enters the bloodstream, it can lead to an increased risk of chronic kidney disease, and impaired functioning of the liver, spleen, and brain. Other issues associated with PM 2.5 include pregnancy complications, diabetes, and hypertension. There are also additional economic and social impacts from emissions, as health problems can lead to missed work and school.

California has implemented several solutions to address the negative impacts of freight. The Advanced Clean Trucks (ACT) regulation from the California Air Resources Board (CARB) requires truck manufacturers to transition from diesel to zero-emission trucks beginning in 2024. California proposed Assembly Bill 1000 that would prohibit large warehouses from locating within 750 feet of sensitive receptors, which include residences, schools, daycares, community centers, playgrounds, health care facilities, places of worship, and prisons. Several additional regional and local agencies have implemented efforts across the state to require warehouses to reduce air quality impacts.

The industry needs more research to understand the impacts of reduced air quality and mitigation strategies. However, it can be challenging to calculate the cost of public health. Time missed from school and work often goes uncalculated. Without the full calculation of these impacts, it is challenging to truly understand the economic impacts of warehouses on public health.

GERALD SCHWEBEL, *IBC Bank*

Bankers play an important role as economic developers, and they often look to create jobs and opportunities in local areas. For example, Laredo, Texas, handles the majority of trade between the United States and Mexico. There is a big push to consider supply chain resilience in Laredo because it is an economic driver for the United States. There is a need to adapt and recover quickly to supply chain challenges, which Laredo has handled well.

While the private sector does not plan to fail, sometimes it does fail to plan, which can add to challenges to supply chain success near the border. The private sector needs to be more engaged in supply chain efforts. There is not enough experience at the local level, which can lead to additional challenges and missteps. There is a constant need to educate public officials on the importance of supply chains and international trade.

In 1994, international trade between Texas and Mexico equaled \$173 billion. By 2019, the value of trade across the Mexican border had increased to \$451 billion and is expected to rise to \$1.43 trillion by 2050 according to the 2021 Texas-Mexico Border Transportation Master Plan. As a result, every major U.S. carrier has a terminal located on the U.S. side of the border and every major Mexican carrier has a terminal on the Mexican side of the border. All of the major 3PL companies are operating in Laredo. Many logistics firms and freight carriers are locating facilities in Laredo because they are trying to match the consumer's need and demand from the supply that is being provided.

The Texas-Mexico Border Transportation Master Plan looks at the impact of border activities on Texas' gross domestic product (GDP). The goals for the master plan are to improve mobility and reliability, sustainable funding, connectivity, cross-border resilience, safety, security, asset preservation, economic competitiveness, stewardship, sustainability, and customer service. However, the objectives of the master plan are only good if they are actually implemented. There is a need to continue telling the economic story of the impacts of trade.

BECKY BRADLEY, *Lehigh Valley Planning Commission*

The Lehigh Valley Planning Commission (LVPC) is the designated metropolitan planning organization (MPO) for Lehigh and Northampton counties, located some 30 miles north of

Philadelphia. The MPO manages the growth and development of the region, which is experiencing exceptional growth and development. Lehigh Valley is located along one of the fastest-growing corridors in the nation for warehousing and logistics and is within one mandated driving shift of many truck routes and major freight destinations on the East Coast. For example, when Hurricane Sandy hit, there were grave implications on the East Coast, and many industries considered moving away from areas that could be potential future direct hits. Lehigh Valley is home to Mack Trucks, Samuel Adams, Ocean Spray, and several other heavy manufacturing industries.

As a result of rapid growth, there is a need to make development decisions quickly. LVPC focuses on encouraging stakeholder collaboration to address and improve understanding of different land use perspectives. LVPC has seen differences in the motives and beliefs about the preferences for different types of land uses in the region. LVPC works with these different groups to coordinate and collaborate on ideas and opportunities to ensure that there is a good balance in the region. For example, LVPC automatically forwards any plans about workforce development to their local transit agency, and they are continually monitoring employment numbers. LVPC undergoes pre-development and post-development scenario planning and analysis, which can be important when trying to tell the importance of freight to stakeholders and public officials.

It is important that everyone have an equal seat at the table, which can lead to freight-related successes, positive zoning changes, and participatory democracy. Training is also critical for stakeholders and public officials. There cannot be too much training. LVPC also provides on-call assistance and community meetings to address freight and other planning needs. There is always an opportunity to develop a new future.

JUNE SMITH, *Hire Newark Alliance*

There is a need to connect communities to high-quality training and career opportunities. Hire Newark and the Newark Alliance have partnered with Jobs for the Future (JFF) and Prologis to undertake a Community Workshop Initiative (CWI) in Newark, New Jersey to develop transportation, distribution, and logistics training and career opportunities in the community. Newark has a large population, but there is a need for more community engagement and investment. Newark Alliance works with local public officials and membership organizations to develop buy-in about the CWI, which can lead to more opportunities for local residents.

Some of the biggest opportunities the CWI focuses on creating are related to finding local job opportunities and encouraging local residents to live, work, and play in Newark. There is a stigma around living in Newark and many people want to leave town. Stigmas can create misled perceptions that then turn into reality. Newark Alliance focuses on improving the image of Newark and creating a safe place for residents to call home which can also lead to more local opportunities for jobs and growth, which can then spread over to surrounding communities.

Some of the challenges faced through the implementation of the CWI in the local communities were related to job accessibility and different levels of education among residents. The implementation of the CWI required conducting several surveys and going out into the community to conduct marketing and outreach so that residents fully understood the available opportunities in their community. It is also important to listen to the needs of the community and

what will work best for the residents. By forming an understanding of the challenges faced by residents, communities can implement economic growth and development in appropriate ways that have the best outcomes for the local community. There is a need to collaborate with local partners and champions that can help make the program a success.

EDUARDO CALVO, *El Paso Metropolitan Planning Organization*

El Paso, Texas is located right on I-10 and is a gateway for trucks coming from the Port of Los Angeles/Long Beach. It is the backbone of the local transportation network and as such, has significant rail facilities. For example, Union Pacific's Sunset Line travels through El Paso, and it is a high-volume intermodal corridor. There are also high volumes of commercial vehicle traffic across the Mexican border into Ciudad Juarez. There are several high-value supply chains in the area, including the automotive, electronics, medical equipment, and appliances industries.

Truck delay is a major concern in Texas, and it can have significant, direct economic impacts. For example, in 2019, Texas experienced \$11.5 billion in congestion costs. Of that, \$1.7 billion was a direct result of truck congestion and delay. It is important to evaluate and understand the impacts of border crossing delays. Border crossing times begin when commercial vehicles enter the queue on the Mexican side of the border and end when they leave federal and state inspection facilities on the U.S. side of the border. Commercial vehicles crossing the border can use Standard lanes or Free and Secure Trade (FAST) lanes, which is a clearance program for low-risk commercial vehicles. However, data from 2019 has shown that average border crossing times in the Standard and FAST lanes are similar at several border crossings, indicating that there may be an infrastructure issue. FIGURE 3 shows the average border crossing times in 2019 based on Border Crossing Information System data.

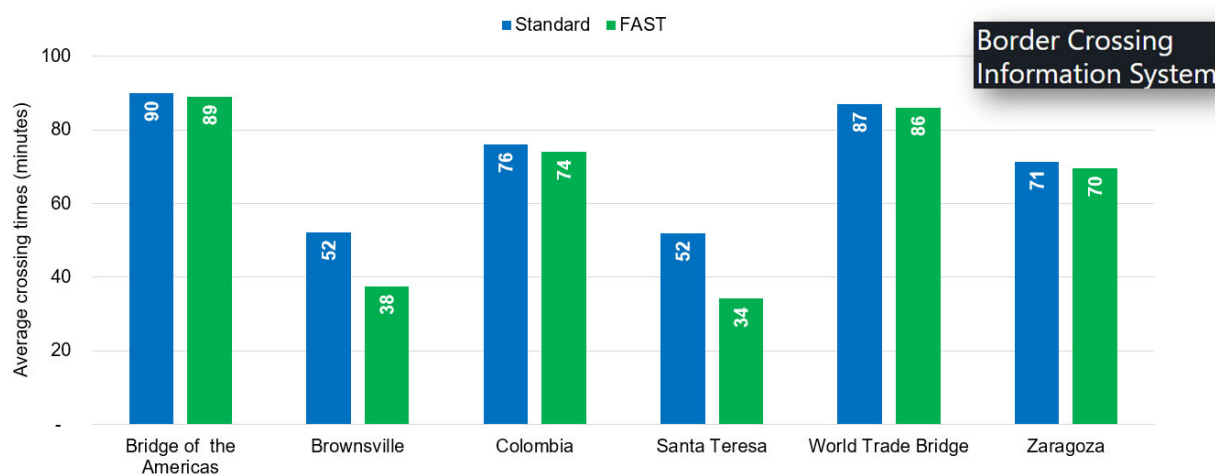


FIGURE 3 2019 Average Border Crossing Times.

Border crossing delays can have significant impacts on supply chain resilience. Taxes and tariffs, challenges with inadequate infrastructure, and inconsistent customs procedures make it more difficult to reach resilience within the supply chain. There is a need to engage with local officials so that there is a thorough understanding of the impacts of decision-making on supply chain processes and what that means economically. Communication strategies are critical.

Discussion

One question was posed to MacIver, Schwebel, Bradley, Smith, and Calvo.

Q: What is one key takeaway from each of the local leaders on the panel?

A: MacIver responded that it is critical to focus on collaboration and creating community forums where both the public and industry stakeholders can come together to meet the needs of everyone. Bradley responded that qualitative data is just as important as quantitative data. People care about their situations, and it is important to understand those stories. Schwebel responded that it is important to continue telling the stories about what is happening in the world and getting the real story out there. Calvo responded that there is a need to find a balance between the public and private sectors, especially on infrastructure issues. Messaging is critical to get individuals to truly understand what is happening in the supply chain. Smith responded that it is important to consider the need for equitable cities and to consider both the health and safety needs of communities. Buy-in is critical to achieve success.

THE FREIGHT COMMUNITY: FREIGHT LOGISTICS COMMUNITY SYSTEMS OPPORTUNITIES AND CHALLENGES AHEAD FOR SUPPLY CHAINS

JOE BRYAN, *WSP, Moderator*

Overview

The final session proposed supply chain opportunities and challenges that lie ahead for the freight logistics community. Panelists discussed topics including the FLOW program, cargo community systems, and port planning innovations. To wrap up the session, a broad perspective was provided with conclusions from the three other perspectives to indicate the prioritizations of the freight logistics community.

PATRICIA HU, *U.S. Bureau of Transportation Statistics*

This presentation covered the FLOW program, including what the program does, why it was unprecedented, and what made it possible. The Biden Administration initiated the FLOW program with the goal to speed up supply chain delivery times and reduce costs.

The FLOW program is the first of its kind to collect data from supply chain stakeholders that can allow FLOW members to better understand supply and demand issues at supply chain nodes. Currently, the FLOW program is evaluating supply chain nodes at the ports in Los Angeles/Long Beach, New York, and Savannah. To calculate the FLOW Landside Ratio, the number of containers discharged from vessels (demand) is divided by the number of available chassis and drayage trucks to move the containers (supply). If the number is greater than one, then there are not enough chassis and drayage trucks available to move goods. The FLOW program is only evaluating imports at this time.

Several principles guide the FLOW program. First, it is a voluntary, secure national exchange of freight information. Second, data are only available to members who share data. The program is sustainable because it is beneficial to the stakeholders using the data. One of the

challenges with creating the program was making sure there was confidentiality and security of the information. By ensuring confidentiality and security, stakeholders were willing to buy into the program, which is what made the program possible. BTS protects and secures the data through its role as one of the 13 principal statistical agencies in the U.S. federal government. By law, BTS can protect the data from legal discovery and the data can only be for statistical purposes. BTS employees are required to sign a non-disclosure agreement (NDA) and no employee can access the data without an NDA on file. Any willful disclosure of the data can result in sanctions and penalties, including a jail sentence of up to five years, job loss, and fines of up to \$250,000.

At the time of the workshop, the FLOW program had 53 members spread across the following supply chain sectors:

- Beneficial Cargo Owner: 15
- Intermodal Equipment Provider: 4
- 3PL: 8
- Ocean Carrier: 4
- Marine Terminal Operator: 12
- Motor Carrier: 7
- Logistics Real Estate: 1
- Class 1 Rail Carrier: 2

FLOW members appreciate the program because they can better understand the health of the supply chain system and have more ability to forecast scenarios and upcoming changes. The goal is to provide the demand ratio at 35, 45, and 95 days out. FLOW members can view sector-specific dashboards, including information on the available space, landside ratio, and the change from the previous day for a specific port. FIGURE 4 shows a glance of the FLOW Dashboard.

The private sector is what drives the success of the FLOW program, but BTS meets with the private sector regularly to understand how the program is operating and what the needs are for the program. There is a lot of communication involved, which is critical to its success.



FIGURE 4 A Glance of FLOW Dashboard.

AMAR MORE, *Kale Logistics Solutions*

This presentation covered what freight community systems are and how they work. The current scenario consists of global airports and ports that are congested. They have inefficient information exchange practices, with some companies still using manual documentation processes. Dwell times are high, and port operations are not transparent. Oftentimes many trucks are coming into ports at the same time and most of the port operations staff do not have information about the number of trucks that will be arriving and what they will be carrying. This can cause further delays if they need to obtain the appropriate equipment to move products.

There is still a lot of paperwork required within port operations. On average, 124 copies of paperwork are needed for air shipments, and 200 copies are needed for maritime shipments. As a result, shippers can be waiting for paperwork up to 85% of the time. Addressing issues related to inefficient paperwork can add to cost savings for supply chain stakeholders. As a result of implementing cargo community savings and creating digital platforms, there can be annual savings of \$50 billion in air and ocean shipment, 10 billion copies of paper, and 625,000 trees.

A cargo community system (CCS) is an electronic platform that stakeholders can use to facilitate interactions between supply chain stakeholders. The CCS addresses visibility concerns and provides real-time information about supply chain processes. FIGURE 5 shows cargo terminal operations processes in pre-CCS scenarios (see image on the left) and post-CCS scenarios (see image on the right).

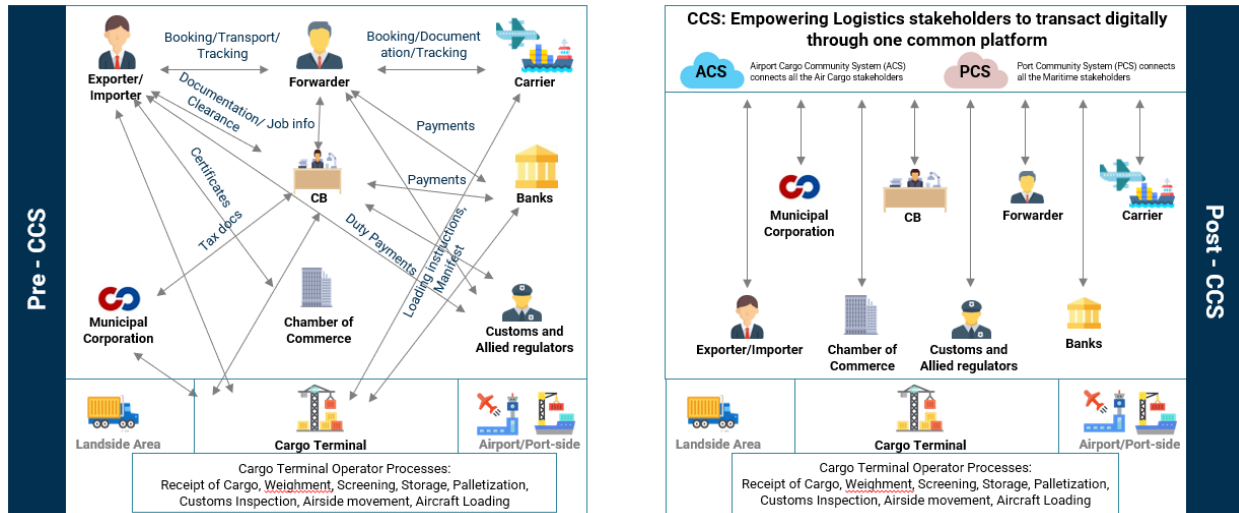


FIGURE 5 Pre- and Post-CCS Scenarios at Cargo Terminals.

Supply chains are experiencing rapid growth and supply chain stakeholders need to replace legacy documentation systems. Some of the key drivers of the growth of CCS are the proliferation of cross-border e-commerce, increased focus on security and access to data, disruptive events, and the need to develop supply chain resilience. The CCS is constantly evolving and continues to promise more opportunities.

Some suggestions to create an even more successful CCS that can improve supply chain operations include:

- Increasing the understanding of CCS and encouraging the implementation at all airports and ports.
- Developing a national-level system that can link the CCS.
- Developing a global level system that can link different information across countries through digital trade corridors.

DAVID LIBATIQUÉ, Port of Los Angeles

This presentation focused on the Port of Los Angeles' experience implementing port community systems and the role that they can play during disruptive events. The Port of Los Angeles implemented its port community system in the winter of 2014–2015.

The Port of Los Angeles worked diligently to navigate data sourcing. They put out a request for proposals (RFP) and implemented a pilot program on one string of vessels. Since the

implementation of the pilot program, they have acquired even more data for the port community system platform.

As a result of their data sourcing efforts, the Port of Los Angeles continues to use its port community system to assess the container movement of imports. The movement of containers through the supply chain consists of several steps. First, a customer orders the product, and a company manufactures it. The second step is loading the product on a ship at the port of origin, which is where data collection begins. The Port of Los Angeles uses marine exchange data to know where the ship is going to berth and then the marine terminal operator stacks the containers at the terminal. When the drayage truck or chassis arrives, the marine terminal operator loads the container, and it goes to an inland port. Approximately two-thirds of cargo moves out of the port on trucks, which is when they lose visibility of the load. However, some cargo also ends up in local rail yards where it goes to major U.S. rail yards. Ideally, the empty container returns to the port.

The pandemic changed everything for the Port of Los Angeles. It put them at the front and center of the supply chain issues and, at its worst, there were 109 ships backed up waiting to get into the port. The problem was that there was not enough space at the terminals to offload containers. The major challenges were related to warehouses and inland rail yards already being full, customers not returning empty containers to the port, and increased truck dwell time on public streets (see FIGURE 6). FIGURE 7 highlights the additional impacts on the supply chain system as a result of the warehouses and inland rail yards being full.

Chokepoints and Stress on the System

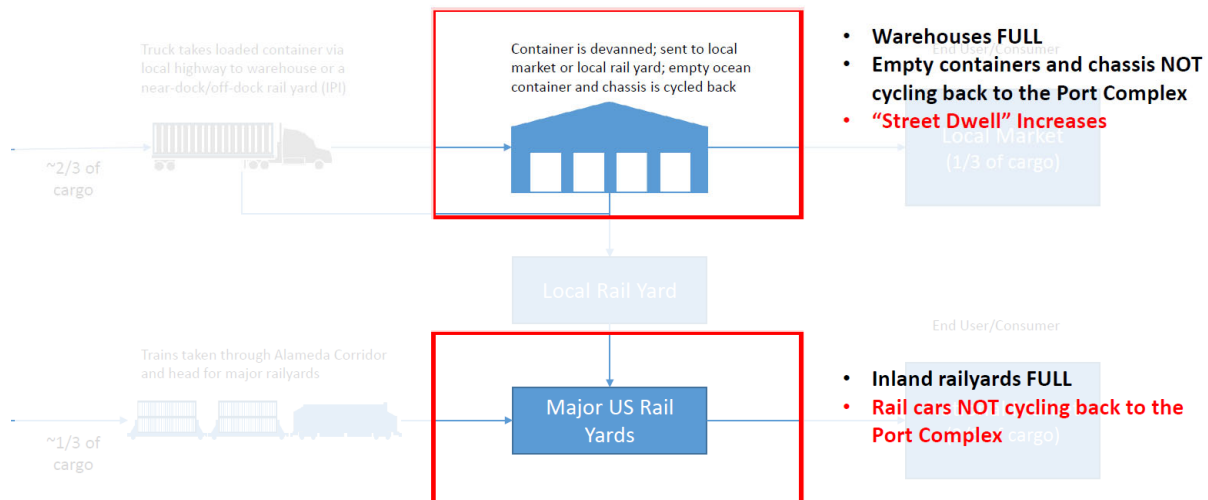


FIGURE 6 Impacts from Chokepoints at Warehouses and Inland Railyards.

Chokepoints and Stress on the System

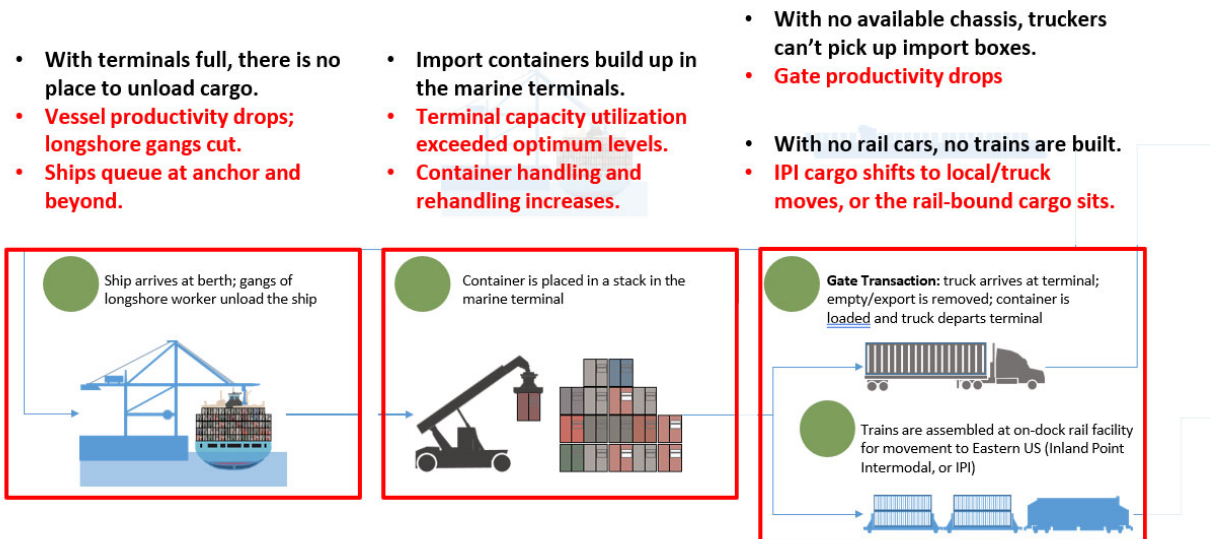


FIGURE 7 Chokepoints and Stress on the System.

The port had to determine if moving port operations to 24 hours, seven days a week was going to alleviate the problem. The Port of Los Angeles attempted 24-hour operations at a couple of terminals, but the results in the port optimization tool did not indicate that it produced an appreciable change in operations. The buildup of containers was too large, and trucks were not arriving to move any containers out of the port. They had a lot of containers that had a dwell time of nine or more days. As a result, they implemented a dwell time fee for any containers remaining in the port for more than nine days. Once the port implemented the fee system, they began to see containers move out of the port.

The terminals led a vessel productivity intervention to implement a vessel queuing system. The visibility allowed the terminals to see a granular level of data that was helpful in dictating policy decisions at the port. Aggregated data can help show trends in port operations that can lead to policy changes that can further improve port operations. There needs to be a clear distinction between public and private data-sharing.

RICK BLASGEN, *Council of Supply Chain Management Professionals (retired)*

This presentation focused on providing a recap of the session, as well as the workshop overall. The following are some of the key takeaways that Blasgen identified:

- A CCS is a common-sense element, especially since the shortest distance between two points is a straight line.
- Patricia Hu was a key individual in implementing the FLOW program. The FLOW program has the capability to lead to profound changes in how supply chain stakeholders manage and understand supply chains.

- On the first day of the workshop, we learned that April is Supply Chain Integrity Month. However, this should be a focus every day of the year.
- General Lyons reminded attendees that unanticipated disruptions—like the volcano in Reykjavik that disrupted air travel—are not going to go away, but supply chains are critical, and we need to do a better job of preparing for disruptions.
- Mike Steenhoek helped portray supply chain challenges in easy-to-understand concepts. It is okay when supply chains are boring, and we should strive for a more boring supply chain.
- Consumers can be the problem, especially as more and more consumers go into stores and purchase things at unnecessary levels (panic buying). These practices can lead to more significant challenges in supply chain forecasting.
- Access to labor is a challenge. This is still an issue and will be one for a while. Similarly, the trucking industry has discussed the truck driver shortage for thirty years, yet freight is still moving.
- Supply chain stakeholders and policy leaders need to communicate the importance of freight more clearly and more frequently so that the appropriate message gets to the right people which can then lead to beneficial changes that can improve supply chain operations.
- Collaboration and communication are critical in leading to improved supply chain processes, as well as bringing together a diverse set of stakeholders.
- While technology is leading to advancements, it is not going to solve all of the problems, especially when it comes to infrastructure challenges. However, technological advancements may lead to unexpected innovations.

Discussion

As the moderator, Bryan facilitated a Q&A session, during which participants posed questions to Hu, More, Libatique, and Blasgen. These questions (Q) and answers (A) are summarized below.

Q: There seem to be two countervailing thoughts at play in the discussions. We want to go back to boring supply chains, but we also want to raise awareness about the importance of supply chains. How can we do both?

A: Blasgen responded that education early on is important. Younger generations need to learn the importance of supply chains and that there are career opportunities available in the field. More added that it is important to stress that the technological advancements, which are exciting, are leading to more boring supply chains, which is still a good thing—so they are interrelated. Hu reiterated that it is also important to educate the public that when supply chain disruptions occur, such as shortages, the disruption impacts personal budgets, which can increase how much people pay attention to the disruptions and advocate for change. Libatique stressed that boring does not mean unimportant or insignificant.

Q: When talking about the available programs and data-sharing opportunities, how can we use this to get trucks off the roads? How can we convince public and private decision-makers that this is an important step to take?

A: Libatique responded that everyone deals with supply chains differently, but it is important to bring all of the stakeholders to the table and make sure that they are sharing the stories about what is happening on the ground with decision-makers. The data-sharing programs are going to

help alleviate congestion and improve safety. More added that policy and funding are critical needs to advance these issues further. Libatique followed up with the need for supply chain stakeholders to do a better job of applying the lessons learned from the pandemic. When the issues are out of sight, stakeholders and the public easily forget about them. The industry still has work to do to improve supply chain operations.

Q: When considering efforts underway to create more resilient supply chains, what is one thing that keeps you up at night and one that makes you hopeful?

A: Blasgen responded that there is a critical need to focus on infrastructure and cybersecurity in the immediate future. However, we also have to remember how far we have come in improving supply chain operations. The terminology has evolved, and operations continue to improve. More added that there is a need to circumvent how people feel about change and change their mindset. There has been change and there will continue to be change, which leads to hope. Hu stressed that the supply chain industry has come a long way. Libatique, in agreement, reiterated that we do not want to miss out on an opportunity for even more productive change.

Summary

Bryan summarized that supply chains are in the midst of change. People have experienced challenges with the supply chain, and they want to see change that will lead to improved processes. There are many strategies that supply chain stakeholders are undertaking to improve efficiencies in supply chain operations. While there is definitely a motivation to improve supply chain operations to increase profits, there is still a risk of going backward and losing steam. The focus needs to remain on preparing supply chains for future disruptions and developing more resilience.

Workshop Wrap-up

DIANA RAMIREZ-RIOS, *SUNY University at Buffalo, Moderator*

Overview

The purpose of this town hall discussion was to focus on the lessons learned, best practices, directions for the future, and possible research and data needs based on panelist presentations and attendee feedback. The workshop addressed the breadth of issues impacting supply chains. Recent strategies for mitigating supply chain disruptions and creating more resilient supply chains were described and discussed.

Workshop panelists and attendees conveyed a lot of information over a day and a half. Ramirez-Rios summarized that attendees learned what the current trends have been, where supply chain operations are heading, and where supply chains still need improvements. Workshops such as this can be a catalyst for change. While policy leaders have approved legislation to improve supply chain operations, we have only broadly defined supply chain resilience. Uncertainty is not going away, but stakeholders can implement strategies to better prepare for it.

The industry and communities need to undertake more efforts to address workforce training and accessibility to job opportunities. The lack of visibility further impacts the issues in the nation's supply chains, but data-sharing opportunities can help mitigate these challenges. Truck parking and last-mile challenges place additional burdens on communities that need collaboration and understanding to fully resolve. Coordination and advocacy need to take place so that the proper messaging on supply chain efforts can remain center stage and additional improvements can make supply chains more resilient.

Participant Key Takeaways

- More efforts need to take place to elevate supply chain management best practices and raise the importance and expertise to the C-Suite level in the public sector, such as at state DOTs. There needs to be more consideration of the research perspective and how the industry can elevate it to get attention at the DOT and MPO levels.
- The industry needs to conduct research quickly, especially on critical issues, such as supply chain resilience, which need urgent solutions. Research also needs to be broad enough to gain wider traction and attention. There needs to be a clear statement of the value proposition associated with freight and supply chains that the industry can use in a variety of applications, including education, lobbying, and research going forward.
- There is a need for a strong voice that can carry the supply chain story and elevate the needs of supply chains to a high level that can result in impactful changes.
- When supply chains are healthy, the economy is better.

Future Research Needs

- The research community needs to conduct more research efforts to reflect the workforce development needs and community impacts from supply chain disruptions.

- There is a need to consider more equitable funding models because the benefits of supply chain improvements may impact several states, but those states do not always share the costs equally.
- Continuing the conversation of developing supply chain resilience will require finding a balance among all of the stakeholders and forming a better understanding of funding and timeframes.
- Redundancy within supply chains is critical to the success of the operations in light of disruptions. Removing redundancies just adds back in more risk. It would also be beneficial to see more research evaluating the impacts of implementing redundancies to evaluate their actual impact.

In Closing

Schofer, as planning committee chair, closed the workshop by stating that this workshop, as with other freight-related workshops and conferences, has elevated the conversation about the importance of supply chains and understanding how the freight system works. The participation of supply chain stakeholders, practitioners, and academics continues to provide insight into how additional strategies can improve supply chain operations and better prepare for future disruptions.

APPENDIX A

Agenda

Tuesday, April 11, 2023

Noon – 1:30 p.m.	Registration
1:30 p.m. – 2:00 p.m.	Welcome and Opening Remarks
2:00 p.m. – 2:45 p.m.	Keynote Presentation: General Stephen R. Lyons (Retired)
2:45 p.m. – 3:15 p.m.	Break
3:15 p.m. – 3:45 p.m.	Session 1: What Do We Need from and for Tomorrow’s Supply Chains?
4:45 p.m. – 5:00 p.m.	Wrap-up Discussion and Adjourn

Wednesday, April 12, 2023

7:30 a.m. – 8:30 a.m.	Breakfast
8:30 a.m. – 10:00 a.m.	Session 2: What Adaptations Developed in Response to COVID and Other Recent Supply Chain Disruptions Have Taken Root? What Processes Are Worth Sustaining?
10:00 a.m. – 10:30 a.m.	Break
10:30 a.m. – Noon	Session 3: New Supply Chain Partners: Engaging Local Leaders to Make Supply Chains Work for Communities
Noon – 1:30 p.m.	Lunch
1:00 p.m. – 1:45 p.m.	Keynote Presentation: Tony Padilla - CANCELED
2:00 p.m. – 3:30 p.m.	Session 4: The Freight Community: Freight Logistics Community Systems Opportunities and Challenges Ahead for Supply Chains
3:30 p.m. – 4:00 p.m.	Workshop Wrap-up

APPENDIX B

Abbreviations and Acronyms

3PL	Third-party Logistics Provider
ACT	Advanced Clean Trucks
BIL	Bipartisan Infrastructure Law
BTS	Bureau of Transportation Statistics
CARB	California Air Resources Board
CCS	Cargo Community System
CHIPS Act	Creating Helpful Incentives to Produce Semiconductors Act
COPD	Chronic Obstructive Pulmonary Disease
CWI	Community Workforce Initiative
DOT	Department of Transportation
EJ	Environmental Justice
FAST	Free and Secure Trade
FHWA	Federal Highway Administration
FLOW	Freight Logistics Optimization Works
FMCSA	Federal Motor Carrier Safety Administration
GDP	Gross Domestic Product
HOS	Hours of Service
IRA	Inflation Reduction Act
JFF	Jobs for the Future
LTL	Less-than-truckload
LVPC	Lehigh Valley Planning Commission
MPO	Metropolitan Planning Organization
NDA	Non-disclosure Agreement

OSRA	Ocean Shipping Reform Act
OTR	Over-the-road
PM 2.5	Particulate matter less than 2.5 microns wide
RFID	Radio Frequency Identification
TRANSCOM	Transportation Command

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