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Innovations in Freight Data Workshop

April 9–10, 2019
Arnold and Mabel Beckman Center
Irvine, California

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Rapporteur
Catherine T. Lawson
University at Albany, State University of New York

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Preface

Meeting in Irvine, California, on April 9–10, 2019, 127 freight community members—including transportation professionals from transportation planning agencies, consultants, industry experts, and academic researchers from across North America—participated in the second Innovations in Freight Data Workshop. Alison Conway from City College of New York chaired the planning committee for this workshop. The planning committee members were solely responsible for organizing the workshop, preparing the call for abstracts, reviewing the submitted abstracts, and developing topics for panel sessions. Catherine T. Lawson from the University at Albany, State University of New York served as the workshop rapporteur and prepared this document as a factual summary of what occurred at the workshop.

In 2017, the first Innovations in Freight Data Workshop highlighted "big data" as a potential new data resource for freight planning, freight operations and mobility, and visualizations for communicating freight issues and solutions for decision-makers. The event brought together traditional freight-planning stakeholders with emerging technology innovators to look for opportunities to interact. Now, 2 years later, the 2019 event built upon these opportunities, bringing the stakeholders with recent experiences with big data for freight—and individuals, organizations, and agencies—to evaluate progress with new data sources and new methods and to discuss next steps to meet existing and future challenges.

This workshop report follows the program agenda and includes summaries of the presentations made by each panel member, augmented with audience questions, comments, reflections on advances in data sources and methodologies, and new challenges. Audience participation varied in length and depth based on the interactions among audience members, the panelists, and the moderators. Topics covered in the various panels, interactive posters, and traditional posters included new uses of GPS trace data, new machine-learning techniques, new uses of existing freight data, and a variety of new approaches for collecting and analyzing freight data. A copy of the program with links to the presentations is available at http://onlinepubs.trb.org/onlinepubs/Conferences/2019/FreightData/Program.pdf.

Special acknowledgments to the Transportation Research Board staff Tom Palmerlee, Scott Brotemarkle, and Mai Quynh Le for their support and organizational expertise. Special thanks to the Iowa Department of Transportation for their leadership of the pooled-fund study for this workshop and the seven other state departments of transportation pooled-fund members.

The views expressed in this summary are those of individual workshop participants and do not necessarily represent the views of all workshop participants, the planning committee, or the Transportation Research Board.

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ALISON CONWAY
City College of New York, Chair, presiding

CATHERINE T. LAWSON
University at Albany, State University of New York, recording

WELCOME AND CHARGE TO PARTICIPANTS

Alison Conway
City College of New York

Welcome to all, on behalf of the planning committee of the 2019 Innovations in Freight Data Workshop. Over the next 2 days, we will have speakers and posters that will dig into freight data issues and help identify key findings. We are expecting to hear about the key advances that we've made since our successful workshop 2 years ago, as well as to help find what we still need to be doing in identifying those key needs in terms of research and practice and what improvements need to be make over the next few years, in the short term. First, I just want to knowledge the tremendous support received from departments of transportation (DOTs) for this event. Iowa DOT led the pooled fund study, with support from seven other state DOTs, and additional support from FHWA.

We have two opening speakers: Roger Millar and Chris Schmidt. Roger Millar, Secretary of Transportation for Washington State, is the chief executive officer for an agency with about 6,800 employees and budget of $7.4 billion. He stewards the state's multimodal transportation system and is responsible for ensuring that people and goods move safely and efficiently. In addition to building, maintaining, and operating the state highway system, the Washington State DOT is responsible for the state ferry system and works in partnership with others to maintain and improve local roads, railroads, and airports, as well as to support alternatives to single-occupant vehicles. He is the President of the Western Association of State Highway and Transportation Officials (WASHTO) and the immediate past chair of the American Association of State and Highway Transportation Officials (AASHTO) Special Committee on Freight. He is also a member of the ASCE Board of Directors, the Intelligent Transportation Society of America Board of Directors, and National Complete Street Coalition Steering Committee and current co-chair of the Cooperative Automated Transportation Coalition.

Chris Schmidt is the Southern California Planning and Modal Programs Manager for the California DOT (Caltrans) in San Diego. He is responsible for all aspects of the management of interdisciplinary teams who develop and analyze policy and data to support implementation of a balanced, multimodal state transportation program. He works across Caltrans to coordinate planning and intermodal activities for the four southern districts. He leads strategic planning and policy development as well as several statewide initiatives related to the implementation of climate change efforts; opportunities to better link transportation to housing; planning for broadband; coordination for freight planning; and investments in program data policy. Most recently, he served as the division chief of transportation planning in Sacramento where he was responsible for the initiation of hundreds of capital projects annually amounting to a multibillion-dollar portfolio. In addition, his focus areas include the statewide regional multimodal system freight smart mobility and climate change planning efforts.

OPENING REMARKS

Roger Millar
Washington State Department of Transportation

Washington State is one of the most trade-centric states in the country, a gateway to the Far East, with over $600 billion in freight-dependent business across the state. Almost half of all the jobs in Washington State revolve around freight and trade. The strength of our freight infrastructure allows us to maintain low cost and reliable supply chains in a global market in a global competition. It is important to our farmers and our manufacturers are able to move their products cheaply and efficiently to make them competitive in this market. We are seeing rapid growth in the freight sector of our transportation economy. Freight demand in Washington State is projected to grow 30% in the next 20 years, fueled by supply chain innovations like Just-In-Time logistics, and the desire for deliveries to our front doors.

Washington State DOT has a good reputation for developing and delivering projects. For example, with the passage of the Transit 3 Initiative, $54 billion was provided to our Central Puget Sound Transit Agency to deliver light rail, commuter rail, and bus rapid transit projects, all at the same time. We have been just recently opened the world's deep port tunnel that we were constructing at the same time we were constructing the world's longest floating bridge. We were constructing a single-lane highway over a mountain pass that gets tens of feet of snow every year. In addition to building good projects, we also need to be stewards of our system.

Before taking on the responsibilities of secretary of transportation, it was unclear whether there was adequate funding for our transportation assets due to the stove piping of information. Although we knew about pavement and structures, we didn't know about all of our assets in the state. Today, we estimate that to replace today's assets, it would cost taxpayers about $200 billion. We spend about $½ billion a year on preservation. At the same time, we have challenges. For example, truckers using Snoqualmie Pass indicate they have to drive on shoulders because the right lane is too rough and tears their trucks apart. In addition, issues surround first- and last-mile connections, congestion on the Interstate 5 corridor, structures are load restricted, and speeds are down. All of these problems need attention. While our legislators are impressed that they spend $½ billion on the state of good repair, it is $700 million less than they should be spending. Over the next decade, we will create a $7-billion state-of-good-repair backlog in Washington State. Regarding the cost of congestion, we estimate $3½ billion in lost productivity due to congestion. Even more sobering is the number of fatalities and serious injuries accidents in Washington State, costing our state's economy $8½ billion annually, more than congestion and state-of-good repair combined. At the same time, our safety program is spending only $50 million.

Washington State DOT focuses on operating and managing our system, applying transportation system management and operations principles. The transportation infrastructure for the future generations is in place today, and any new additions are fractional, or minor, compared to our entire system. We need to manage this system more actively to achieve better safety, better throughput, convenience, and equality. In addition, we need to think about land use and the relationship between land use and transportation. To accomplish our goal of better management we will need data sharing, and new approaches for thinking about system and corridor planning. Managing traffic looks to Intelligent Transportation Systems (ITS), and in Washington State, we have over $1 billion in ITS infrastructure across the state. For example, in the Seattle area, Washington State DOT operates 9,000 sensors, loop detectors, Bluetooth sniffers, video cameras, lidar, and radar—capable of collecting information for use for a variety of operations, including active road weather information, weigh-in-motion (WIM) systems, and online truck permitting.

Perhaps there is a lesson we can learn from the energy sector. Several decades ago, it was realized that the best new source of energy was not nuclear, coal, natural gas, wind, or solar. The solution was to encourage residential customers to reduce their use of electricity, making it possible for energy to be sold to unregulated industrial customers for higher profits. Applying this approach to the transportation industry, where road capacity is a limited resource, could provide individuals currently driving alone over long distances between where they live and work, with attractive alternatives to free up capacity to move freight more efficiently? To encourage the public to change their behavior, we need to investment in transit, biking, and walking and a better understanding of the relationship between housing choices and transportation options. The trade-off for young families is whether they want a house with a big backyard and a long, slow commute to work instead of living closer to work in denser neighborhoods. They could spend more time with their families and less time commuting. All of these issues, where to live, the cost of housing and commuting, and overall quality of life, are conversations we are having in Washington as we manage demand.

Many people think connected and autonomous vehicles are the solution for the future, but it is also possible that these technologies are currently too immature to take seriously (e.g., similar to the previous competition between Beta Max or VHS technologies). It is possible that cooperative, automated transportation is a better solution. The cooperative aspect is to use public transportation, not the competing mode of Transportation Network Companies (TNCs), as the backbone ripe for investment. It can be automated, rather than autonomous, because nothing is really autonomous in a viable system.

Washington State DOT is engaged in traditional Traffic System Management and Operations, including operating traffic signals and other technologies, modernizing as we move forward. Washington State DOT is investing in very large projects. For example, the Puget Sound Gateway is a $2 billion segment of new highway that connects the Port of Tacoma and the Port of Seattle, including connecting warehousing and manufacturing distribution centers in South King County and Pierce County. Our plan is to make our two ports more competitive and create family wage jobs in South King and Pierce counties where families live so they won’t have to commute to downtown Seattle.

As a member of the AASHTO Board of Directors and President of the Executive Committee for WASHTO, I find that discussions are focused on the future of federal policy and freight policy, in particular. There are technological advances we have to consider and there are workforce challenges that we have to address. For example, one third of our maintenance team in Washington State are eligible to retire. Forty percent of our engineers are also eligible to retire. Washington State DOT operates the Washington State Ferry System, the largest ferry system in the country, second largest in the world. We move 25 million passengers a year. Seventy-five percent of the captains—the men and women who operate the boats—are eligible to retire and these are highly skilled positions. In addition, we expect demographic changes will produce a more-diverse work force, with new ways of problem solving with new perspectives, with greater breadth and depth of experiences. As Washington State becomes more diverse, it will become more competitive and a better place to live.

There are more challenges ahead, including environmental and economic instability and uncertainty. In a global environment, where our nation has been a leader for so long, and a number of unanticipated changes and events, we are reauthorizing a transportation act where there is a tremendous opportunity to make federal policy more proactive, more flexible, and more adaptable. The Moving Ahead for Progress in the 21st Century Act (MAP-21) and the Fixing America's Surface Transportation (FAST) Act, for the very first time, created a much greater emphasize on freight. We have a freight program. We have formula funding for freight, and a grant program for freight, but no longer have a freight research program. We are looking at policy recommendations in the reauthorization that re-establish the cooperative freight research program to provide research to assist the state's delivering their projects. Funding is important to reform the National Highway Freight Program (NHFP) to more clearly include integrated multimodal solutions, as opposed to highway solutions, and to remove caps on multi-modal investment.

AASHTO has reorganized from its original center of power with the Standing Committee on Highways. Previously, state engineers controlled decision-making and they required two-thirds of the states to agree, making policy change glacial at AASHTO. The reorganization in 2016 modernized the committee structure and included all of the disciplines, putting all the modes on equal footing. Replacing the Standing Committee on Highways is a council of highways and streets, but the council in active transportation and has the same status at AASHTO, along with the council on aviation, the council on public transportation—which I now chair, the council on rail transportation, the council on water transportation, plus the special committee on freight. With our reorganization, we plan to develop and support legislation and regulation, improve our planning practices, enhance the freight data that we have, understand and be prepared for emerging technologies, improve our urban as well as rural multi-state and cross-border freight mobility, and promote freight transportation systems that support community goals and environmental goals.

Looking to the future, we have a new focus on freight system optimization, to be on inside the dock, inside the warehouse, and blurring the lines between public- and private-sector responsibilities. We have a need for supply chain and commodity flow data to better do our jobs. For example, if 1,000 trucks leave the Port of Seattle every day, half full, the same freight could move in 500 full trucks. Right now, the public sector is not able to estimate the utilization of trucks moving goods. Clearly, private-sector stakeholders know individually, the volumes in their trucks, but there is no mechanism to share and make all hauls more efficient. We need to understand the origins and destinations of freight shipments. We were talking about the Long Beach and Los Angeles and their use of the GE Transportation system, where they know what the containers contain before they leave the Far East, instead of having ships arrive, and discharge their cargo on the dock, where it has to be sorted.

To do our job better, we need data, metrics, and best practices. We need metrics to identify freight congestion points and bottlenecks, and not just spatial bottlenecks, but temporal bottlenecks. For example, many of our truckers park on the periphery of metro Puget Sound for the night. When they get up in the morning, they travel in the commuter peak because the dock opens at 9:00 a.m. and the warehouses open at 8:00 a.m. We are looking at practical solutions and strategies as opposed to adding a lane of capacity, maybe we move the need for that capacity to a different time of day.

Working with limited funding, we find our expertise walking out the door as people retire; and at the same time, we need to be able to compete with the private sector for data analysts. We need better modeling tools to support decision-making, better partnering with our private-sector partners, with local and regional freight stakeholders, to be able to effectively leverage resources. We find ourselves competing for funding rather than cooperating to grow the pie. Washington State DOT and the ports and the cities and counties in the state of Washington compete every time there is a federal opportunity for resources, rather than working together, as it is hard to change from a competitive nature to a more cooperative and collaborative nature.

Truck parking is an issue throughout Washington State, particularly the Seattle–Tacoma area along our Interstate corridors. Our truck parking survey found that half the respondents find themselves fatigued because they can't find a place to park their truck. Over half of them said that they frequently don't feel safe where they are parked overnight. The communities that host the truck stops don't want more trucks, but they want the things that trucks bring. With concerns about safe places to park, ports with docks that sit empty overnight, and warehouses with empty truck parking behind locked gates overnight because of security concerns, could offer a collaborative solution.

Looking forward to technologies transforming the way freight works as e-commerce continues to grow, faster than overall retail growth. Connected and autonomous trucks are developing rapidly, including freight carriers improving freight mobility with truck platooning with help from labor. We need better data sources and tools so we can do policy and legislation, planning and programming, and improve the movement of freight for a sustainable future for our country. Your work is critically important to the success of transportation and the movement of freight. I applaud you for what you do. I am thankful that you are here and learning from each other and collaborating to make our transportation and our world an even better place. I wish you a successful workshop and thank you for your time.

Chris Schmidt
Caltrans

California is the nation's largest international trade gateway, with a very extensive system of state highways, railroads, ports of entry, both land and sea and a significant amount of air cargo in the state as well. Caltrans is the department of transportation for the fifth largest economy in the world, with responsibilities, larger than some other states, with sufficient jobs associated with the freight industry in California. A third of the economy is freight-dependent, not just from global entry, goods that are moving through our ports, but it is really also the products that we produce in California and ship all over the nation. Forty percent of the containerized goods are coming through the ports of Los Angeles and Long Beach. Many of our communities are disproportionally affected by that importation of goods. If you live near one of these ports of entries, you bear the burden of air quality and noise. We are challenged with truck parking issues as well. California has cultural diversity, with some of our most diverse areas, (e.g., Los Angeles, Long Beach, San Jose, and San Diego), are also port cities, making them representative of the kinds of impacts that we see from the trade industry.

In California, we have seen tremendous expansion in our freight industry between 2015 and 2016. There was one of the largest growing sectors in our economy which is not only represented both in the state, but also overall in the freight industry as a whole in the nation. Freight entails more than imports in ports of entry, it includes how the last mile materializes on our local city streets and managing the curb in our urban environments. How do we do that in the world of TNCs, also known as shared mobility, while in the world of packaged delivery everyone is competing for that same curb front. At the same time, we want our transit system to be successful, we have congested roadways that's only going to get worse when we have deliveries being made and no place to park those vehicles.

Despite the overwhelming benefit in the state for freight, the general public doesn't understand that value of the freight industry, what it does, and what difference it makes in their own lives. They expect that their Amazon package will be on their doorstep when they get home at night and they wonder where it went if it isn't there because somehow it shows up magically. They have no idea all the steps it went through to actually get delivered to them. Nor do they fully recognize how the goods get to the store when they go to buy their groceries. Freight makes a difference in our daily lives, with its dependences and interdependences. We need to plan for a system that is performance-based and addresses all these needs, while being incredibility sustainable, equitable, and dynamic because it's changing all the time; we constantly have new emerging pathways coming forward.

We focus a tremendous amount on safety and sustainability. Specifically, the safety in terms of both worker safety (e.g., operators of the system), and the general public. Freight can be a relatively dangerous endeavor. California is mission-bound to reduce greenhouse gas (GHG) emissions and to address climate change aggressively, including the freight industry. For example, in the Trade Corridor Program, we have additional $300 million that are programmable annually for freight projects. We tie with about $100 million from the federal authorizations, giving us $400 million to invest in trade-specific projects annually.

What are the most transformative, most impactful projects in the state? That is a big challenge for us and we need data to do that. California is a complex state with lots of folks who want to participate in transportation planning. We have regional partners who are planning the future very large metropolitan areas. The Big Four include San Diego, the Los Angeles basin, and the Bay Area, with some inland areas (e.g., Sacramento area, Fresno area, Central Valley). These regions all plan for themselves under our metropolitan planning organization (MPO) process, with their own goals and policies for what they are trying to achieve. Caltrans tries to tie all of them together. At the same time, we have many, many other stakeholders, including private sector stakeholders, which we are constantly inviting into discussion, along with lots of advocacy organizations.

Environmental advocacy has been active in the state for a long time, but new social and environmental justice advocacy are now participating as stakeholders. Local communities speak with one voice and they speak repeatedly: "please invest in our communities because you need to start to undo some of the wrongs that have been done historically". We reach these stakeholders with our strong freight advisory committee, meeting with them regularly—there are about 60-plus members strong. We have a broad cross section of participation and healthy discussions at those meetings, viewable on our website under the freight advisory committee.

We are very proud of our Sustainable Freight Action Plan, designed to establish state policies so we could speak with one voice, with nearly 60 action items: equity, cleanliness, safety, security, and really having a fair system for all. This plan is not federally or state mandated plan—our governor asked us to put it together in conjunction with other state agencies, recognizing that we might be at cross-purposes with each other. The DOT, along with the energy commission, the California Air Resources Board (responsible for regulating emissions and green-house gases), as well as the Governor's Office of Economic and Business Activity Development, GoBIZ, are tasked with developing the plan together. In addition, we are moving rapidly into this era of making data-driven decisions as it is absolutely crucial that our decisions aren't just political, recognizing that many decisions are made at the region-level rather than by the state.

Our regions use and analyze data and need information. In addition, our elected officials need to prioritize and complete projects. To do this, they really want data to also guide their proposals. At Caltrans, we want to know "How do we develop this data?" and "What is the appropriate data and how can we actually apply that?" In addition, we need data to solve problems including congestion, transportation security, and air quality. We want a stronger and more-robust economic development that is equitable. We also want to tackle land use. While California is a large state, it is quickly consuming farm and other land uses, but may not be making the best land use decisions because we have a serious housing and jobs disconnect. As Roger Millar previously mentioned, folks live in one place, work in completely different location, and transport themselves long distances that are really impacting their quality of life and results in the generation of large amounts of GHG activity. To make data-driven decisions, we need to have the right information and it needs to be transparent. Existing data collection methods are not necessarily providing the granularity for the types of decisions that we would like to make. Decision-makers always want better and better data and more-specific details in order to guide their investment decisions. Even when the most appropriate data is not available for a decision, the decision still must be made based on the best data available.

We have made a lot of progress in this state in reducing GHGs, cleaning up the various pollution and emission sources, both stationary and mobile. The transportation sector makes up about 40% of our GHG emission profile, as actual vehicles moving. How do we address the freight sector contributions? Foundationally, we are talking about moving goods from the market to consumers and that requires the physical transportation of these goods. How do you do that in a more equitable and sustainable manner? We are currently discussing more fuel-efficient trucks as a solution. As you are probably aware, California has some of the cleaner truck standards in the nation and lots of that fleet has changed over, but we need to do much better than the 2010 standard that we have today. We also want to move to zero-emission technologies overall.

Yesterday, at the Freight Committee meeting, our partners at the Port of Los Angeles and Long Beach talked about their climate change actions. They are really trying to do everything they do with material handling equipment in the port, yet the over-the-road truck is perhaps the largest target as we try to get that vehicle to be zero emission as they haul approximately 80% of the goods moved in the state. As a result, we also suffer from the same issues of truck parking. Recently, in one of our freight advisory committee meetings—one of our community members pointed out that they have about 100 different places where trucks are parking and storing containers within the footprint, or the general confines of the Los Angeles–Long Beach Port complex. Those communities are being affected by truck parking.

We are undertaking a statewide data-driven study to determine where the truck parking is actually needed. Similar to Washington state, we have trucks parking out on the rural fringe areas before they enter into the urbanized areas, while others are making interstate trips, up the entire spine of California on the I-5. Where do these truckers need to stop, particularly give the hours-of-work rules? As a key safety improvement, we want truckers to be on the road operating while they are not impaired. Truckers need a place to stop up and rest and it none are readily available; they must spending time trying to locate a space. Caltrans is partnering with other states to study the problem, including our I-10 study with a recent grant that the Texas DOT. We want to know how to make data available for users of that corridor and the technologies that we deploy in our four-state example, hopefully is something that we can deploy nationally and statewide. For example, Caltrans has begun to explore truck platooning, with research and opportunities to partner with the private sector, requiring significant automation and technology deployment. The California Highway Patrol is very concerned about these kinds of technologies as well as concerns about overweight and oversized trucking.

We are looking for opportunities for cross-border and cross-jurisdictional data sharing. Our coalition partners include I-5, I-15, and the I-10 in the broader Western states region. On top of that, we have some good data from the ports and a good understanding of what commodities are flowing from there, but don't always have the same data set from cross-border flows with Mexico imports and exports. In addition, our ports of entry on the landside are also very busy. We really struggling with, as in Washington, is freight congestion on various corridors, both truck and rail. Our rail system is expected to provide additional passenger service, so we have passenger service operating on freight tracks or freight is operating on passenger tracks, depending on how you look at and who owns and operates those facilities. Freight rail and passenger rail conflicts could benefit from some operational efficiencies, but ultimately, it comes to capacity (e.g., having enough sidings) to make that system work better.

Where do we typically look to get our information? We are using the National Performance Management Research Dataset (NPMRDS) probe data. However, it can be difficult to navigate and we would appreciate help making it easier to use. We also need a dataset for all roads where freight moves, as the NPMRDS is primarily collected on the National Highway System. We have very strong interest in trying to articulate that issue, also at the municipal level. We need to know what is going on within these communities. How do we address their concerns? With a lack of information, they react to the complaints from communities and citizens and then immediately react (e.g., designate a truck route), but without the appropriate data for such a critical decision.

We definitely need NPMRDS for all routes. We are using it for performance monitoring as all the other states for the MAP-21 performance metric, but we've also been asked by our Transportation Commission for some datasets that we can use universally on the system. NPMRDS holds that to some extend for trucking if we could make that available for all roads. We are looking to use that data both as setting a baseline, but also as an evaluative tool. Once we implement projects, can we actually go back in future years and monitor the progress that we have made and actually seen the investments pay off? We need to make sure the projects we build are truly are the most transformative, achieving the greatest outcomes, with evidence of a demonstrable change and benefits. Transparency is key using funding measures that constantly report the outcomes, based on good data. For example, when a particular recipient is assigned to deliver a particular project, they sign a base-line agreement with the commission and that baseline agreement discusses the project outputs on what will be built and the outcomes. These measures identify what was actually achieved, and needs to be auditable.

We struggle with knowing exactly what flows are coming from and going to: the origin and destination (O-D) identification issue. We want to be able to answer questions about what is in the truck, the container, or the rail car. It is important to understand commodity flows are to both articulate those flows, and also to emphasize and perhaps de-emphasize, some other things. To date, the data collection methods for O-D are difficult to deploy. We are hopeful that future automated data collection will provide improvements. Intercept surveys with trucks can be incredibly difficult and expensive. At the same time, we recognize that data alone is not sufficient; we need to turn the data into digestible information that is useful for making decisions. Public agencies need researchers and data scientists to meet this challenge as we can't hire the high-tech, well-paid data analyst found in the private sector. We need help distilling findings into public policy decisions.

We provide funds for projects and want them to be the best projects, the ones taxpayers deserve. I am hoping that the future technology advances will be easier to identify and deploy these projects. Big data platforms hold tremendous promise. Our successes will bring success to the private sector. We need to ensure our communities remain successful and that we provide protections for their health and welfare. Having data for all these purposes is critically important because we want California to continue to be successful, functional, with a vibrant economy that is also sustainable. In addition, we need data to ensure we are serving all our people equitably. I lay that challenge to you and I am hopeful that these few days here of data conferencing will allow us to learn a great deal.

KEY TAKEAWAYS

Mario Monsreal
Texas A&M University Transportation Institute

Both opening speakers focused on the expanding role freight plays in their states, with a number of challenges in common (e.g., congestion, a better understanding of truck parking needs, delivering large project with limited funding). In addition, they recognized the need for high quality data to assist in the identification and prioritization of future projects, while keeping the existing transportation system functioning under dynamic conditions. They pointed out the need for commodity flow data, including O-D information, collected using automated data systems, processed, and reported with appropriate granularity at a level that is useful for decision-making. These new forms of data require a new set of skills also desired by the private sector. They described the need to identify partnership opportunities with freight community members, many of whom produce the types of data needed for accurate analysis. Workshop participants will be looking for what new data sources have emerged in the last 2 years, what new methods have been developed for new data and existing data, and what challenges remain for the freight community to effectively, cost-efficiently, and transparently use freight data resources.

Novel Methods of Data Collection

NIKOLA IVANOV
University of Maryland CATT Laboratory, presiding

SARAH HERNANDEZ
University of Arkansas, recording

Innovative data collection methods are being developed to address persistent freight data challenges, including invisibility of local movements and data time lags. This panel discussed innovative applications to collect location-specific freight parking, routing, and behavior data.

A SELF-SUSTAINING, SELF-PERPETUATING WEB-SCRAPING APPPLICATION FOR CRUDE OIL RAILROAD ROUTE INFORMATION

Chieh (Ross) Wang
Shih-Miao Chin
Ho-Ling Hwang
Hyeonsup Lim
Oak Ridge National Laboratory

Background

Recent advances in horizontal drilling and hydraulic fracturing have made shale oil and gas extraction profitable. High gasoline pricse and shifted energy security policies also contributed to the boom of domestic shale oil production. However, the rapidly increasing oil production has outgrown the capacity of existing pipeline infrastructure, and other modes of transportation like railroad which has been increasingly utilized to transport oil. As the amount of crude-by-rail stays high, safety concerns have also risen. Shale oil trains have had many major fiery derailments since 2013. All these derailments unleashed volatile shale oil that erupted in huge fireballs and burned for days. These incidents have led to public awareness of the danger and risks associated with crude oil trains and more people have learned that a sizeable amount of highly volatile liquid fuel is being transported by rail from North Dakota to east, west, and Gulf of Mexico coasts.

Crude-by-rail operations are important to emergency preparedness officials to assist with helping residents of affected communities to better understand the process of determining the risk associated with oil train movements; to form realistic, scientifically based perceptions of a likely crude oil disaster; and to participate in a variety of decision-making activities on how the risk of a disaster should be managed. To do this effectively, it is necessary to compile a crude oil train database capable of being used in conjunction with associated energy commodity O-D flows and logistical information found in the Commodity Flow Survey (CFS) data and the Freight Analysis Framework (FAF) data.

Oil train routes are considered as business sensitive information by railroad companies, who have kept the detailed oil train route information from the public. Although the U.S. DOT has issued an Emergency Order that requires railroads operating trains to submit their crude-by-rail movements, volumes, and frequencies to the State Emergency Response Commission, such information is reported at the county level, which is not granular enough for accurate crude-by-rail safety and risk assessment.

Innovations

To uncover the unknown routes and obtain knowledge concerning crude-by-rail safety, this research uses an untraditional way to obtain route information from social media data, specifically, the Flickr photo-sharing website. This study outlines a self-sustaining and self-perpetuating web-scraping (web-harvesting) application that can collect and update oil train route information continuously. Specifically, the web-scraping application automatically retrieves information and sources of a web page (e.g., Flickr.com), filters images based on key words or tags, extracts image properties (e.g., geographic locations), and organizes the extracted information into a database.

Using the collected oil train route information, in conjunction with other data sources, such as population along oil train routes and potential hazards of crude-by-rail incidents, this study further examines the potential risk of crude-by-rail along these routes and provides the concerned public and associated agencies with the urgently needed oil train operating information for informed decision making (Figure 1).

Contributions

This effort is being designed to be self-sustaining, self-perpetuating based on the ability to use the web-scraping approach. This innovation will be a continuous effort that helps concerned public and officials collect and update crude-by-rail routing and operating information, which can lead to enhanced assessment of potential safety hazards and better planning for emergency response and decision-making.

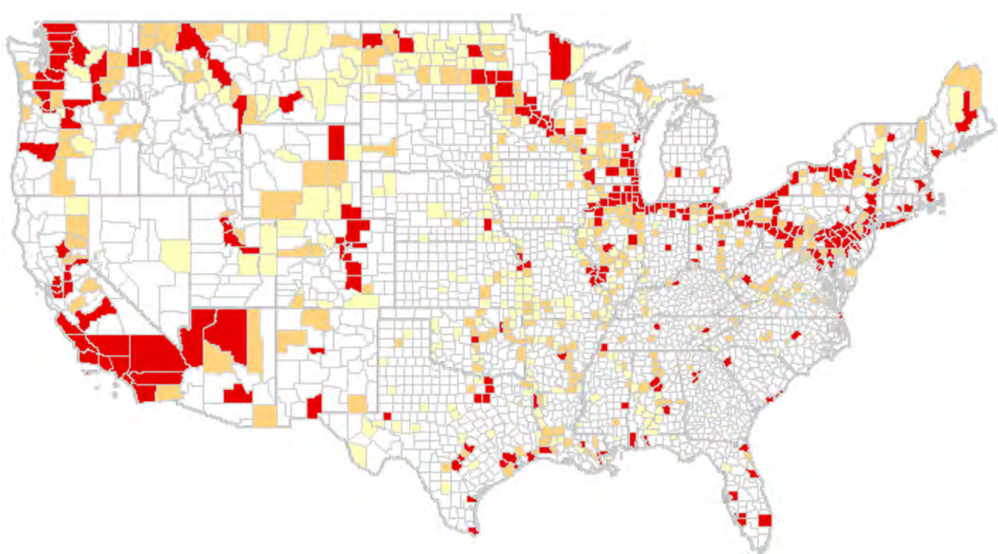

FIGURE 1 Crude-by-rail risk assessment by county.

NEXT-GENERATION SMARTPHONE OR TABLET-BASED COMMERCIAL VEHICLE SURVEY

Lynette Cheah
Singapore University of Technology and Design

Kyungsoo Jeong
Massachusetts Institute of Technology

Alex Marach
CPCS

Background

In freight movement studies, data collected from commercial vehicle (CV) surveys help planners better understand vehicle operations and activities. Fleet tracking studies that use Global Navigation Satellite System technology to collect location traces of vehicles reveal vehicle trajectories (stops, routes, tours). Driver intercept surveys, traditionally conducted manually, reveal more about stop activities, vehicle loads, shipment sizes, commodity types, and other trip details.

Attempts have been made to integrate these approaches, which help in understanding trip activities with respect to vehicle movements. For instance, the Canada Vehicle Use Study applied a survey instrument that involves logging spatial data, engine data, and trip purpose electronically (Allie 2014). A custom On-Board Diagnostics (OBD)–GPS logger was used, which includes a screen to allow drivers to input trip information. In Singapore and Boston, the research team conducted CV surveys that combine GPS tracking with driver surveys (Ding-Mastera et al. 2018, Alho et al. 2018). Post-travel, drivers verify vehicle traces and declare stop activities either through a web interface or through follow-up phone interviews. While drivers can complete the survey online, many relied on assisted phone interviews conducted by surveyors, which was more intrusive and burdensome.

Innovations

This research enhances data collection efforts by developing a new mobile application (app) for surveying. Smartphone-based travel surveys have already been previously deployed to understand passenger transport. Mobile devices are more portable and versatile with multiple sensors integrated (e.g., GPS, accelerometer). They offer the potential to collect high-resolution mobility data more efficiently. The approach leverages this capability and applies it to better understand CV movement and activities as well. This CV survey instrument accommodates smartphones or tablets to collect location data. It then presents inferred information, such as stops and predicted activities, in an activity diary through user-friendly interfaces on the app for drivers to verify and provide additional inputs. Replacing the GPS logger and the web survey with a single mobile device facilitates the ability to obtain high-resolution and accurate data, and also simplifies the data collection procedure with reduced survey operational burden.

As a proof of concept (POC), the app is to be tested with 10 CV drivers in Singapore, recruited and trained to use the app. During the data collection period, tablets with the app will be mounted on the vehicle dashboards. On their own time, drivers can verify detected stops and answer stop-related questions as prompted by the app. Each driver will be offered an incentive to complete their travel and activity log via the app over five consecutive working days to test technical feasibility of the approach. The tests will includes location accuracy, accurate stop detection, as well as operational issues (e.g., device deployment and return), and a drivers' ability to independently use the app. Figure 2 provides an illustration of the Future Mobility Sensing (FMS) app data and processing steps.

Contributions

By harnessing mobile sensing technologies, the app solution is enhanced to collect high-resolution and accurate freight data. In this study, to overcome fragmented data issues in conventional approaches, a smartphone- or tablet-based solution is designed and implemented to support CV surveys through a dedicated app, which (1) utilizes various mobile sensors to collect vehicle movement data, (2) includes backend machine learning components to detect vehicle stops and travel intervals, and (3) presents inferred information in a summarized daily activity diary to collect additional inputs from drivers about vehicle activities, commodity size and vehicle payload. Moreover, as such solution has high portability and accessibility, the survey flow can be simplified with minimal involvements from each respondent, who only needs to carry the mobile devices while driving, and provide information according to prompted instructions when available. The survey procedure includes survey recruitment, distribution of mobile devices, participant training, data collection and daily data verification. The results and best practices derived from such pilot can be beneficial to both researchers and planners who may be considering deploying CV surveys in the future.

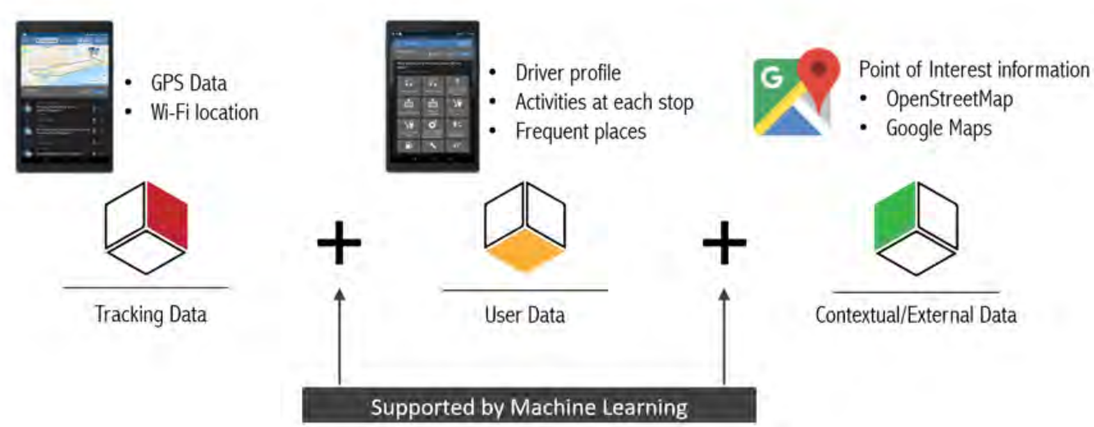

FIGURE 2 Illustration of three types of data used for FMS freight app.

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LEVERAGING THE CROWD: THE APPLICATION OF CROWDSOURCED DATA TO GENERATE TRUCK PARKING INSIGHTS

Alex Marach
CPCS

Background

It has been acknowledged that nationwide that there is inadequate truck parking. For example, 75% of truck drivers have difficulty finding parking more than once a week. As a result, there is an economic cost to truck drivers for this shortage. It has been reported that 48% of truck drivers need at least an additional hour to find parking, and this costs the drivers approximately $5,600 in potential wages. In addition, the inability to find parking impacts safety and can lead to damaged infrastructure. The Arizona Truck Parking Study reports that the Arizona State Freight Plan also identified truck parking as a key issue. What are the solutions and opportunities that would guide Arizona DOT with their decision-making process to allocate $10 million in NHFP funds? The study revealed issues associated with the available truck parking supply, utilization and gaps, both with public and private truck parking locations. There are more than 7,030 truck parking spaces statewide in 129 locations, with an average of 55 spaces per location. The key need is to define and prioritize parking opportunities and solutions, to identify where to deploy capacity, and to disseminate information.

Innovations

This research demonstrates the use of crowdsourced data to analyze the proportion of truck parking spaces at public rest areas and private truck stops that are occupied (utilization) to inform public-sector policy and investment decisions. Transportation agencies are increasingly focused on truck parking issues resulting from the growth in truck traffic and the electronic logging device (ELD) mandate. Major issues include specific locations where there is insufficient truck parking and concerns over the resulting unsafe parking practices. To date, analyzing the utilization of truck parking has relied on visual surveys conducted over a limited time period (often only 1 or 2 days), extrapolated truck GPS data, or formula-based estimates. Crowdsourced data from Trucker Path, as used by CPCS in the Arizona Truck Parking Study, is a new source of data generated by nearly 800,000 truck drivers who use the Trucker Path app to find and report truck parking availability.

Trucker Path data provide deep insights into the temporal and spatial variations in truck parking utilization at public and private truck parking locations. Using a full year of Trucker Path data allows the flexibility to analyze truck parking based on the time of day, day of week, or month, as well as analyze variables that are unique to a particular transportation agency, such as seasonality, roadway closures, and construction. Additionally, fusing crowdsourced data with truck GPS data provides a comprehensive picture of the supply and use of truck parking spaces and the impacts of insufficient truck parking. Therefore, this research is an example of a new data source for freight planning and fusing new and traditional data sources to improve insights into truck parking issues.

Figure 3 provides a visualization of an analysis, including the point coverage overlaid on an aerial photo of the area second-ranked location. Truck parking utilization has both spatial and temporal variables which change by time of day and will vary based on location or proximity to freight generators (e.g., manufacturers, warehouses, distribution centers). CPCS implemented a network centered approach to visualizing truck parking that is similar to how a truck driver might view the utilization of truck parking, specifically displaying the utilization of truck parking locations that are closest to each roadway segment based on the time of day. Visualizing the data at a segment level and fusing these data with surveys of truck drivers and truck GPS data provide much greater detail than was previously available on where truck parking utilization is particularly high and helps public-sector agencies target investment.

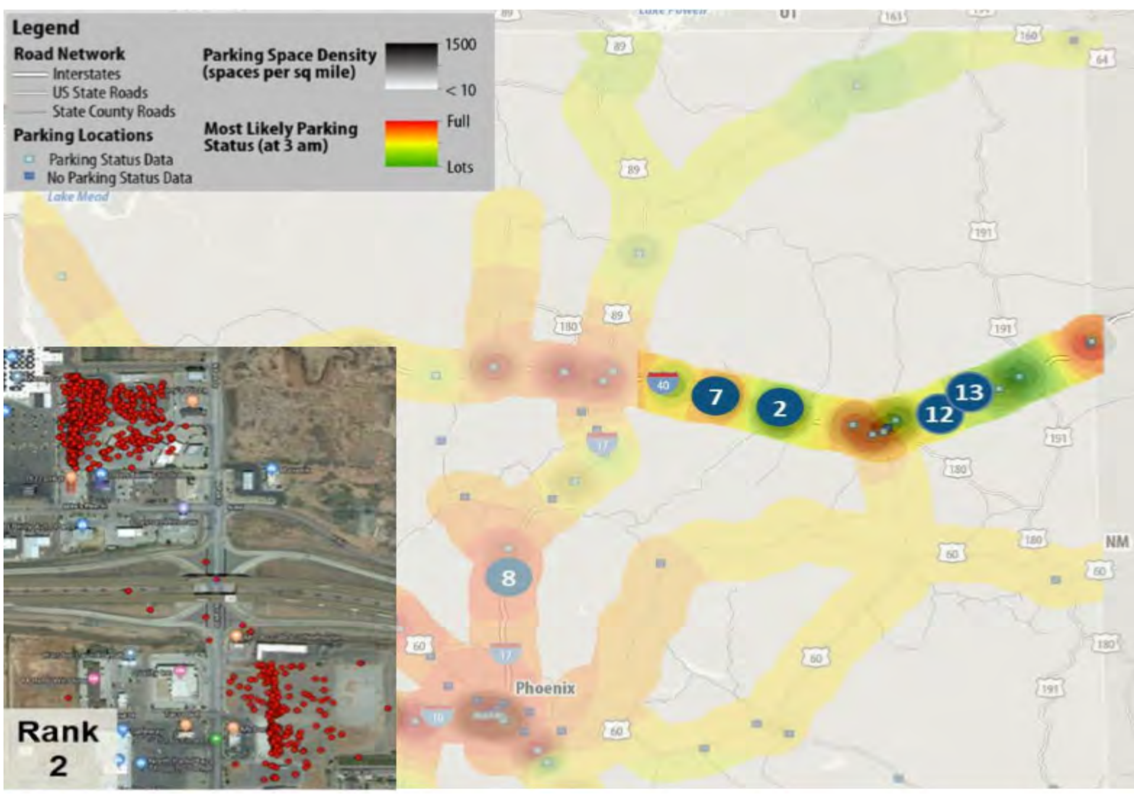

FIGURE 3 Composite visualization developed to identify truck parking issues.

Contributions

This research provides an example of how the public sector can work with the private sector to leverage data they generate to improve transportation planning. The data generated by Trucker Path is proprietary, but is immensely helpful to studying truck parking. The use of Trucker Path in Arizona provides an example of the potential opportunities for the public sector to leverage private sector data. The opportunity to leverage private sector data will only increase as technology is developed and implemented to address problems that were previously thought to be too large or complex.

The use of Trucker Path to study truck parking is applicable to future truck parking studies, public-sector decisions on what and where to invest resources, and is applicable to local, state, and corridor freight planning efforts. Both the public and private sectors benefit from the use of Trucker Path to analyze truck parking because this approach provides a more comprehensive temporal and spatial view on truck parking than is currently available, resulting in more informed decision-making and better outcomes. For example, a comprehensive understanding of the utilization of truck parking enables transportation agencies to identify the locations with the most acute truck parking issues and match the most applicable solutions, such as capacity expansion or information systems. This approach sets the stage for transportation agencies to accurately identify truck parking issues and efficiently match solutions to maximize the impact of public sector investment.

Audience Dialogue

To begin the dialogue, a member of Transport Canada shared the current practice of the natural resource department in Canada to publish oil-by-rail export data. In addition, locations critical for evacuation planning are purchased from vendors (e.g., schools, hospitals) and spatially displayed using geographic information systems (GIS). A rail professional pointed out that rail routings can change based on current events (e.g., embargo with Venezuala). Emergency responders are able to use Ask Rail, an app providing information on the content of trains and routing information. Railroads need to consider the trade-offs of safety and security with protection of propritary information, ensuring appropriate information is shared with the right personnel and planners. Another audience member, referring to the map of rail incidents, requested the source of the data. The research team indicated that Earth Justice was the primary source, and supplemented two or three other sources with similar information. These sources provide details on each event, including how many people were evacuated, whether or not a fire was involved, and other relevent details.

Regarding the Singapore CFS, an audience member noted that drivers often do not know what commodity is being hauled in the United States and whether this was also the case in Singapore. According to the researchers, there are cases when the driver does not know what commodity they are carrying and are given the option of indicating “do not know” on the survey. In the pre-survey, the company or vehicle owner fills in the commodity usually carried in a truck. This information can be used in the event a particular driver is unable to identify the commodity hauled on a particular trip. In general, it is assumed that business operations are similar between the United States and Singapore with respect to driver knowledge of commodity hauled.

An audience member wanted to know whether the researchers considered surveying shippers, in addition to truck drivers. According the research team, they were trying to recruit shippers and connect the data to the driver information. Another question focused on respondent burden, particularly considering the number of items to be provided, including the purpose of the haul and the cargo. The question further focused on how long it would it take for the driver to complete the information request for each stop and whether there was an effect on response rates or completion rates based on the number of questions. The research team indicated that the average time spent verifying the activities for a day approximately 15 min. Currently, there are no statistics on the drop-off rate. It was noted that the platform used in the research collected data on consecutive days from each driver and machine-learning techniques provided pre-filled information to reduce the survey time for each stop. In addition, the research team designed pop-up functions that detected stop durations of 3 min or more. A page pops up to alert the driver that a stop is being detected and the driver can then verify the purpose of the stop.

Regarding the United States' deployment plans, a question was asked about how to connect and become involved in the mobility sensing freight platform recruitment efforts. The research team indicated that the United States' future freight logistics survey has three phases. The research team has completed the first two phases, including the first phase to pilot a truck driver survey and the second phase to track shipments. The third phase will integrate the collection of truck GPS and shipment data simultaneously. Researchers are looking for establishments who have outgoing shipments as well as operating their own fleets so they can track their shipments. Recruitment is currently underway, using GPS loggers for shipment tracking and tablets for the driver survey component.

An audience member asked about the level of accuracy for the Trucker Path data. The research used three conditions: full, some spots available, or many spots are available. For the purposes of the research, 50% full or greater are of concern. A survey of app of users indicates that 97% found the data useful for finding truck parking. Another question focused on the identification of unauthorized locations (e.g., ramps), and whether overflow parking locations were differentiated from completely random locations off the interstates. The research found that Arizona DOT had four truck parking rest areas that actually have designated overflow areas and these locations were included as designated locations. Any trucks found parking on ramps were classified as undesignated parking locations as the purposes of these facilities is to allow trucks to safely decrease and increase speed before merging, which means that parking impacts the functionality of these areas. In addition, these locations were not built to withstand the weight of the trucks on the shoulders. One of the findings regarding Arizona DOT's rest areas was that they are chronically over-subscribed, suggesting the need to assist truckers with finding private spaces that are nearby.

An audience member had questions regarding the threshold time period used to collect data to consider a truck parked, and any kind of consideration or restrictions about the land use or truck routes during the data collection phase. The research used land use data when trucks were observed parked in vacant lots to correctly identify if the location was across from a truck stop which may or may not be used by the facility. Each parcel was analyzed to ensure any truck parking spots considered undesignated was owned by someone other than the truck stop operator. Spots where trucks were stopped for at least 30 min were counted as actual stops, with two different designations for trucks parked over 8 h, and trucks parked from 30 min to 8 h. Eight-hour period are typically associated an overnight stay. What was interesting was there was lot more of the 8-h and below stops, but because of the overall length of the 8-h and above stops, they actually comprised a larger total number of stopped hours in the study.

An audience member pointed out the reference to the approximately 7,000 truck parking spots in Arizona and whether these spots were actually counted, or if the Trucker Path information provided the counts. The research took the Trucker Path data and looked at each individual location and validated the number of spaces. In some cases, counts were available from an XML feed that could be downloaded and cross-referenced. Another audience member requested clarification on the percentage of state-owned facilities. Twelve percent of rest areas are state owned, while according to the 2015 information from Jason's Law (federal law aimed at providing safe locations for truck drivers to park) in Arizona and other information, between 5% and 7% of spaces were state owned. Another audience member asked whether specific data provided by Trucker Path having individual user information would make it possible to track movements, or if their data was aggregated. The researchers indicated no user IDs were collected from the app.

Regarding the research method used for the Arizona DOT study, using GPS data and overlays of additional information, an audience member wondered if it would it be possible to anticipate future parking demands, and if there were any correlations considered for other factors that contribute to truck parking shortages that could be used for planning purposes. The researcher stated that the scope of the project did not include forecasting, although he indicated that annual average daily truck traffic (AADT) and potential volumes could be used in the future as a form of projections. Different factors that affect truck parking (e.g., warehousing development, population clusters, heavy users of freight-dependent industries) to identify potential truck parking were examined.

Finally, all three presenters were asked about their experience with bias in the data. For example, would rail data, or truck data near populated areas be impacted, or would respondents be more likely to refuse to participate based on the task of answers questions? The oil-on-rail research had large quantities of data, but didn't address bias directly, in a statistical sense. However, there were correlations with results from other sources (e.g., *Wall Street Journal*). For the Singapore study, the research team expressed concerns regarding self-selection bias, although drivers in Singapore were more homogeneous than drivers in the United States. In the United States study, recruitment was conducted in local areas and only drivers belonging to smaller establishments were included. This created a potential bias, leading the research team to ask for drivers from larger establishment, more likely to be participating in interstate transportation, to reduce this bias. The survey effort is attempting to cover both local deliveries and interstate deliveries in the United States.

Potential bias with the Trucker Path app data could most likely be a higher propensity for locations with substantial truck parking to have more observations because there is a higher chance that a truck driver who drives into that area has the app. The benefit of using an observational collection method such as Trucker Path is that it requires only one driver to use the app to collect utilization rates. That said, for larger facilities (e.g., 400 spaces), the chance that that is regularly updated is higher. The researcher also used truck GPS data, which probably has an underlying distribution of trucks that may not be representative as that distribution is likely geared towards larger fleets rather than smaller fleets. Thus, there could also be a bias in the analysis.

One of the ways to reduce bias is to use an active truck parking advisory group. For this research, the Arizona Trucking Association participated in the validation checks, using the Trucker Path data and other alternative sources to get at that information, along with extensive quality assurance–quality control (QA-QC) procedures to validate the actual locations. For example, because Trucker Path has roadside gravel lots included in its inventory, there were locations not designated as truck parking. Arizona DOT could provide information on whether the site should be blocked off or transformed into formalized truck parking if it is an alternative for truck parking.

KEY TAKEAWAYS

Jeff Short
American Transportation Research Institute

New Data Sources

- Flickr photo-sharing data with a web-scrapping methodology.
- Trucker Path app as a source of parking utilization data.

New Methods

- Combining the Flickr data with county-level risk assessment to beter understand hazardous materials hauls on rail.
- Combining the functionality of GPS and web surveys in a new mobile app for surveying truck movements and collecting data on commodity hauls.
- Combining Trucker Path data with land use data to determine truck parking needs.

New Challenges

- Rail routes for hazardous hauls can change due to market conditions resulting in safety concerns.
- Truck drivers often are not aware of the commodities they are hauling and are unable to provide this information, regardless of the methods used.
- Previous demand for truck parking spots could be accelerated with hours-of-service (HOS) restrictions and very accurate directions are needed assist drivers in locating a safe location to park.

Hot Topics

- Commodity identification to promote safety.
- Truck parking locations to accommodate HOS restrictions.

Developing Freight Data into Decision-Making Information

HOLLY COHEN
Florida Department of Transportation, presiding

JULIUS CODJOE
Louisiana Department of Transportation and Development, recording

State and local agencies are now using common data sources such as vehicle probes, traffic sensors, and WIM systems in innovative ways for freight planning and performance measurements. This panel discussed new freight planning and performance measurement applications for public agencies.

TRUCK EMPTY BACKHAUL: A FLORIDA FREIGHT STORY

Joel Worrell
Florida Department of Transportation

Background

Truck empty backhaul (TEBH) is a phenomenon by which heavy trucks return to their origin (empty) after unloading freight at its destination. This results in empty truck miles that may otherwise be used to carry goods during the return trip. TEBH contributes to the multimodal issues of freight–flow imbalances. Empty trucks negatively impact the utility and efficiency of the trucking industry with increased supply chain costs, reduced productivity, imbalanced emissions, fuel wastage, added roadway congestion, and limited driver resources. High TEBH out of the state has been widely acknowledged as a major issue in the state of Florida. But, it is evident that this phenomenon has not been quantified with robust datasets, measures, or methodologies. Trucks are defined as full when axle loads exceed 60,000 lb, empty when axle loads are less than 40,000 lb, and partially empty for any loads in-between.

Innovations

This study develops a comprehensive methodology to quantify the degree of TEBH using WIM data. The study further reviews and quantifies potential factors impacting TEBH in Florida using freight information and datasets. The outcomes of this study are utilized to formulate feasible recommendations to constrain TEBH in Florida. The primary dataset used for this analysis is WIM. It is a micro dataset that includes the individual records of trucks (FHWA Classes 5 to 12) passing through a WIM site. The dataset includes date, timestamp, travel direction, travel lane, truck gross weight, vehicle class, vehicle length, axle spacing, and axle weights for every record. This dataset is an incomplete time series and an unbalanced panel data as the data may not be collected continuously because of technical or weather issues. The spatial coverage and temporal coverage of WIM data considered for the analysis is 30+ Florida WIM sites and 2015–2017, respectively.

The data contains over 100 million individual records. The dataset is cross validated with weigh station data being the reference datasets. The WIM dataset is analyzed comprehensively to compute empty truck percentage by classifying trucks as overweight, heavy–full trucks, light–full trucks, empty trucks, heavy–partially empty trucks, light–partially empty trucks, and bobtails. This classification is based on truck length, axle, and weight dimensions. The final outcome helps to quantify the degree of empty trucks leaving the state and build a classification tree algorithm which can be utilized for real-time quantification of the empty back haul. Figure 4 illustrates the steps taken in the cargo status process.

Using this technique it was determined that approximately 54% of all trucks entering Florida are full, while 30% to 47% of all trucks leaving Florida are full. These findings confirm that there is a trade imbalance. Cubed out trucks make up nearly 20% of all truck traffic, with a higher percentage of these trucks entering compared to leaving Florida. In addition, partially empty trucks make up approximately 10% of all trucks. It is also possible to better understand temporal aspects. For example, the highest percentage of empties are inbound in May, while the lowest percentage of empties are outbound. The percentage of empty trucks increases during the middle of the day compared to truck traffic at night.

Potential solutions for the imbalance could be to attract more manufacturing firms; consider more "pony express" loads instead of full truckloads; and incentivize "value added" manufacturing or import of semiprocessed goods for products for Florida markets. It might be possible to invest in projects that facilitate expedient outbound movements of freight. In addition, collapsible cargo containers offer a potential solution as well.

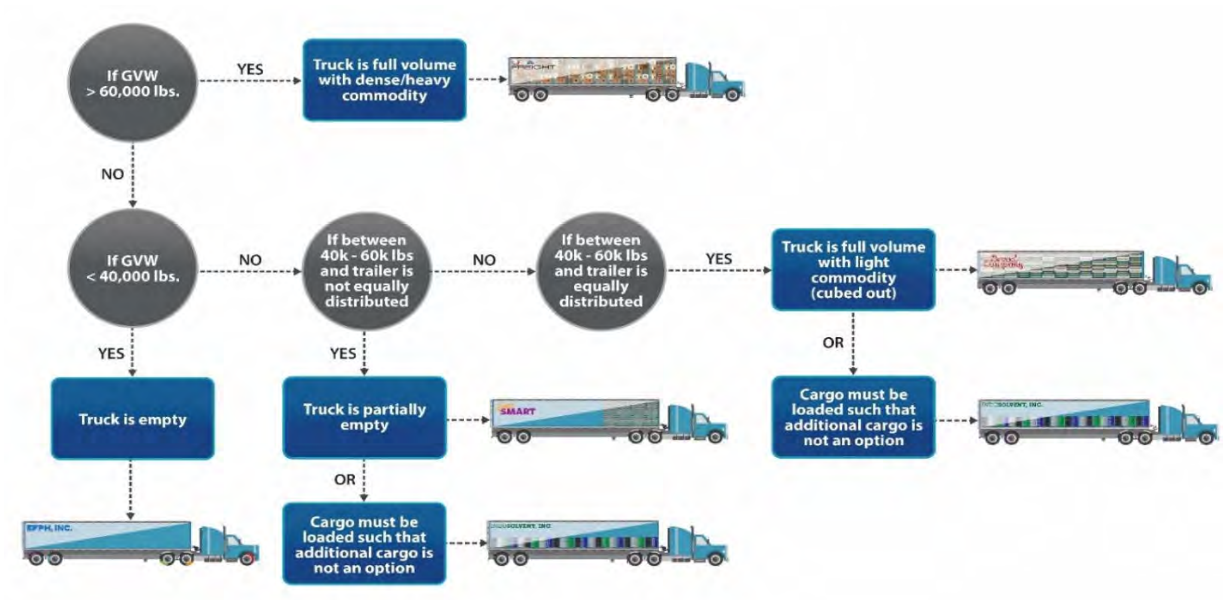

FIGURE 4 Methodology for determining truck cargo status.

Contributions

This research was initiated due to a lack of observed, empirical analyses of TEBH. Up until this study, all assertions of high TEBH were anecdotal. This novel methodology can be applied by any state DOT if they collect disaggregate per-vehicle record data at WIM-enabled continuous traffic monitoring sites. The new methodology allows for a finer-grained analysis by identifying cubed out and partially empty CVs based on overall axle weight distribution for each vehicle. Through this analysis, recommendations may allow for the identification of specific industries that significantly contribute to the truck empty backhaul phenomenon.

USING FREIGHT DATA TO INFORM THE 2018 TEXAS 100 MOST-CONGESTED ROAD SECTIONS

David Schrank
Bill Eisele
Texas A&M Transportation Institute

Background

In response to increased roadway congestion throughout the state, the 2009 Texas Legislature mandated that the Texas DOT annually produce a ranked list of the most congested roadways in the state, which is now called the "Texas 100 Most Congested Road Sections" (TX100). The TX100 database is comprised of roadway inventory data from Texas DOT and speed data from a private company vendor (INRIX is the company in 2018). The list measures congestion by the number of extra hours of travel time (also called "delay" and captures both hours and volume) experienced by travelers on each section of road analyzed. Because of the significant delay values in the most congested corridors, and the slow nature of solution implementation to address a congested roadway, the overall list changes little from year to year. The Freight Group of Texas DOT contributed to the success of Texas 100 Study. Specifically, four indices were used to measure total magnitude—vehicle delay in hours; truck-only delay; vehicle delay per mile; and truck only delay per mile. Other measures used include travel time index and planning index to assess the performance of individual travelers experiences as individual traffic measures.

Innovations

In 2014, a truck-only version of the congestion statistics was added to the database. Every one of the nearly 1,800 sections of roadway (almost 10,000 mi) tracked in the database has both an "all-vehicle" and "truck-only" set of statistics. The full database can be found in the spreadsheet at (https://mobility.tamu.edu/texas-most-congested-roadways/).

Congestion is sometimes interpreted as a sign of economic growth, but for individuals or truckers attempting to navigate a congested roadway, it often simply feels like a problem. Congestion costs about $11.7 billion for all vehicles in the 1,800 sections of roadway in wasted time and fuel including about $1.2 billion in costs associated with trucks. There are many underlying causes for sections climbing or falling in the rankings including economic prosperity, land use changes, major construction, congestion outside the traditional peak periods, and weather. Since the TX100 database captures these changes, it is used by Texas DOT and transportation agencies in Texas to identify the most congested of these sections and ensure that an emphasis is placed on addressing solutions in those top locations.

By adding truck-only data and congestion statistics, the TX100 database shows that not all bottlenecks are truck bottlenecks. Some locations, because of land use and commuting patterns, are dominated by automobiles rather than truck travel and in these locations the rankings can be very different for all vehicle delay versus truck-only delay. For example, Loop 1 in Austin is ranked 21st for all-vehicle delay and 229th for truck-only delay. Conversely, SH-249 north of Houston is ranked 91st for all-vehicle delay and 24th for truck-only delay. This type of information is helpful to planners to determine which treatments or solutions might be appropriate on a given section of roadway.

The results of the study, using visualizations, make it easy to communicate congested areas to elected officials. Another tool used by the researchers is the Congestion Management Process Assessment Tool. This tool provides truck mobility visualizations for MPOs to assess local road congestion patterns. Figure 5 displays a technique to illustrate travel times from a particular location.

Contributions

The data in the Texas 100 Most Congested Road Sections allows transportation agencies to make more-informed investment decision based on data. Additionally, it informs the conversation of the benefits that were derived from investment decisions after the fact.

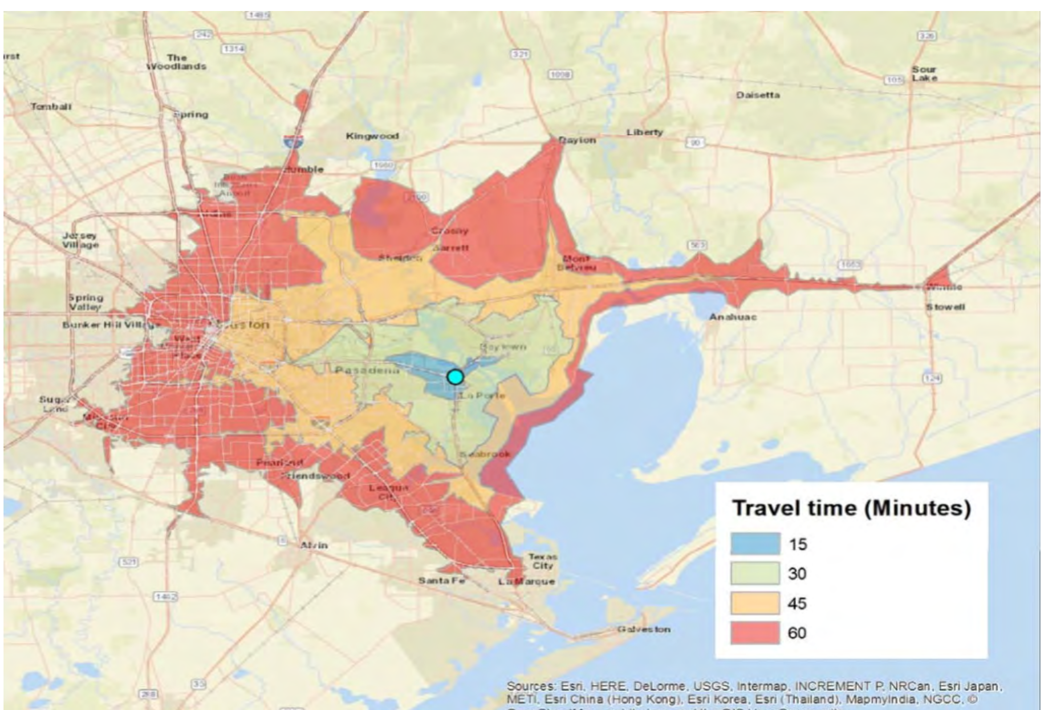

FIGURE 5 Visualization of travel times from designated location.

TRUCKS AND THE PORT OF VIRGINIA: UNDERSTANDING FREIGHT PATTERNS WITH BIG DATA

Robert Case
Hampton Roads Transportation Planning Organization

Catherine Manzo
StreetLight Data

Background

Understanding where port-related trucks travel once they leave a port facility has always been a challenge for freight planners and modelers. This research examines a method for measuring highway gateway usage by port trucks. This data is expected to inform highway project prioritization, inform current highway studies, and support funding applications. Specifically, the objective of this research is to determine freight patters in terms of where trips originate (ports) and where they pass through the region (gateways). The data sources used were the ATRI and StreetLight.

The ATRI data consists of 7.5 million "pings" that include location data (longitude and latitude). The initial analysis using R, an open-source statistical software, was difficult to interpret, resulting in the attempt to clarify patterns by adding the StreetLight data.

Innovations

The research was focused on assisting planners at the Hampton Roads Transportation Organization (HRTPO) with the use of commercial truck data analytics from fleet managements systems. Metrics developed by StreetLight Data, a mobility analytics provider, helped HRTPO measure the volume of port-related truck traffic on area roads and thus identify the most popular gateways for port-related trucks. Understanding the behavior of port-related trucks is critical for HRTPO. The nearby Port of Virginia is one of the largest ports on the East Coast and 60% of cargo leaving the facility is transported by truck. HRTPO used GPS data to identify the highways that were most commonly used by port-related commercial trucks.

Planners compared the big data-derived results with truck counts obtained from Virginia DOT. While the data from Virginia DOT contained the total number of trucks at the highway gateways, they did not indicate the share of trucks that were affiliated with the Port of Virginia. HRTPO determined that, while the total commercial truck counts were fairly similar, the results from big data were slightly higher. This difference is important—it shows that commercial trucks affiliated with the port have different travel behavior than average trucks, and it highlights the importance of interstate highways to trucks leaving the Port of Virginia.

HRTPO was able to implement these results in a number of different ways. For example, using the HRTPO Prioritization Tool, projects that increase access to port facilities could be identified. HRTPO was not able to quantify which projects would actually improve port access until this study was completed. Having quantifiable results is helping HRTPO choose projects that will be the most effective in managing commercial trucking impacts. Figure 6 provides a visualization of truck densities.

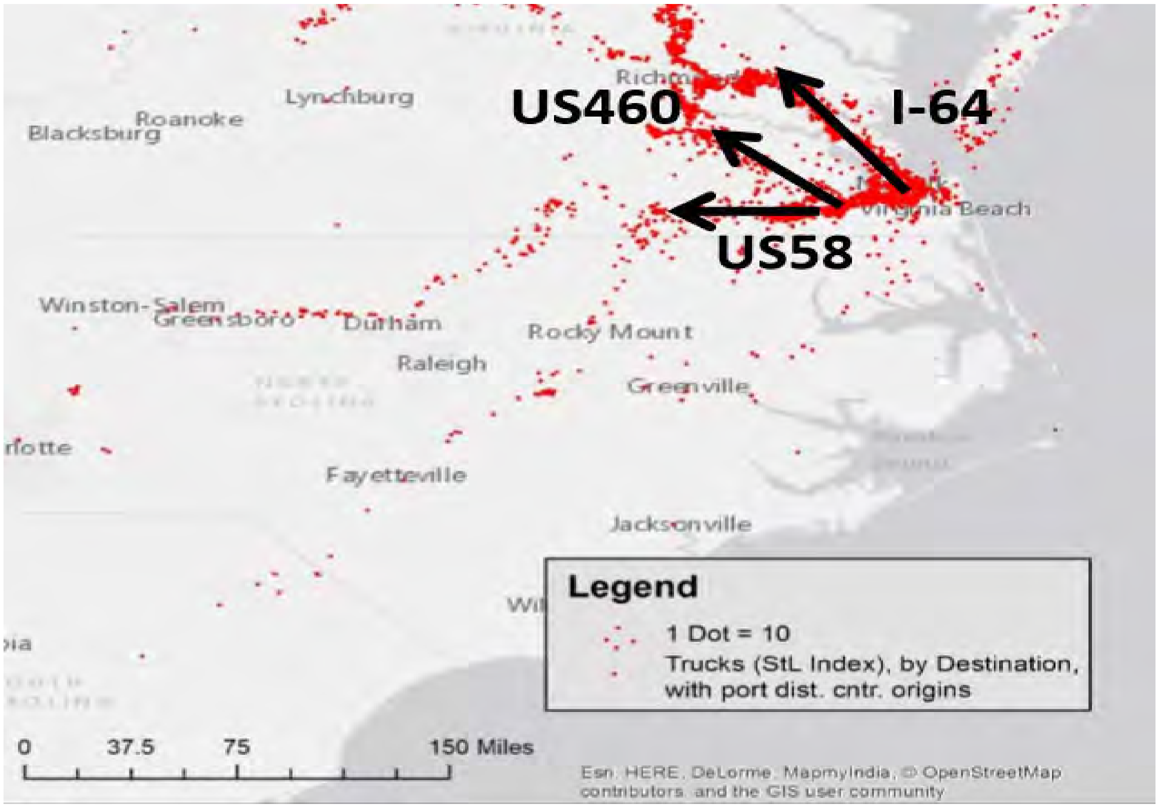

FIGURE 6 Visualization of truck locations for origin–destination analysis.

Contributions

This research used data from fleet management systems to understand commercial truck activity related to ports. Importantly, these techniques can be applied to other special truck activity generators, such as distribution centers. New algorithmic processing techniques are helping planners use these "big data" resources more efficiently and effectively. All probe data provides additional benefits, and no dataset, as yet, offers a full solution.

Audience Dialogue

Regarding the Texas 100 study, an audience member wanted to know why only 100 cases were examined. According to the researcher, the Texas legislature was responsible for the decision to focus on the top 100 most congested areas in the State.

A number of questions focused on the Port of Virginia's approach to identifying origins and destinations. For example, an audience member asked if, in addition to trips from the ports, weretrips from distribution centers, both to and from the ports, included? This was followed by a discussion on distribution centers as both origins and destinations. As a follow-up to this discussion, another audience member asked about the types of projects to be evaluated (e.g., highway projects versus port-related projects). The concern is whether different types of projects would produce different types of results. The research team provided a lengthy clarification on the differences between the datasets used in the study. It was possible that the original concerns were due to use of only a small set of ATRI data. In addition, there was a discussion on formal data usage agreements. Returning to the probe data study, a comment was made regarding sampling bias with the Streetlight data. According to the researchers, the very nature of data processing attempts to consider this issue in its algorithms and there is an assumption that there is representative samples for all road segments. The discussion concluded with a focus on how freight data could be used to inform decision making and how to identify the most appropriate type of data to use for an origin and destination study.

Coming from a freight industry perspective, an audience member commented that as a private entity, freight community members have their own orientation to managing their processes. Given this approach, the audience member asked whether, from the state policy perspective, the next step will be to influence the freight industry to maximize the efficiency of their systems. The researcher agreed with this concern and replied that an effort is being made to share the results of the study with freight community managers and the larger trucking industry to assist in possible ways to influence decision making by the private sector. This was followed by a question on whether the HRTPO study took into consideration the yearly variation in truck loads as there was a possibility that this will be impacted by changes in economic conditions. The response was that this type of analysis is yet to be conducted and will be considered in the future.

KEY TAKEAWAYS

Mario Monsreal
Texas A&M University Transportation Institute

New Data Sources

- Per record WIM data.
- Processed truck probe data.

New Methods

- Using per-record WIM data to calcualte truck capacity utilization.
- Truck-only congestion statistics to understand truck in congestion or bottlenecks.
- Using processed truck probe data to determine origins and destinations from ports and distribution centers.

New Challenges

- WIM data isn’t complete due to equipment outages and weather impacts.
- Per-record WIM only indicates a commodity is being hauled, but doesn’t provide information on what commodity.
- Processed truck probe data requires assumptions on activity patterns and requires validation strategy to ensure assumptions are correct.

Hot Topics

- Understanding truck capacity efficiencies.
- Trucks caught in congestion and statistics regarding the impact of the congestion.
- Attempts to establish origins and destinations of truck trips.

Developing Data Systems to Manage Commercial Vehicle Behaviors

DONALD LUDLOW
CPCS, presiding

PAUL BINGHAM
HIS Markit, recording

Understanding truck activity patterns and supply chain behaviors is critical for planning for and managing goods movements and prioritizing infrastructure investments. This panel discussed new methods for identifying, measuring, and visualizing freight activities.

IMPLEMENTATION OF A NATIONAL FREIGHT FLUIDITY MONITORING PROGRAM

Marygrace Parker
I-95 Corridor Coalition

Joseph Bryan
WSP USA, Inc.

Background

The purpose of the Freight Fluidity Monitoring Program is to measure the general performance of representative transportation supply chains and their networks over time. Information on how transportation supply chains perform from the perspectives of shippers, carriers, and receivers is critical to knowing if supply chains are working or failing. This information is critical to determining if and where public investment, or changes in policy and regulation, might improve freight system performance and support economic competitiveness and growth. Existing data and analysis tool products available to public sector planners cover (*a*) economic drivers and freight demand and (*b*) information about the condition and performance of the highway, rail, and other networks.

Innovations

This FHWA-led program is being designed to provide information to fill a gap between those two elements with detail about supply chains—the paths along which freight shipments move—and end-to-end trip performance. The Freight Fluidity Program is gathering and reporting information on quarterly and annual trends in travel time, travel-time reliability, and approximate cost for representative supply chains across the United States. The program is engaging state and regional government partners to develop analysis of first- and last-mile moves, monitor regionally significant supply chains, and to supplement the data gathered for the National Freight Fluidity Program with local data and information. This approach takes real freight movement and fluidity data and monitors it over time.

Figure 7 provides a spatial display of the supply chain performance using the highway Planning Time Index (PTI) for 24 sectors averaged over four quarters.

Challenges facing this approach include ensuring confidence by industry partners of the confidentiality of their supply chain information. The research team members were careful in the approach they used to ask for information and were very clear about what they were and weren't asking and how the data was to be used and for what actual purposes.

Contributions

Development and implementation of a Freight Fluidity Monitoring Program addresses the MAP-21 and FAST Act mandates by providing a mechanism to support freight strategic plan development at the national, regional and local level to assist in preparing freight network condition. Performance reports provide the metrics (travel time, travel time reliability, cost of representative supply chains) that will make supply chains visible in transportation planning - bridging the gap between public- and private-sector to inform public-sector policy and investment decisions. This research provides a significant advancement because utilizes real suppy chain data from top freight industries as opposed to data from a model.

This research represents an advancement for practice that uses public–private data sharing efforts and is advancing the private-sector perspective to freight activities. This also represents a new way to engage the freight industry to help monitor performance of supply chains. The technical aspects of the research are simple, utilizing existing data sources and existing visualization platforms (e.g., Tableau and GIS).

FIGURE 7 Supply chain performance analysis.

TRUCK ACTIVITY PATTERN CLASSIFICATION USING ANONYMOUS MOBILE SENSOR DATA

Taslima Akter
Sarah Hernandez
University of Arkansas

Background

To construct and maintain a transportation system that supports the efficient movement of freight, it is necessary for the public sector to understand the economic drivers of freight flow. This is a challenge as the operational data commonly used by the public sector is void of information on commodity and industry classification. For example, an increasingly popular source of truck movement data comes from onboard GPS units or cell phones (and perhaps from ELDs in the near future). This data is shared with the public sector by private companies but is anonymized to protect privacy by removing information about truck type, industry served, and carrier–fleet for example. Thus, it is not immediately possible to tie this data to underlying economic conditions used to predict freight travel demand.

Innovations

This study used advanced machine learning and spatial analyses to classify trucks by industry based on activity patterns derived from anonymous GPS data. Examples of industry categories explored include agriculture, poultry, forestry, industrial equipment, consumer packaged goods, and oil–gas–petrol. The major components of this research are (1) identification of salient features of truck activity derived from anonymous GPS traces and (2) development of classification models to distinguish truck GPS traces by industry. Examples of salient features include stop frequency, stop duration, trip length, and ratios of trip length to stop frequency. This is coupled with spatial land use data including agricultural crop locations, business patterns, rest and truck stops, and point of interests to further determine the purpose or type of stop.

Both unsupervised and supervised machine-learning models, which are highly adept at discovering patterns from large data streams, were used to predict the industry associated with a truck movement based on the identified features. First, a K-modes clustering algorithm was used to extract common industry types evident in the selected features. Later, a neural network model was used to classify trucks by industry.

Significant pre-processing steps were carried out to prepare the large streams of GPS data for analysis including identification of stops and complete, connected paths and manual groundtruthing of industry types for a large sample of the anonymized truck GPS traces. The stop identification algorithm used point and space–mean–speed to determine if the truck stopped to perform freight activity (e.g., pick-up–delivery or rest) and then groups sets of GPS pings into stop clusters using minimum bounding rectangles. The path identification algorithm used the All Road Network of Linear Referenced Data to identify the complete, connected path of a truck movement. Figure 8 displays the outcome of providing a visualization of industry classes on road links.

Challenges for this approach include the difficulty of assigning truck "pings" to the nearest industry location. The use of buffering in GIS and the development of a buffer zones provided a potential solution for this issue.

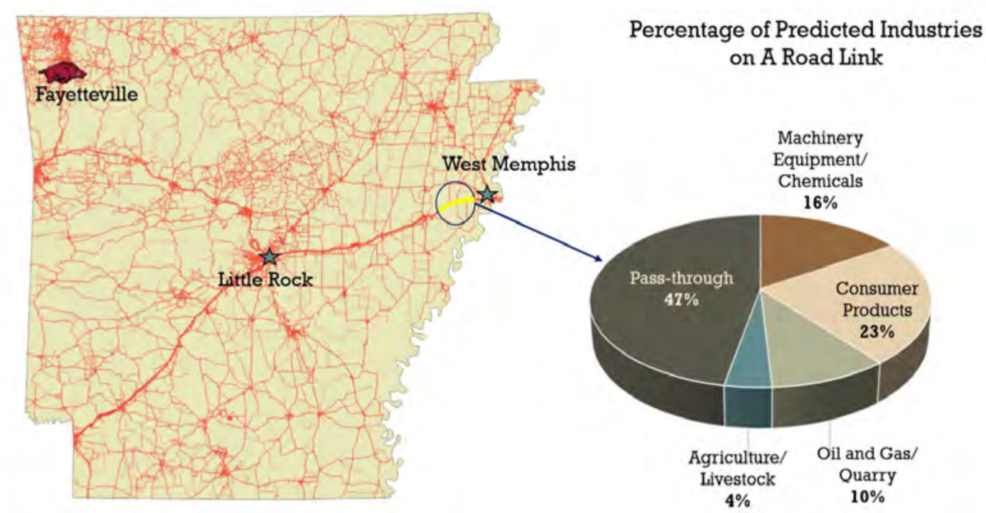

FIGURE 8 Analysis of commodity type on the road network.

Contributions

Ultimately, this research extracts industry classification from large streams of truck GPS data while maintaining the anonymity of the GPS data. Specifically, data like the fleet, driver, and company of the truck are not identified but the industry served is revealed in a useful but aggregate form. Truck movement data identified by industry can be used to better link the underlying economic drivers of freight movement to operational characteristics. A key advancement of this approach is its utilization of existing data in a new way. While truck data is fairly easy to inform tours and truck volumes, this information is difficult to tie to particular commodities. The research, using truck activity patterns and GPS data-derived industry classifications with nearly an 80% success rate. This advancement could support community-based travel demand models (TDMs) for freight.

ADVANCED USES OF TRUCK GPS DATA: TRUCK TOUR TYPOLOGIES, CONNECTING LONG-HAUL AND SHORT-HAUL TRUCKS, AND LONGITUDINAL ANALYSIS TO UNDERSTAND CHANGE IN BUSINESS PRACTICES OVER TIME

Collin Smith
Vincent Bernardin
Resource Systems Group, Inc.

Background

Passively collected truck GPS trace data are now available to TDM developers as a data source for the estimation, calibration, and validation of truck and freight demand models. Their usage is becoming increasingly common. With the availability now of several years of past data from truck GPS trace data vendors, it is possible to develop a multi-year GPS dataset of the region being studied and make comparisons of changes over time. This offers the opportunity to understand trends in the region, and to test whether the model being developed is capable of responding to input changes through short term forecasting sensitivity tests. Such tests would involve one year of truck GPS traces that are used for estimation or calibration of a base-year model and a second year of truck GPS traces that are used for forecast (or backcast) validation.

Innovations

This research is focused on the development of a truck model for an East Coast metropolitan area. Two years (2015 and 2017) of passively collected truck GPS trace data were procured for the project for the use of designing, estimating, and calibrating the model and then for evaluating the forecast sensitivity of the model. The truck GPS trace data were processed using consistent methods for the 2 years into trips through stop identification methods and then grouped into tours. The 2 years of data are being expanded using truck counts to represent the full population of trucks moving in and through the region. The 2 years of data are being compared with each other and with other local data such as land use data to understand the differences in truck travel behavior between the 2 years and to embody the model with the ability to forecast those changes.

The research covers three main innovations that are embodied in the work. The first is the advanced methods to process the GPS data from raw GPS traces into trips. This includes techniques such as identifying and filtering intermediate stops which is important for linking these data to commodity flow data to understand freight movement as well as truck movement. The second innovation is the use of these data in data-driven truck modeling, where the data are used to characterize aspects of truck travel behavior such as truck tour typologies and support the identification of linkages between long- and short-haul truck movements at transshipment locations. The third innovation is the use of longitudinal data to understand short terms changes in truck travel behavior in response to land use and transportation supply changes. Figure 9 displays derived densities of medium-weight vehicles using the processed data.

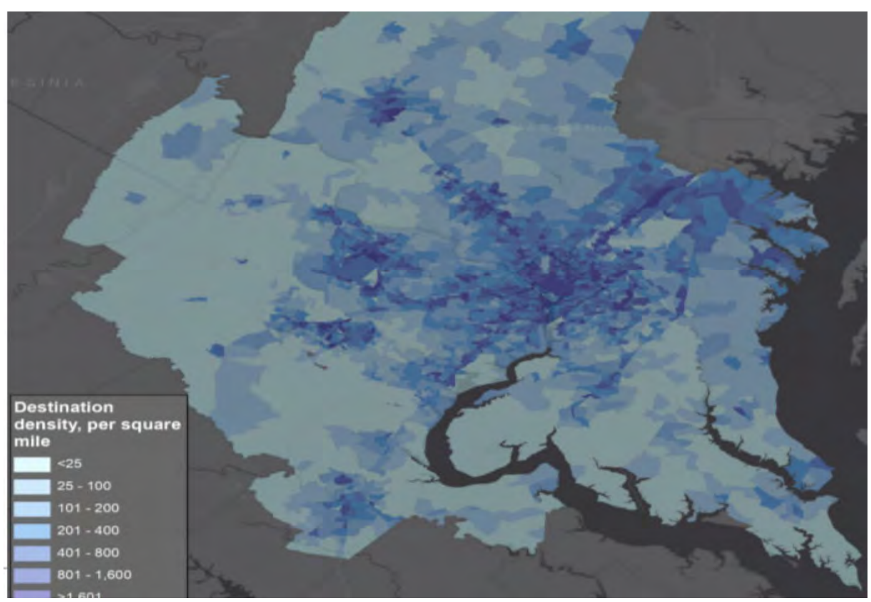

FIGURE 9 Derived destination density of medium-weight vehicles in 2017.

For this research, data was aggregated from multiple sources to record unique trucks, their weight class, with minute-by-minute tracking over several days of activities. At the same time, challenges included the uncertainity surrounding the quality of the probe data and other input data sources. In addition, the data only covered 2 weeks of truck activities. For some regions, this type of sample would only be useful as a "snapshot" of activity, lacking seasonal variation (e.g., locations where agricultural hauls occur differently across the year).

Contributions

This research represents the state of the art in processing and analyzing passively collected truck GPS trace data. When these new data sources are used well they provide a cost effective way for freight stakeholders to understand the behavior of the freight and truck system and to make well supported planning decisions. The work includes one of the first attempts to demonstrate the use of multiple years of truck GPS trace data for the purpose of developing a truck model and then using the data to support testing of forecast sensitivity. This application also evaluates the issues of comparing samples of GPS trace data over time, both in terms of the inherent variability in the data given changes in sample make up over time and other control issues that affect comparing transportation data over time such as differences in weather and other incidents between time periods. The ability to understand the short term forecasting ability of truck models is important when trying to answer the question of whether they are appropriate tools for use in evaluating potential policies or projects.

Audience Dialogue

The moderator began the discussion with the following question for the research team. Using anonymous mobile sensor data, given the nearly 80% reported accuracy, what were some of the issues for the other 20%? The research team noted that for consumer products, there were issues with oil and gas trucks. Walmart has more than one type of distribution center, including fuel locations, resulting in some confusion on the delivery being either goods or fuel. Because the data feeds were anonymous, they contained no information on commodity hauled, only the location of the truck. Truck GPS data from ATRI for 2 weeks in February, and the months of May, August, September, and November were used for this study. The data does not include when a particular truck started a trip, making it a challenge to understand all the activities. In addition, it is difficult to identify clearly a stop as some trucks may be queuing up or just taking a short break, unlike the behaviors typically found in passenger travel. In particular, some trucks were driving all through the day, perhaps with different drivers. The trucks were coming and going back and coming to again the home based location. They were actually the oil and gas fuel trucks starting from an oil well and making dedicated trips to the distribution center and fuel stations. This is a typical trip pattern for mid-Arkansas, and would not be found in either eastern or western Arkansas.

An audience member asked about the activity-based algorithm approach and agent-based modeling approaches. The research team was aware of agent-based models for passenger vehicles where it is easy to identify the agent activity profiles (e.g., starting from home, going to activities during the day, and returning to a home location). However, freight trips rarely have this type of basic behavior. The research team had 400,000 truck records that were clustered into six distinct activity profiles. It is anticipated that these profiles will be useful for activity-based freight models.

Regarding truck tour typologies, an audience member noted the issue with not knowing the initial conditions of a GPS stream (e.g., the first set of pings received from a truck) and how can it be determined if it is a short haul or a long haul? Also, owner–operators potentially have more irregular route types and timing, making it difficult to classify their tours or vehicle profile type. The research team indicated the importance of looking at the whole data stream, rather than a small sample. When everything is examined, it is possible to see all the activities going to a particular stop, and if the activity is repetitive, then a particular type of tour can be classified based on the distance between the stops and the number of stops. With respect to owner operators who might not necessarily have the highest usage rate relative to a motor carrier who keeps a unit in operation on a constant basis. How can the impact of HOS or how far a driver is into a particular trip? The research team indicated that the majority of the data used contained large quantities of activities were repeated so it makes sense on the reasonableness check that they did so probably a lower percentage were the data where they didn't have any idea what was going on.

Another audience member who was primarily familiar with passenger GPS (e.g., taxi data with "1" for passenger and "0" for no passenger) asked how it was possible to determine if a truck was carrying freight from the GPS trace data. The research team explained that there were distinct differences in truck activity patterns based on the location of rest areas, different tour types, stops for fueling, and that the pattern of truck moving obviously different from passenger travel. It is possible to convert the available data into trip tables and those trip tables can be used to determine the number of trucks moving from this origin to that destination. That said, the GPS data contains no information on the commodity hauled.

The moderator noted that 2 years ago, at the first Innovative Freight Data Workshop, the freight data community tended towards "work arounds" rather than collecting real data as it seemed too difficult to obtain actual data feeds from the private sector. However, as illustrated in the Freight Fluidity Monitoring Program, 20 companies provided real data. The moderator then posed the following questions. What procedures or innovative approaches did this research use to accomplish this success? How was the research team able to convince these companies to participate, given the amount of time and expense currently being used to synthesize and estimate parameters rather than gathering actual data? In addition, how does the actual data collected compare to previous efforts to synthesize comparable information? According to the researchers, they had to have a clear content message about what the fluidity project intended to do or not do. They needed to ensure the potential participants that they were not conducting a "gotcha" exercise, but rather the research intended to really understand performance from the transportation system user's perspective. Clearly, costs data is a part of this story.

The research team was careful with respect to how questions were framed. During the interview process, they were clear about what they were asking, without straying from the script. Often the research team members heard from companies that other efforts asked questions outside the agreed upon scope, attempting to do "mining" rather than gather specific details. The research team was careful to separate confidential details and not ask for any company-specific performance data that could be derived from other means. They did not ask for volume data or who their customers were. The research team was willing to be more general in some cases with details, including suppressing company names, using categories instead.

The research team stated they believed these companies agreed to participate in the research because they cared that the public agencies devote attention to the right things. The companies expressed clear concerns about the performance of the transportation system services they were receiving, the direction of the performance, and that they wanted to be addressed in the future. For example, one of the largest truck shippers in the country in terms of the number of trips that they generate indicated they were finding a 5% to 8% loss in truck capacity over the course of that year. As a result, they could not get the trucks to pull the loads that they had, and they had loads everywhere. In addition, they had a daily large requirement and they could not meet. They wanted the fluidity of the system to be improved. They also had a substantial complaint on the rail side. Across the modes, speed and reliability components are important and the cost of the operation is of crucial concern.

KEY TAKEAWAYS

Alisha Pena
Texas Department of Transportation

New Data Sources

- Information collected from a discrete set of firms regarding their costs and operations.

New Methods

- Using private-sector cost data to understand supply chains for a subset of commodities.
- Using machine-learning to cluster GPS data and GIS to establish percentage of predicted industries on a road segment.
- Longitudal analysis of GPS trace data for truck models that connect short- and long-haul trips.

New Challenges

- Supply chains analysis is only a snapshot of a subset of commodities.
- GPS truck data can be analyzed as tours and volumes, but difficult to tie to a particular commodities.

Hot Topics

- Supply chain analysis using actual data from the private sector.
- Commodity movements by road segment.

Interactive Poster Session

CASEY WELLS
Texas Department of Transportation, presiding

SAM HISCOCKS
Iowa Department of Transportation, presiding

Presenters utilized large flat-screens to interactively demonstrate innovative freight data applications, many of which combine multiple data sources–technologies (e.g., GPS, Bluetooth) to improve data collection, analysis, and decision-making.

AN EVOLUTION IN OPEN-SOURCE INTERACTIVE FREIGHT DATA VISUALIZATION

Ben Stabler
Colin Smith
RSG

Background

Freight is the economy in motion and visualization of freight flows makes our data and model results more understandable and relevant. Traditional analysis of freight data and models has focused on static tables and charts, which are certainly useful for several reasons, but are not especially successful in stakeholder outreach, building shared ownership, and increasing the impact of visualizations. Interactive data visualization dashboards help improve the interpretation of freight data and freight model outputs.

Innovations

Initially, the researchers developed data visualizations dashboards as a final reporting step to a data processing exercise or modeling system. For example, for the Piedmont Triad's Tour-Based Freight Model, the researchers developed as an R-based dashboard that is exported upon completion of a model run. This dashboard includes various innovative interactive visuals that the user can explore on their own. Feedback on the dashboard has been excellent, but because the dashboard is tightly coupled to the model implementation and design, it is not straightforward to adapt to a new region–data set–exercise.

In an effort to develop a more truly open source application (not just in spirt, but also in use) RSG, in conjunction with others, developed ActivityViz as a freight data and model visualization toolkit (see http://rsginc.github.io/ActivityViz). ActivityViz is a more general-purpose open-source travel and activity data visualization dashboard that is used for interactive data analysis, exploration, and storytelling. The tool is in use by numerous transportation planning agencies for both data and model visualization. The tool is implemented in the latest JavaScript technologies, but is highly customizable, and includes example implementations for multiple types of data and agency case studies. The tool features several innovative interactive visualizations for exploring data, including visualizations of tours, O-D flows using chord diagrams, goods and persons in time and space throughout the day, and animated bubble maps for trips by purpose. In addition, the tool is published using GitHub pages which eliminates most of the administrative backend in traditional web-based technologies. Complete instructions for configuring the tool are also available online. This improved deployment strategy makes setup and maintenance much easier for freight data analysts and modelers.

ActivityViz was recently used to visualize ATRI truck flows throughout the state of Nebraska and is currently being setup to visualize INRIX truck flows throughout the Washington, D.C., region. Freight data visualizers are useful for outreach, validation, and are available for the freight data workshop community to use, and eventually contribute to this open-source effort.

Contributions

Using the open source interactive ActivityViz visualization toolkit is especially useful for visualizing freight data and model results. This tool helps improve the interpretation of freight data, supports the freight model calibration and validation process, and supports freight modeling and planning in general. This visualization toolkit provides a flexible addition to the freight data analysis and modeling toolbox and is part of an overall attempt to improve the interpretation of outputs from disaggregate freight models where many elements of the outputs change from scenario to scenario. Finally, data visualization makes data and model results more understandable and relevant to the stakeholder community. This approach requires data standards as a basis to build the analytical tools.

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ACCOUNTING FOR UNCERTAINTY IN FUTURE GOODS MOVEMENT: PROCESSING FOR GENERATING MORE GRANULAR, HIGHER-VOLUME DATA TO SUPPORT PLANNING

Derek Cutler
EDR Group

Background

Planning can be supported by leveraging distinct, known data sources. Organic (or expected) change is driven by evolving economic growth patterns, population growth patterns, and evolving technical efficiency. There are also disruptive changes that include the global economy and trade, weather and seismic events, and technological innovations. These two forms of change can results in alternative futures for patterns of population and economic conditions, commuting and freight flows, and the need for transportation investments. Specific data is needed to feed into models of change and must be effectively communicated.

Innovations

To meet future data needs, two databased are needed: a domestic database and a foreign database. The domestic database is composed of data inputs (e.g., FAF flows, origin FAF zones, modes, destination FAF, and commodities). The down allocation process for the domestic database used gravity functions (Implan) and Oak Ridge National Laboratory inputs. The domestic data outputs include inter-county flows that employ the origin county, mode, destination county, and commodity. The foreign database is composed of data of the WiserTrade information that include trading partners, foreign mode, port of entry–exit, and commodity. The down allocation process uses the FAF mode splits, Implan, and Oak Ridge National Laboratory inputs. The data outputs include detailed inter-county data with origins and destinations, trading partners, foreign modes, ports of entry–exit, domestic modes, and commodities. Freight is the physical manifestation of inter-industry transactions. The underlying drivers of the economy can be used to understand freight patterns.

Contributions

Regional economics can be used to redraw freight patterns. This process faces a number of challenges. For example, building an understanding of linkages requires using geographical detail, developing multiple scenarios, and understanding the relationships to commodities, facilities and countries. In addition, the sheer volume of the data makes screening all the available records difficult. This study strives to develop system to provide the ability to find and summarize trends and behaviors. It also must provide robust capabilities to make it possible to explore the drivers of the revealed trends. Interactive maps, graphs and analysis are made possible through the fusing of various existing sources of data and provide freight flow information at the county level for decision-making.

DESIGN AND PILOT OF A SHIPMENT-TRACKING METHOD TO SUPPLEMENT A COMMODITY FLOW SURVEY

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Massachusetts Institute of Technology

Lynette Cheah
Singapore University of Technology and Design

Background

The objective of this research is to develop and test a shipment-level data collection technology and methdology. Further, it will demonstrate the feasibility to supplement conventional CFS for freight studies and analyses. In conventional CFS, there is sizeable effort and burden associated with collecting shipment data from respondents. Several shortcomings have been identified (Lawson, et al. 2006), which are lack of information on shipment transport legs and transshipment locations, and incomplete survey responses (i.e., 60% completed information). There is a need for an approach that will allow for the capture of shipment characteristics, the use of GPS traces, and user-verified geolocation data (e.g., stop activities and travel modes). These data need to have high resolution and require little need for human inputs.

Innovations

FMS is a web-based survey platform, designed for efficient, accurate, and mangeable data collection efforts. FMS has been developed to utilize sensor technologies (e.g., GPS) and is designed to help characterize freight movements and provide rich data for freight modeling. This platform has been designed to host different survey instruments and make use of various sensing technologies, which allows analysts to target different entities (i.e., shippers, fleet owners, and drivers) who make decisions on freight movements. The methodology developed collects high-resolution and accurate shipment data using FMS-Freight, demonstrating and evaluating the feasibility and viability of the proposed methodology through case studies.

FMS-Freight aims to address the limitation of conventional efforts and enhances the quality of freight data by capitalizing on GPS technology that helps to collect accurate shipment movement and traces. The procedure involves embedding a GPS device with sampled shipments, automatic generation of the shipments' traces and timeline based on sensor data, and user verification of the timeline and answering additional questions. This is supplementary to the existing CFS questionnaire, and enhances the capabilities to capture freight flows by combining user-verified geolocation data with detailed shipment information.

FMS-Freight leverages advances in sensing technologies and data processing techniques with transport mode detection and stop detection algorithms housed in the backend system to minimize manual entry required of survey respondents. As a result, the FMS-Freight can provide rich shipment data containing entire transport chains and sequences of multiple modes. In addition, a shipment data dashboard has been developed, which is a visualization tool that provides information feedback to users and can serve as one incentive for a business establishment to participate in the survey. The dashboard aims to evaluate a shipper's performance by analyzing and visualizing data collected from the platform and provide meaningful information to the respondent. The survey instrument is also capable of processing existing shipment tracking and trace data from third-party devices if the respondent has them and is willing to share.

Focus group discussions were conducted with freight industry experts from the United States and with business establishments in Singapore so as to obtain feedback on the survey approach, and design of the survey instrument including dashboards. Finally, to demonstrate the concept, small-scale pilots in United States and Singapore are underway, by recruiting business establishments who sends out shipments. From the pilot studies, researchers are able to report on survey recruitment enabled by provision of dashboards, the shipment tracking capability of GPS devices, as well as the viability and scalability of the proposed method.

Contributions

This study aims to examine a potential data collection technology and methodology to be added to or substituted for existing freight data collection efforts, which is challenging to respondents and and also costly, as revealed in literature. The FMS-Freight developed in this study will help to fill the significant data gap in the freight planning and modeling sector by capturing shipment characteristics, paths taken, and freight activities at intermediate locations with high precision. Thus, path-based (i.e, multi-leg) commodity flows can be provided. The implementation of the proposed approaches is expected to provide more detailed and timely data to researchers, policy makers and stakeholders. Complementing the CFS with the proposed enhancements, FMS-Freight developed in this study will play a role in collecting and processing data more frequently and more accurately. These data can be used to supplement CFS data and increase the quality of commodity flow data in a cost-effective way. The proposed research will lead to collecting data that potentiates ongoing model calibration and validation, which allows practitioners to better forecast freight flows to inform decision support systems. From the point of view of freight stakeholders in private sectors, FMS-Freight is a data collection and visualization platform that will provide useful benchmark information to respondents who participate in the survey.

Challenges remain with the ability to recruit shipper participants, resulting in very limited samples and the loss of some GPS units. The results of this type of deployment is highly dependent on the type or size of the shippers recruited for the study. Without a truly random sampling strategy, the final results are likely not representative of a national or regional scale. It is worth noting that there is a need to combine this approach with sufficient incentives or policies to assist in obtaining a representative sample.

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ENHANCING TRUCK ACTIVITY MONITORING SYSTEMS BY USING ADVANCED TRAFFIC SENSORS

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Andre Tok
Institute of Transportation Studies, University of California, Irvine

Background

Based on the statistics provided by CFS in 2012, trucks transported the highest proportion in values, tonnages and ton-miles among all modes, accounting for 73.1%, 71.3%, and 42.0%, respectively. And the total values hauled by trucks are expected to follow a rising trend. However, the growth of demand for truck transportation on highway network leads concerns on congestions, emissions as well as roadway safety. While availability of truck activity data has grown significantly in recent years with the greater access to GPS and telematics data, there are still gaps in available data that can provide a comprehensive understanding of truck activity across industries on both spatial and temporal level.

Innovations

This research attempts to fill this data gap through the integration of two complementary data sources: advanced inductive loop data and Bluetooth data. Generally, inductive loop sensors are deployed across all lanes of roadways to capture the overall traffic traversing traffic detection sites. By equipping these sites with advanced inductive loop detectors, inductive signature data obtained have been used to develop long distance truck tracking models and detail truck classification models. Hence, each detection site in the network provides truck population information.

Bluetooth devices have shown to be a suitable communications platform for communication between in-vehicle devices. With the recent development of this technology, the penetration rate of Bluetooth devices on roadway networks have been following an increasing trend. Each Bluetooth device carries a unique identifier, Media Access Control Identifications (MAC IDs). By tracking this unique ID, truck activity patterns can be acquired on highway networks. However, because not all vehicles are equipped with Bluetooth devices, Bluetooth sensors are only able to capture a subset of vehicles detected in the traffic stream. In addition, the MAC IDs are not associated with vehicle types information.

In this research, Bluetooth MAC IDs are matched with their corresponding signature such that classification predictions of these signatures can be corroborated across multiple observations to improve its accuracy and reliability—essentially providing multiple validations for each unique vehicle. At the same time, truck activity patterns with detailed truck classification can be extracted from the sampled Bluetooth truck trajectories. Consequently, trucks can be tracked on both temporal and spatial level. Nevertheless, as with many probe-based approaches such as truck GPS trajectories and telematics data, the sampled trajectory information may present biases of the overall truck network flow. This study seeks to remedy the sample bias problem through the fusion of comprehensive truck count data from advanced loop detectors with sample truck trajectories from Bluetooth data. With this integration, the Bluetooth penetration rate within each truck body type can be identified, and provide a platform for better addressing the inherent bias associated with Bluetooth penetration.

This study also combines camera and advanced traffic sensors to detect truck flow at selected locations in California. The process generates significant volumes of useful information including truck flow and congestion through by day and time of year by truck type.

Contributions

From the freight planning perspective, this research can provide truck path flow information by truck body types which can be used for the calibration of the freight forecasting model. From the performance measurement perspective, with the integration of Bluetooth and inductive signature data, this research seeks to remedy the sample bias problem and provides much more reliable performance measures on the highway network. Substantially, this research can serve the transport agencies' needs, such as identifying the impacts of truck emissions on disadvantage communities, improving CV border crossing surveillance systems, and supporting regional border management systems.

The technology remains challenged by multiple trucks that are moving consecutively as the individual trucks appear merged. While this technology has potential for providing solid truck counts data, it lacks details on what type of commodity is being hauled.

FIRMS IN THE FUTURE: APPLYING TODAY'S DATA TO FORECAST THE EVOLUTION OF FIRMS FOR FREIGHT MODELING

Brent Selby
Krishnan Viswanathan
Cambridge Systematics

Background

Freight modeling is a key component of understanding the state of transportation which stands at the nexus of economics, mobility, congestion, land use, and business development. Freight and truck modeling depend on information about firms. Freight transport is the result of complex interactions of a variety of stakeholders, principally firms, in the region or state and beyond. Different type of industries have different freight needs. It is generally assumed that firms produce varying amounts of freight movements that correlate with their size (e.g., employment or floor area). As a result, firms are an essential starting point for modeling freight, just as households are the basic agents of passenger modeling. For this purpose, firms must be forecast at a level of detail and accuracy for suitable to the complexity of the model.

Innovations

This study addresses the questions regarding data for modeling of firm evolution as a component of a truck touring and freight movement model. The firm evolution (sub) model produces a rich, disaggregate set of firms to be used as input for simulating the truck and freight movement. As an evolution model, a series of econometric models are used to simulate the firm's events—creation, employment growth, dissolution, relocation, and in- or out-migration—that consider determinants such as the firm's internal attributes (size, age, and past growth) and local conditions. The primary data source for estimating and seeding the model is the National Establishment Time Series (NETS) database, which contains annual records of the existence, location, and size of firms. The NETS database was chosen because it captures all the necessary information regarding yearly changes in location and employment size at a firm level over multiple decades. While many other data sources exist for employment and some for firms, they do not provide a way to track the progression of individual firms. The time period extends over many years to avoid overfitting to short-term trends, and to reduce any bias in the firms' actions towards behavior prevalent in that time. Furthermore, NETS includes firms of all sizes from all North American Industry Classification System (NAICS) 2-digit categories, the industry classification used in this model.

Given the impacts freight has on pavement conditions (close to 80% of freight movement is by truck in the United States), and the role that freight plays as a proxy for the state of the economy, it is critical that robust data be used to understand and forecast how firms evolve over time to get a better handle on freight movements today and into the future. Disaggregate data with individual firm characteristics over a long time period form the basis for firm evolution. However, they alone don't paint the complete picture about freight movements. Additional data were used to evaluate and inform usage of the data and validation of the model. The choices of using and processing different data sets is driven by the need to understand and reflect the industries which are most important to freight activity.

Contributions

This work describes the data needs for the emerging firm forecasting technique of firm evolution. This aspect of freight modeling is as important to it as household population is to passenger demand modeling, but is often conducted at an aggregate level. Using a disaggregate framework provides for data inputs that better reflect the local economic activity and makes more flexibility possible in future models. Many agencies acknowledge the value of accurately simulating current and future freight movement and the vehicles it puts on their roadways, railways, and through their ports. Those looking to improve their modeling or introduce a new model altogether will need to understand the conditions which drive these models. This work provides a discussion of and practical guidance for using data to develop the firm population to serve as the basic input for predicting freight activity. It is informed by previous case studies as well as future development and application plans.

Increased automation is likely to affect certain industries despite increased growth. This creates a challenge for relying on the number of employees as a true correlating factor with future freight flows. There is a need for higher data resolution and higher frequency in updates.

IMPLEMENTING FREIGHT FLUIDITY IN TEXAS

Bill Eisele
Nicole Katsikides
Texas A&M University Transportation Institute

Background

Researchers and transportation planners need to be able to understand supply chains from end-to-end. The measurements for freight fluidity include travel time, travel time reliability, and cost of moving freight shipments.

Innovations

This research provides the methodology and application of freight fluidity analysis at the state level with examples based upon work sponsored by the Texas DOT. The objective of this presentation is to demonstrate Texas DOT’s state-level application through its analysis of freight and economic information and the role of fluidity analysis outputs in investment decision-making. Freight fluidity analysis involves the assessment of freight performance along key supply chains to support transportation investment and policy decision-making. Fluidity involves understanding the economic conditions of a particular geography, identifying the key freight routes or supply chains, understanding data and measures of performance and quantity, and then applying freight performance measures to identify bottlenecks in these supply chains. This information helps relate the impact of freight performance to the economy and provide decision-makers with information on locations of investment opportunities, operational or capital. International fluidity implementation and success in Canada has led to national and state interest in the United States.

Canada has used multimodal fluidity analysis for the past decade and has coordinated transportation and economic policy to create plans and deliver investments that support Canadian business through efficient supply chains. The FHWA is currently undertaking a national-level fluidity project. This project applies the fluidity methodology to key U.S. supply chains and select regions of the United States.

In addition, both Texas and Maryland, and most recently Colorado, are taking steps to research and develop state-level applications with Texas DOT innovating fluidity applications. The goals of the state initiatives are to improve on freight mobility understanding and planning. This is important because fluidity information may help states meet federal freight mandates for planning and use of federal-aid freight funds. It may also help states coordinate with economic development entities and business in order to best support economic sustainability and growth. This Texas work represents a major step forward in state-level freight performance analysis, as it is the first implementation of fluidity analysis of this kind at a state level. The methodology for this work involves three key steps: framework development, market and supply analysis, and demonstration of analytics.

Fluidity analytics included development of travel time traces, heat maps, and contour maps that illuminated freight congestion and bottlenecks in several regions of the state. This information, considered with the economic market analysis, helped identify potential options for policies and investments.

This research helps propel traditional freight, transportation performance analysis of congestion, and reliability by adding an economic relationship that states need to describe the magnitude of freight mobility and to determine investments most effective for the economy. Key findings are that fluidity is useful in understanding freight bottlenecks and providing information that decision-makers can use to make transportation investments and policies that best support and grow the economy.

The methodology uses a three part fluidity analysis that includes a framework development, economic assessment, and performance measurement. The framework development provide a foundation and a roapmap for the fluidity analysis. It includes specific questions about the concept of fluidity and sets a vision for how fluidity will be measured and monitored by decision-makers and the public. The economic analysis identifies economic opportunities and supply chain relationships chains, a statewide perspective of supply chains, current economic activities, and data sources available for assessment. The next step is to apply performance measures to key supply chain routes, including identification of bottlenecks and impacts of future investments. The performance measures use the Urban Mobility Scorecard (UBS), the 100 Most Congested Texas Roadways, contour and heat maps, and calculations of freight fluidity measures.

Contributions

States and MPOs are seeking practical approaches to improve on freight planning, work which propels traditional freight transportation performance analysis forward. Despite major steps forward in the past decade for freight analysis, states and MPOs are still limited in ability to understand freight performance, especially in terms of supply chains and impacts to markets and jobs. This work supplements the traditional analysis of freight congestion and reliability by adding an economic relationship that states need to describe the magnitude of freight mobility and to determine investments most effective for the economy. Specific benefits of this work include a recipe for assessing markets and supply chains and systematic guidance on applying travel time traces, heat maps and contour maps to analyze congestion and bottlenecks. Additionally, this work provides insight for how to assess freight in relation to markets and to identify ways to improve on freight fluidity.

With this type of information, the public sector can work with the private sector to identify investments and or operational approaches that will best sustain and grow the economy. Public sector use of this type of analysis can help in the transportation planning process by providing leadership and decision-makers understanding of how freight bottlenecks affect their markets. This may help improve consideration of freight in planning and allow freight projects a stronger voice, especially related to the economy, when the public sector develops plans and programs, especially long-range investment programs and project justifications. Current or planned construction areas, event venues nearby, unique factors, and other related impacts also need to be included in the analysis.

INTERNATIONAL TRUCK TRAVEL IN THE SOUTHERN CALIFORNIA REGION: UNDERSTANDING FREIGHT PATTERNS WITH BIG DATA

Keri Robinson
San Diego Association of Governments

Jess Stetson
StreetLight Data

Background

Beginning in 1991, federal, state, and local transportation planners have tried to formalize the integration of freight and intermodal planning as described in the Intermodal Surface Transportation Efficiency Act. Of particular concern has been new ways of collecting truck flows into communities, along freight corridors, and around major freight hubs. Traditional methods for collecting data on truck movements (e.g., stationary, fixed-point measurement devices) are time-consuming and expensive. At the same time, new location-enabled and wireless technology devices allow for continuous spatial tracking of truck movements, acting as probes (e.g., GPS, MAC, radio frequency identification devices). In addition, new roadside traffic sensors including lidar, microwave radar, and Bluetooth produce movement data. The spatial nature of these data offer new ways of visualizing how trucks move in, around, and through communities and larger regions and may decrease costs and increase quantities of data available for analysis.

Innovations

The San Diego Association of Governments (SANDAG) accessed Streetlight Data from 250 count locations in southern California and the Northern Baja California region. The sites were selected from existing screen line locations used for modeling by SANDAG and Southern California Association of Governments, and included locations along the interstate, state routes, and prime arterial roadways in Baja California, from Ensenada northward though the San Diego County ports of entry. O-D data provided by Streetlight Data is being tested for its utility as a means of visualizing multiple business and operational relationships throughout Southern California, particularly binational trade within the San Diego region. Sixty zones are being used to determine the level of accuracy for key O-D pairs from the "big data" compared to existing data sources and information from stakeholders about these relationships.

Contributions

The methodology developed for this study is intended to provide a comprehensive snapshot of regional freight flows. The assessment of the limited sample of Streetlight Data GPS-based truck volume and O-D data is only the first step in the future vision of obtaining freight visualizations. SANDAG plans to incorporate techniques suitable for visualizing freight for large scale regional planning, using a collaboration with private vendors (e.g., StreetLight Data, their parent company INRIX data, Air Sage Data, and ATRI data). The expectation is to be able to visualize truck data using data fusion, where existing data is combined with new locational data sources, and routinely updated and refined.

NCFRP 49: WEB GUIDE FOR UNDERSTANDING AND USING NEW DATA SOURCES TO ADDRESS URBAN AND METROPOLITAN FREIGHT CHALLENGES

Vivek Sakhrani
Donald Ludlow
CPCS Trancom, Inc.

Background

The rapid explosion of new freight data sources is creating significant opportunities for more effective and well-targeted planning and operation of roadways, particularly in urban and metropolitan areas.

Innovations

This research explored how new sources of freight data, including "big data" from smart cities initiatives, crowdsourcing, sensors, and cameras are being or could be used to address urban and metropolitan freight challenges. The interactive web guide includes a source-use concept map to show how transportation agencies can employ a variety of analytical techniques using these data sources to address persistent freight challenges. Video vignettes help make the value proposition for agency use of these new data, and application case studies illustrate a variety of agency best practices.

Contributions

The guide includes organizational principles and checklists that agencies can use to safeguard against the common policy and institutional challenges of leveraging new data sources. This research was previously published and provides an excellent guide on the type of technologies available for selected purposes. A challenge remains in how to update the guide as more technologies are developing at a rapid rate.

Reference

TRB. *Understanding and Using New Data Sources to Address Urban and Metropolitan Freight Challenges*, National Cooperative Freight Research Program, Transportation Research Board, 2019. www.ncfrp49-newfreightdata.com. Accessed April 10, 2019.

SPATIOTEMPORAL ANALYSIS OF THE FREIGHT ANALYSIS FRAMEWORK DATA

Monique Stinson
Argonne National Laboratory

Birat Pandey
Federal Highway Administration

Background

The general trend in U.S. population shift since the 1800s has been westward (Kerski 2011) and in more recent years, towards the south. In this study, researchers examined freight trends from 1997-2012 and assessed whether similar shifts in freight activity intensity have occurred. The FAF database is often used to study baseline and projected freight traffic volumes (FAF 2018). However, since FAF data covers the entire United States and spans the 1990 through 2010, geographic trends in freight intensity over time can also be examined. The analysis focuses on freight production and consumption by states using the available FAF data from 1997–2012. The objective of this study is to examine changes in freight flow intensity in the United States by demonstrating an applicable method utilizing publicly available FAF 2018 data.

Innovations

The methodology for this research uses the mean latitude and mean longitude of freight tonnage in terms of production and/or consumption is computed the weighted average latitude and longitude of states, where the weights are the state−level tons (see https://www2.census.gov /geo/pdfs/reference/cenpop2010/COP2010_documentation.pdf).

Three variations in tons are used: production (origin) tons, consumption (destination) tons, and combined origin + destination tons. State centroids were found using GIS with geographic boundaries. The population center has shifted gradually westward over time. It has also shifted slightly southward. The freight center follows a similar trend in terms of directionality. The trend are also similar in terms of magnitude (about 40 mil over a 15-year period), suggesting that freight production and consumption is correlated with population concentrations.

Contributions

This work is designed to inform the future of freight planning in the following ways: First, it will show how FAF can be used to examine spatial and temporal trends in freight activity intensity. FAF is not widely used for such analysis, but due to its comprehensiveness and availability, it has potential to provide value to studies that may benefit from such a perspective. Practitioners and policy makers will benefit by learning from these findings and considering ways to apply the methods to study questions of their own. Second, the study will highlight the importance of conducting analysis not only with a snapshot of freight activity, but also from the perspective of trends in freight activity as well as fusion with other data. Specific findings from the study are anticipated to underscore this point. A contrast will be made based on analysis potential with a data snapshot vs. analysis potential using this fusion method. Third, for application purposes the knowledge of spatial and temporal trends in freight activity will benefit planners by providing insights on these trends.

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THE FUTURE OF URBAN GOODS MOVEMENT: AN EVALUATION AND IMPLEMENTATION OF DATA-DRIVEN METHODS

Ethan Yue Sun
Fatemeh Ranaiefar
Fehr & Peers

Background

One out of 25 people in the United States produce one e-commerce delivery per day, and this rate is expected to increase, especially in urban areas. This trend is primarily a result of advancements in on-demand goods delivery services and increases in e-commerce, which are ultimately changing the way people purchase and receive goods. As communities encourage and implement higher-density and mixed-use developments, it is becoming more important to consider the needs for commercial and residential goods movement. Research suggests that is a significant disconnect between land use decisions and the delivery of goods associated with difference land uses. In addition, agencies dedicate a great deal of time and effort developing and using software tools to estimate future delivery and travel demand; however, it’s neither clear how the frequency of delivery vehicles and people’s travel choices will change as on-demand goods delivery become more prevalent, nor is it clear how predictive tools will need to evolve.

Innovations

To guide this research into the evaluation of on-demand goods delivery, the researchers implemented two distinctly different approaches. To evaluate each of the approaches, the research team used a step-wise process, devising a set of parameters to test model sensitivity on on-demand goods delivery and identified the associated data and methods present in each approach. The research concludes with a summary of each approach, the data used, the results, and recommendations for future data collection.

The first approach focused on freight TDMs and the degree to which they are capable of reflecting changes to the types of parameters relevant to urban goods delivery and produce performance measures at a scale to provide insight for decision makers. Each parameter was tested independently on several MPO freight models from around the country to compare real life expectations to changes in key model outputs including vehicle miles traveled, truck and delivery vehicle volumes, and emissions.

The second approach uses methods to develop a supply and demand hot-spot analysis that geographically quantifies the supply (i.e., available parking, curb space, and capacity of delivery vehicles) and demand (i.e., commodities or deliveries) and combines them into a suitability index that can be used to identify "hot spots" where supply and demand are not aligned. The purpose of this approach is to produce estimates of delivery activities at the block level. This methodology is based on research Fehr & Peers conducted for the U.S. Environmental Protection Agency on the relationship between the built environment and travel patterns. The analysis uses a combination of existing GIS data and newly collected information to develop variables highly correlated with delivery activity. Since delivery activity is highly dependent on many factors, several variables were compiled to forecast delivery demand, including, but not limited to, population density, employment density, land use mix, proximity to commercial districts, and socioeconomic factors (i.e., age, income, and vehicle ownership). The results of the delivery demand model analysis indicate locations where demand for delivery vehicles will be highest.

Contributions

This research identifies the data and parameters at multiple levels of detail for the supply and demand for evaluating urban goods delivery both TDMs and hot spot analysis. The data and methods are compared for a wide range of MPO models and datasets, along with the performance metrics most relevant to both the public agencies (i.e., congestion, curb management, air quality) and the goods shippers (i.e., delay, cost per delivery). In addition to the evaluation of data and approaches, the results of implementing each approach and insights into the applicability for multiple use cases and areas for future research were provided. The "heat maps" generated in with this approach depend on many data sources and contribute to the understanding of on-demand for goods deliveries in urban areas. At the same time, it is difficult to distinquish between those on-demand deliveries by purpose (e.g., lunch deliveries, groceries). More details are needed for decision-making purposes.

KEY TAKEAWAYS

New Data Sources

- Domestic database composed of FAF elements that are down allocated for inter-county flows by mode and commodity.
- Foreign databased composed of WiserTrade elements including trading partners, foreign mode, port of entry–exit and commodity, and down allocated for import county data.
- High-resolution shipment data using FMS-Freight, a web-based survey platform using GPS probe data.
- Bluetooth and loop detector signature data matched to detect truck movements.

New Methods

- An open-source, interactive, visualization toolkit for freight analysis including: visualizaiton of truck tours, O-D flows using chord diagrams, and trip purposes (ActivityViz).
- Using the NETS database to estimate the evolution of firms that impact freight.
- Development of a fluidity analysis that assesses markets and supply chains, with systematic guidance for travel-time analysis; heat and contour maps to identify congestions and bottlenecks.
- Comprehensive snapshots of regional freight flows using a limited sample of probe data with origins and destinations to produce visualizations.
- Use of the weighted mean latitude and longitude of freight tonnage of production or consumption to determine freight flow intensity in the United States.
- Development of a suitability index to identify hotspots where supply of available parking, curb space, and capacity of delivery vehicles is mismatched with demand for deliveries.

New Challenges

- Establishing data standards necessary to produce visualizations of truck activities.
- Being able to recruit shippers to participate in surveying efforts, even when technology reduces respondent burden.
- The presence of multiple trucks moving consecutively when using Bluetooth and signature matching techniques being identified as individual trucks.
- Increasing automation impacts the methods that rely on employment to understand freight generation.
- Being able to identify congestion due to construction, special events and other unique factors in bottleneck analysis.
- Being able to distinquish between on-demand deliveries for lunch deliveries or groceries from regular freight deliveries.

Hot Topics

- Freight data with high levels of granularity (e.g., Bluetooth matched with inductive signature data).
- Visualization of granular data for O-D studies and congestion analysis.

Emerging Data Streams and Future Freight Applications

PATRICIA HU
Bureau of Transportation Statistics, presiding

ALAN HOOPER
ATRI, recording

Transformational technology advances, such as artificial intelligence (AI) and the Internet of Things, and increasingly vast datasets, such as transaction records are expected to enable new advances for freight data collection, behavior analysis, and decision-making. This future-looking panel discussed the new opportunities that these innovations may offer for freight planning and management.

EMERGING DATASETS AND THEIR IMPACT ON TRANSPORTATION

Zach Strickland
FreightWaves

Background

Freight is a highly fragmented industry with more than 4,500 trucking companies with $200 million in annual revenues; 20,000 shippers who spend more than $10 million in annual trucking costs; and 1,600 brokers with $10 million in annual revenues. In addition, often data is measured at the highest levels, lagging in timeliness and nonspecific in nature, with transportation companies looking internally to gauge their own performance. Recently, the proliferation of freight data derived from new technologies (e.g., onboard data collection) is serving as secondary uses of these technologies from which the trucking industry could directly benefit. The technologies and related applications include:

- ELD data made for measuring HOS that can also be used to track movement patterns and moving speeds,
- Electronic Tender data from shippers sending load requests to carriers electronically that can serve as a proxy for volume and carrier optionality, and
- Telematics data, which measure various activities of a truck such as fuel consumption, acceleration, and hard braking.

Innovations

These new data sources can be aggregated to produce salient and timely market data to support a variety of decision-making processing within the freight community. Electronic tender volumes and rejection rates, for instance, can provide insight into which markets are experiencing outsized demand for trucking services; similar data can be leveraged to identify the supply-demand relationship between freight load requests and available trucking capacity on a near real-time basis. Figure 10 displays wait time in minutes for specialty stores.

Contributions

Uses for the growing volume of data collected from ELD and telematics technologies include:

- The number of trucks available by market over time;
- Driver detention time associated with loading–unloading freight by facility over time;
- Fuel economy by market and over time; and
- Geospatial mapping to understand traffic and congestion issues as they develop.

TRUCKING INDUSTRY PERSPECTIVE: ELECTRONIC LOGGING DEVICES = POTENTIAL WAYS TO LEVERAGE THE DATA FOR OPERATIONS EFFICIENCY

Greg Dubuque
Liberty Linehaul West

Background

Currently, there is considerable attention focused on operational effects and unintended consequences of the ELD mandate faced by motor carriers, as well as by their drivers and customers. As a carrier, Liberty Linehaul West (LLW) began using ELDs 2 years prior to the implementation of the mandate in December 2017, running them in conjunction with paper logs to familiarize their drivers with this new technology and 42,000 mi were logged in an ELD-equipped truck to better understand the potential operational impacts this recent technological requirement would have on both fleets and drivers.

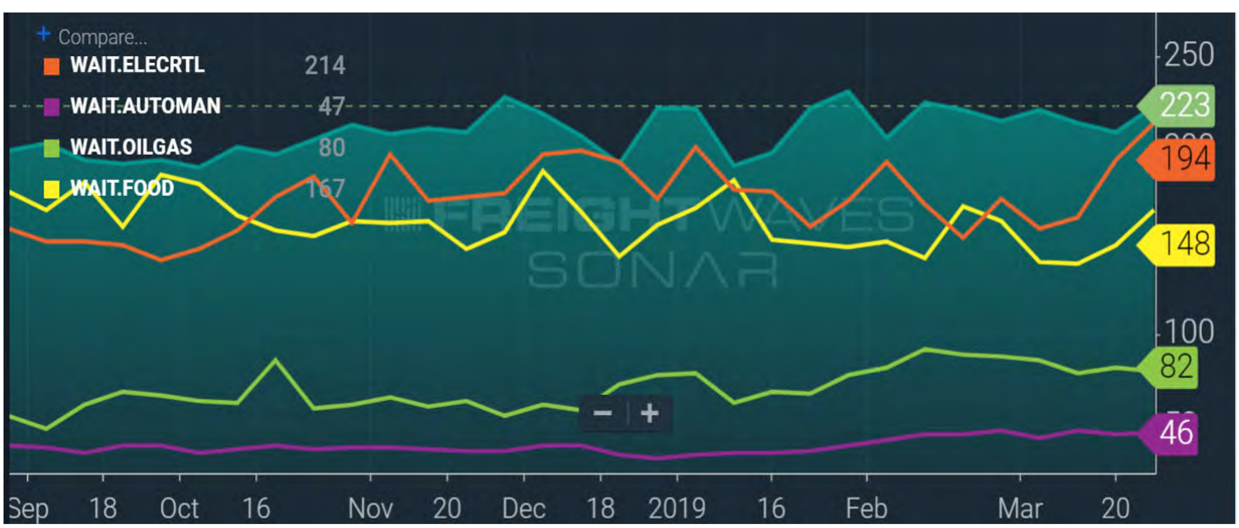

FIGURE 10 Wait time in minutes for specialty stores.

Innovations

The key impacts on operations associated with ELDs include:

- Customers are now committing to motor carriers further in advance to ensure proper trip pre-planning and to lock-in capacity while it is available;
- Driver hours are more transparent to dispatch, allowing for better prediction of delivery times and better planning of a driver's workload; and
- A greater value placed on a driver's time since ELDs provide visibility into detention time at customer facilities.

Several unintended consequences from the ELD Mandate have been recognized including:

- Motor carriers are dealing with additional pressure from shippers to accept shipments and commit capacity in advance;
- Service failures are more likely when unforeseen circumstances affect driver time;
- Shippers demand larger empty trailer pools to allow greater lead time on loading the trailer before a pre-arranged pickup; and
- Increased demand for local trucks and drivers to save over-the-road driver hours through drop-and-hook operations.

Contributions

ELDs offer a new form of data that shows promise, but must be handled carefully to ensure access to the valuable information that can be gleaned. Special attention to unintended consequences is critical to reduce negative impacts and promotion of the safety benefits the program was intended to provide for the trucking industry and the public.

THE ELECTRONIC LOGGING DEVICE MANDATE AND TRUCKING: HOW WE GOT HERE AND OPPORTUNITIES FOR FREIGHT DATA, PLANNING, AND MANAGEMENT

Jeff Short
American Transportation Research Institute

Background

GPS data in trucking began with the introduction of asset tracking to trucking in the 1990s. Since that time, the scope and scale of truck GPS data has grown substantially and improved in terms of precision, frequency, and the variables collected. Additionally, the ELD Mandate has created a new source of freight data by electronically capturing information such as driver duty status, location, operation type, and situational context regarding operation conditions.

In addition to the different types and growing scale of trucking data, this presentation also covered the types of analyses these data have been used for in the past and the direction in which they are headed going forward. Initially, truck GPS analysis was centered on space–mean speed measurements, which eventually transitioned to a greater focus on truck spot-speed analysis. The acquisition of static vehicle identifiers that followed a truck over time facilitated more in-depth analyses, such as O-D and truck parking studies.

Innovations

Moving forward, new types of analysis can be conducted using ELD data. For example, Figure 11 displays a comparison of two drivers using Flex HOS rules (proposed rule changes to allow truck drivers more flexibility in their hours of operation). Additional analyses that are now possible with data derived from truck GPS and ELDs could include:

- Assessing the impacts of detention time on motor carriers and truck drivers;
- Studying commodity movement patterns;
- Identifying the extent of e-commerce operations and the associated effects on traffic patterns;
- Measuring the effects of traffic congestion on trucking operations;
- Examining truck moving speeds and volumes through major freight bottlenecks; and
- Modeling the effects of changes in regulations on trucking operations.

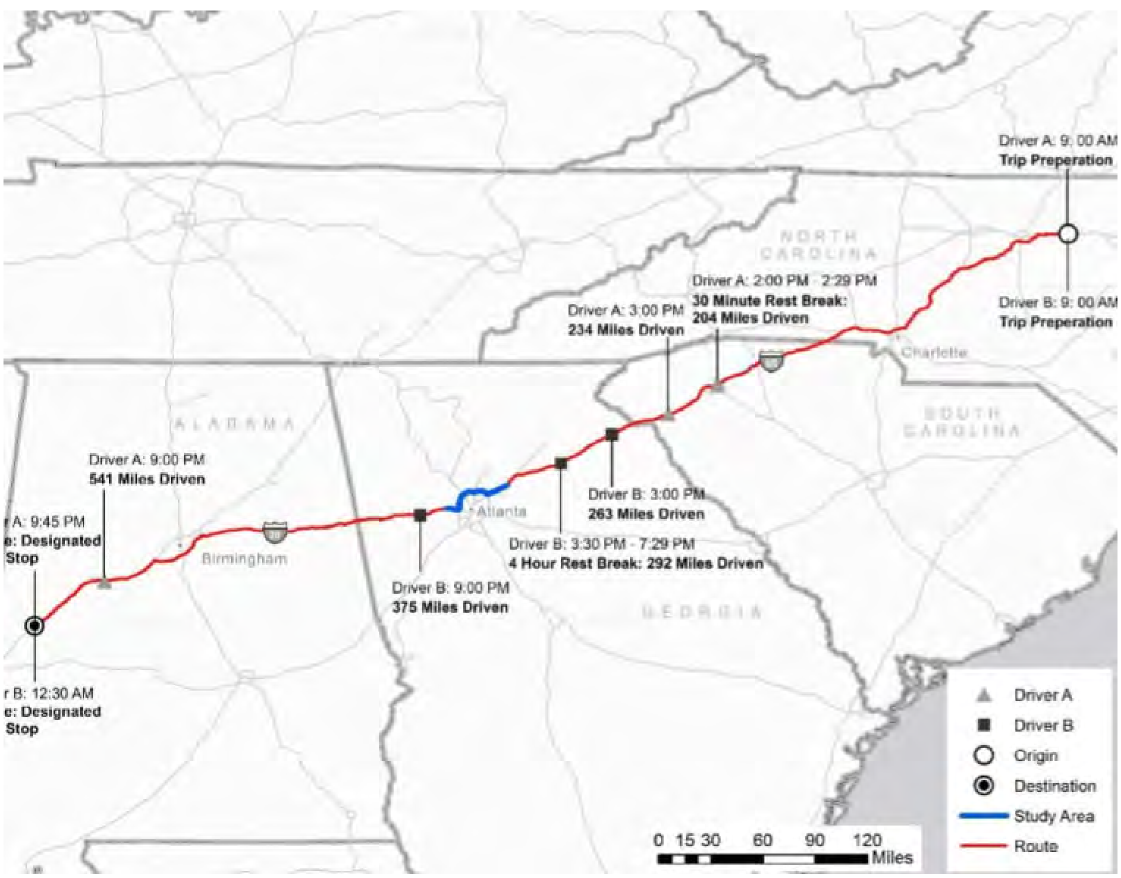

FIGURE 11 Comparison of two drivers using flex HOS rules.

Contributions

GPS on vehicles already provides essential information for transportation planning and analysis. ELD data also has the potential for providing high-quality information for planning and analysis, but requires a good understanding for what and how the data will be used.

Audience Dialogue

After a brief question and answer session between the audience and panelists, the moderator facilitated a discussion that predominantly focused on the data sharing and privacy issues raised by a number of participants, as well as on other emerging freight data streams beyond those mentioned by the panelists.

Data sharing and privacy issues emerged as a major theme from the participant discussion, as several participants confirmed that these concerns can be a major impediment to acquiring data necessary for freight analyses. The panelists and several audience members emphasized the need to build trust with those from whom data are being collected; strictly enforcing data anonymity and non-disclosure agreements among all stakeholders involved in the collection and analysis of the data were the strategies most frequently mentioned by participants as essential in establishing this trust. Additionally, being clear as to the purposes for which the data are to be used, and articulating the benefits of providing data, were among the other observations made by individual participants.

The audience was also solicited to share other emerging data streams with both trucking and non-trucking applications. The data streams discussed by individual participants included:

- Working with public agencies to study freight generators by market segments to further refine policy models and better understand where trucks are going and why,
- The global application of the Automated Identification System (AIS) collected by the United States Coast Guard to avoid maritime vessel collisions, and
- Using AIS to estimate and monitor maritime vessel dwell times at ports.

Separately, several questions were posed specifically to panelist Greg Dubuque to solicit feedback from a motor carrier representative on freight-related issues:

- In response to the mention of a pilot program in Canada to electronically standardize hazardous material shipping documents, the panelist was skeptical that such a system would work in the United States due to the difficulty of enforcing uniformity in the context of interstate commerce.
- Based on a previous discussion of the driver shortage increasing shipping costs, the panelist was asked to provide the industry perspective on this critical issue. For his fleet, the growing focus on and cost of the recruitment and retention of drivers served as the most direction operational impact.
- In response to a comment on emerging load board technologies, the panelist responded that load boards are not in LLW’s long-term plans. It can work out to be more efficient for a customer to pay for an empty backhaul to reduce turnaround time due to growing driver costs. In some instances, it can be better for the fleet’s bottom line for a driver to run an empty backhaul than it would be for that driver to pick up a new load.

KEY TAKEAWAYS

Heather Monteiro
Hickory Ridge Group, LLC

New Data Sources

- ELD measuring HOS.
- Electronic Tender data generated from shippers sending load requests carriers as a proxy for volume and carrier optionality.
- Telematics data that including fuel consumption, acceleration behavior and hard braking.

New Methods

- Visualizations of electronic tender trends useful for describing activities.
- Visualization of ELD–HOS details for scenario analysis.

New Challenges

- Techniques to provide adequate privacy protections for ELD data, while maintaining the value of the information useful for planning and research.

Hot Topics

- Data sharing with the private sector to assist planners and decision-makers in their understandings of truck activities and drivers needs.

Poster Session

YATMAN KWAN
California DOT, presiding

CHESTER FORD
Bureau of Transportation Statistics, presiding

Using traditional posters, presenters discussed a variety of unique approaches for freight data collection, performance measurement, planning, and visualization.

A FREIGHT FORECASTING TOOL FOR NORTHERN NEW JERSEY

Daniel Beagan
Christopher Lamm
Cambridge Systematics, Inc.

Background

Freight data and forecasts come in a variety of formats that are often not compatible with each other. Consequently when agencies desire to test economic and transportation scenarios, they are faced with incompatible definitions of geographies, economic sectors, commodities, years, and TDMs. The North Jersey Transportation Planning Authority (NJTPA), the MPO for northern and central New Jersey, developed a freight forecasting tool (FFT). The NJTPA FFT is an interactive Microsoft Excel-based forecasting tool that allows the user to test various economic scenarios as well as to calculate the specific impacts of economic or transportation drivers.

Innovations

The FFT makes the necessary crosswalks to harmonize Transearch commodity reports and forecasts and the outputs from the R/ECON econometric model from Rutgers University, with the zonal system and overall truck trip tables of the NJRTM-E (NJTPA's TDM). The outputs include regional and county level summaries of freight activity for the forecast years, and scenarios selected by the user, as well as commodity group truck trip tables that are ready to be input into the NJRTM-E. The FFT was developed as part of the 2040 Freight Industry Level Forecasts Study and further enhanced as part of the Regional Freight Commodity Profiles Study. A new round of enhancements to the FFT is set to begin, which will incorporate new freight and econometric forecasts through 2050. As part of this effort, the FFT will be enhanced to use publicly available FAF data, and to generate e-commerce delivery trip tables.

Contributions

This research demonstrates the use of a spreadsheet-based tool that fuses data and forecasts from different commodity and econometric models, disaggregates those forecasts to smaller geographies, provides outputs that can be integrated into traditional TDMs, and will be updated to address e-commerce shipments and publicly available commodity data and forecasts (i.e., the FAF).

STATEWIDE FREIGHT ACTIVITY AREAS

Joel Worrell
Florida Department of Transportation

Background

The purpose of this study is to develop and implement a methodology to identify freight activity areas in the state of Florida. Freight Activity Areas (FAA) are clusters or groups of freight facilities that generate, distribute, or attract large amounts of freight activities. They also have a significant impact on Florida's transportation sysyem and its economy. While FAAs are not specifically airports, seaports, spaceports, intermodal logistics centers, or freight rail terminals, they can be designated in areas that are located close to these facilities.

Innovations

The methodology included running an Inverse Distance Weighted (IDW) interpolation analysis for freight-related parcel data, freight-related employment, and truck traffic data independently and then a weighted overlay analysis that combined the output of the three interpolation analyses to produce a single map that averaged the inputs. The final step involved reclassification of the weighted overlay analysis to produce freight clusters for areas with high values (hot spots).

Freight transportation planning in the public sector has traditionally focused on major transportation hubs—airports, seaports, spaceports and intermodal rail terminals. The agglomeration of other freight activity generators like distribution centers, warehouses, and manufacturing facilities in the last decade has led to an increased interest among public agencies and private firms to identify the major FAAs for their planning, operational, and other transportation projects. This study had unique requirements laid out by stakeholders which included:

- Locating freight clusters. Ports, airports, seaports, intermodal rail terminals are well-known locations. However, a data-driven analysis is necessary to identify the spatial locations of FAAs that are not known transportation hubs.
- Well-defined concepts. FAA is a novel concept and warrants defining it in a clear and a concise fashion while separating it from existing transportation hubs.
- Raw and disaggregate input datasets. Analysis needs to utilize disaggregate datasets that are raw (as opposed to synthetic), verifiable, and are easily accessible. Datasets produced by different state–public agencies were preferred datasets.
- Intelligible and repeatable process. Ensuring that the process is intelligible and repeatable is important from a statewide and an institutional perspective.

An example of a FAA is the Miami perishable goods distrbution area.

Contributions

Multiple data sources used in this study include: the Florida Department of Revenue's parcel data; the Florida Department of Economic Opportunity's employment data; and Florida DOT's AADT. However, the truck AADT had limitations. The FAAs can be further classified or characterized by regions, freight industry mix, employment, and freight parcel living area. Truck transportation activity (truck AADT) is considered as one of the input variables in the pilot study, but truck AADT has limitations. Some alternatives for truck transportation activity are enhanced trip generation studies or probe datasets like truck GPS data. Comprehensive data processing and data wrangling followed by analytical algorithms will be necessary to convert raw truck GPS data streams into useable information. It will be important to identify the roadway segments which connect the FAA to the major roadway corridors and provide strategic freight growth opportunities.

CALIFORNIA VEHICLE INVENTORY AND USE SURVEY: LARGE-SCALE DATA COLLECTION AND FUSION WITH TRUCKING DATABASES

Anurag Komanduri
Mobashwir Khan
Cambridge Systematics

Background

The U.S. Vehicle Inventory and Use Survey (VIUS) has long been the comprehensive source of information for conducting policy research in the areas of truck emissions, planning, forecasting, and policy research. However, it has not been implemented in the past 15 years, and some of the information is now dated. Caltrans recently completed a massive online truck vehicle inventory and use survey (CA-VIUS) to better understand what trucks are traveling on the roadways and for what purpose.

Innovations

The final dataset includes data from over 15,000 trucks—both registered in California and throughout the United States. The resulting dataset provides Caltrans with rich information about several key behavioral aspects such as annual truck vehicle miles traveled (VMT), payloads, empty travel, and truck trip lengths. When combined with other information collected from the survey such as vehicle age, tractor-trailer combinations, and fuel type, agencies in California have the ability to answer pressing questions in air quality and emissions, fleet turnover planning, travel forecasting and planning, and routing.

While the implementation of a large-scale survey of this nature may be interesting to practitioners, researchers focused on the resulting dataset, presented key findings, and outlined a roadmap of how this dataset will likely be used to supplement future projects.

Contributions

As California spearheads the approach to tackle emissions and reverse climate change, understanding how trucks move and operate on its roadways is very important. The CA-VIUS dataset will help researchers at Caltrans and other statewide agencies to better understand operational characteristics for today's trucks. Better data helps with developing thoughtful policies and research briefs that can influence meaningful change.

In the short term, the data is being used to update the statewide freight forecasting model and this model will be used to conduct policy scenarios as Caltrans embarks on its long-range planning. In the longer term, the data will allow researchers in California to influence air quality and emissions research which is of critical importance. Research briefs and scenario results generated from these studies will likely help agencies nationwide and perhaps even internationally in developing data programs and policies that can influence change in their own jurisdictions.

CHARACTERIZATION AND ESTIMATION OF TRAFFIC VOLUME: A TRUCK AND PASSENGER CORDON STUDY OF SEATTLE'S URBAN CORE

Gabriela del Carmen Giron-Valderrama
Anne Goodchild
University of Washington

Background

The rapid urban growth and the densification of the urban space have increased the travel rates for people, services and goods coming in and out of the cities. This increase not only affects roads but all the elements of the transportation network. For freight, specifically, several studies have stated that the competition for space among road users and lack of adequate infrastructure force delivery drivers to either search for vacant spaces or park at unsuitable areas causing negative impacts on safety and road capacity.

Many municipalities lack robust data sources that provide them with accurate estimations of the traffic vehicle volumes entering and exiting the urban core. Without having up-to-date information on the total freight demand, public agencies face challenges in effective devise strategies to minimize the costs of congestion that hampers urban freight delivery efficiency. With a population of 725,000 and a density of 8,350 residents per square mile, Seattle is now the ninth most congested city in the United States. Meanwhile, Seattle is expected to grow in 135,000 inhabitants by 2040. Seattle's unprecedented growth and geographic constraints set up a significant challenge for the municipality to meet the movement demand of people, services, and goods efficiently.

Innovations

This research documents a cordon study to provide an estimation and characterization of traffic volumes, prioritizing in CV volumes, for the denser and most constraint area in Seattle. This area named the Center City, holds downtown Seattle, plus three adjacent rapidly growing neighborhoods. The team has established a baseline cordon CVs and car count for the Center City area. Manual counts will be obtained by reviewing video data for all high-volume gateways (i.e., intersections and highway ramps) surrounding the cordon line, which will provide the team with the opportunity to collect a more complex vehicle classification. Data will be collected for two consecutive days, for a 24-h period each, for every location. Additionally, 7-day video footage will be recorded in five locations to capture the variation in CVs volumes along the week.

As part of this research, a new vehicle typology is being proposed to perform a more comprehensive cordon count of the CV fleet and share of the different activities these vehicles perform (i.e., waste management, delivery–pick-up of goods, emergency responses, service, construction). Cordon counts are a valuable tool in the planning and decision-making of local governments to understand travel patterns and vehicle fleet characteristics. The data collected for this study will allow research and the municipality to estimate the total flow (vehicle by type and time period) into and out of the study area, and the accumulation within the cordon by the time of day. This research outlines the methodology and the implementation of an urban cordon study with a focus on CVs flow, and the best practice to manage the collected data. Furthermore, this research represents the first phase of the development of a framework for a Seattle CV's traffic model that will allow the evaluation of different scenarios to improve traffic demand policies.

Contributions

This research effort advances the state-of-the-art by establishing a robust and accurate method to collect, classify, and manage traffic volumes data of vehicles entering and exiting dense urban areas. The data about these volumes is necessary to inform public agencies in their efforts to develop more efficient traffic demand strategies and specifically, to understand the nature of the CVs flow. Implementing periodical cordon count programs allow local governments to monitor the performance of traffic operations and changes in travel demand. These studies, alongside other data collection efforts (i.e., household surveys, CFS, O-D cordon surveys), ensure a comprehensive understanding of the system and therefore, powerful tools that local government can use to model, evaluate, and devise transportation planning policies.

CONCEPTUAL ROUTING FOR POTENTIAL HYPERLOOP FREIGHT NETWORK USING THE FREIGHT ANALYSIS FRAMEWORK DATABASE

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Shih-Miao Chin
Ho-ling Hwang
Hyeonsup Lim
Oak Ridge National Laboratory

Background

Drawing heavily from vactrains, the Hyperloop is potentially a feasible and promising mode of transportation for passengers and freight. The Hyperloop is a closed, wrapped tube or system of tubes through which a container vessel can travel almost free of air resistance or friction, carrying people and goods at high speed. Sucking the air out of the tube, the system eliminate resistance to the container vessel. Theoretically, container vessels can travel through vacuum tube and whisk passengers and commodities at a speed as high as 2,500 mph. Since the conception of the Hyperloop, several potential routes (e.g., between Los Angeles and San Francisco) have been proposed. However, most of these routes were considered based on passenger transportation perspectives (i.e., population centers).

Innovations

The primary objective of this study is to explore potential Hyperloop networks or routes that are logistically and economically feasible based on freight movements in the United States. The FAF integrates data from a variety of sources to create a comprehensive national picture of freight movements (weight and value) among states and major metropolitan areas by all modes of transportation. It provides a national picture of current freight flows to, from, and within the United States and projects such freight flow patterns into the future. The FAF freight movement database provides a unique opportunity to simulate and estimate the benefits and effectiveness of implementing the Hyperloop within the United States.

Using the FAF freight flow estimates for all commodities shipped among the 132 FAF zones (e.g., states, metropolitan areas), this study identifies potential Hyperloop routes based on the estimated costs and benefits of replacing existing transportation modes with the Hyperloop system. Based on the identified routes, this study further maps the potential Hyperloop network and system hubs, as well as locations where the Hyperloop system interacts with other modes of transportation.

Contributions

While the Hyperloop is still a conceptual mode of transportation, many feel positively about its future. Results of this study can shed light on what the future of freight transportation may look like. It will give freight stakeholders in both public and private sectors a big picture idea about the potential benefits and challenges of implementing Hyperloop as the fifth mode of freight transportation.

DATA ASSESSMENT METHODS FOR TRUCK–SEA VESSEL FLOW ANALYSIS

Mario Monsreal
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Texas A&M Transportation Institute

Background

Truck and sea vessel activity are intrinsically connected. However, the relation between these two flows is not always clear. For instance, although one might expect a 1-to-1 relation between the two types of shipments, that is unlikely the case as many maritime containers carry consolidated cargos that have multiple (and different) final destinations. Furthermore, various truck capacities and regulations play a critical role in determining the actual relation between these two shipment modes. A clearer and quantitative understanding of the relationship between vessel and truck shipments allows public agencies and organizations to understand the truck-vessel interface, their system use, and plan–prioritize related system improvements. It also sheds light on how better efficiency can benefit industry partners.

Innovations

This research provides improved understandings that would not be possible without a thorough assessment of available and needed data, and the development of appropriate methodologies. In separate (and symbiotic) contracts, the Texas DOT and the Maritime Transportation Research and Education Center have contracted with the Texas A&M Transportation Institute (TTI) to consolidate data sets and produce methodologies for sound analysis of the truck–vessel flow relationship. The specific contributions of these symbiotic projects are in the form of statistical analyses to determine vessel and truck activity correlations and causalities using the ports of Freeport and Brownsville, Texas, as case studies.

At the core of these analyses lies a methodology for freight data sourcing, data mining, and data fusion. This data assessment methodology uses three basic data sets: (1) vessel activity data, (2) truck activity data, and (3) a review of port requirements and practices for handling both input and export cargos. The case studies present different conditions, and thus, different data requirements and availability. Therefore, these case studies provide real and different scenarios for developing appropriate methods for data sourcing and consolidation. The differences between both cases also influenced the data assessment methodology. Specifically, both studies acquired and prepared vessel activity data for non-liquid cargos, which consisted of AIS data acquired from a private vendor. Depending on the case (Freeport or Brownsville), these vessel activity data were complemented using additional and different data sets (e.g., port administration, census).

Truck activity data were collected from GPS probe data and the NPMRDS. Facility capacity is a linking factor to determine truck–vessel flow behavior. Therefore, in the case of Freeport, the methodology included a terminal capacity analysis using a specialized software. These analyses entailed additional data handling and assessments. Results are in the form of a data assessment methodology with particular data merging and handling processes for each case, and metrics on the relations and impacts of vessel arrivals on the adjacent highway network. The analyses investigated explanatory (independent) variables, and identified relationships between specific shipment activities for both modes. Future work for Texas DOT will include performing the capacity analysis in Brownsville using lessons learned from the Freeport analysis.

Contributions

A clearer and quantitative understanding of the relationship between vessel and truck shipments allows public agencies and organizations to understand the truck-vessel interface, their system use, and plan–prioritize related system improvements. It also sheds light on how better efficiency can benefit industry partners.

EMERGING DATASETS USED IN ADVANCED FREIGHT MODELS

Kaveh Shabani
Maren Outwater
RSG

Background

Freight planning has received significant attention in recent years and transportation agencies are increasingly examining details of freight forecasts to better understand supply chain decisions and ways to improve freight mobility. Advanced behavioral–agent-based freight models are now being developed that consider supply chain and delivery systems to provide a more complete understanding of freight movement and forecasting. Application of recent sources of emerging data combined with new methods have allowed freight models to advance. Moreover, new data sources collected from mobile or navigational systems have provided opportunities for calibration and validation of advanced freight models. Technological advances associated with collecting big data have been exponential, leading to a massive increase in the amount of data that is generated, stored, and distributed. While transportation planning agencies have begun developing these models, existing literature on their details, data sources used, and applications are limited.

Innovations

This research discusses the freight data sources utilized by each of the behavioral/agent-based freight models developed in the United States including models for the Chicago Metropolitan Agency for Planning, Florida DOT, Wisconsin DOT, Phoenix's Maricopa Association of Governments, Oregon DOT, Baltimore Metropolitan Council, and Metro (Portland, Oregon). Best practices using new data sources associated with emerging freight data sources and data sources used in these advanced freight models are reviewed along four dimensions (geographic scope, inputs, calibration–validation sources, and data gaps). These include discussion of emerging data sources (e.g., CFS PUM, INRIX, ATRI, StreetLight, NETS, FAME), innovative data implementation approaches, validations/calibration dataset, and data gaps and issues. Application of emerging data sources, data fusion approaches and other data utilizations by public sector agencies to meet freight planning or freight performance measurement requirements are discussed in this presentation. Data used for inputs, estimation, calibration, and validation along with any data that was desired but not available are identified for each developed advanced freight model and discussed.

Data sources already applied and used for advanced freight models are discussed along various types including employment data, economic data, transfer facilities, freight flows, freight surveys, truck GPS data, and modal volumes data. During this synthesis of advanced freight models, public agencies were also asked regarding any data that was desired but not available and the responses were compiled and discussed with a discussion of general data gaps in freight modeling.

Contributions

Advanced behavioral–agent-based freight models provide improved tools to better understand supply chain decisions and the policy levers for improving freight mobility. This can provide critical data to support performance measures that evaluate freight policies and programs. This synthesis of best practices for advanced behavioral freight modeling experiences and their data utilizations provides agencies and freight stakeholders with a reference to evaluate their use of freight data sources and their applications in already built or future freight models to be built. A handful of public agencies in the United States are in the process of developing—or have already developed—behavioral–agent-based models of supply chain decisions and freight movements. This is largely attributable to funding from the FHWA Broad Agency Announcement awards and the second Strategic Highway Research Program C20 program. This presentation evaluates the use of emerging freight data sources to support the broader application of these methods to forecast future freight flows. Public agencies can benefit from this synthesis to assess the feasibility and practicality of developing similar models and use of data sources for their own regions based on the experiences of other agencies.

MIND THE CURB: FINDINGS FROM COMMERCIAL VEHICLE CURB USAGE IN CALIFORNIA

Mohammadreza Kamali
Anurag Komanduri
Cambridge Systematics

Background

Growth in e-commerce is radicalizing how shippers view last-mile logistics. A key component of last-mile logistics is curb usage. So far, researchers have focused on last-mile logistics through the lens of the private sector, but not many studies have measured the impacts of e-commerce and CV usage on public space, (e.g., curb space). This study addresses that gap using a POC study conducted in California. Caltrans implemented a POC study to assess how granular data may be collected to study circulation and parking of CVs on local streets in urban centers.

Innovations

This study describes the POC effort undertaken to study CV curb usage in both southern and northern California. The objectives were pretty simple: go around the block and collect observable CV data. Curb usage key attributes such as duration, time-of-day, authorized versus unauthorized parking, type of vehicle used, and the companies that own these trucks were studied. A traditional data collection methodology was followed since curb usage is difficult to measure via methods such as GPS.

This study provides insight into urban curb usage that can be useful for city planners, policy-makers, and public and private delivery services. Curb usage data can help city policy makers implement more effective parking strategies targeted towards delivery vehicles so that they don't hinder oncoming and through traffic in the urban core. A larger-scale data collection effort of this nature can be very useful in assessing parking demand over time and by season.

If expanded carefully, this approach can enhance data collection to understand curb usage and will allow agencies to implement new transportation policies, If all the data elements are well understood, cities can even modernize the effort. For cities of the future, such data collection and management will be the currency to provide livable cities.

Contributions

The data collected in this supplementary exercise provides a cost-effective way to analyze curb usage. This type of data collection can be deployed quickly and can be used by agencies to study the following metrics:

- Identify CV activity that is not captured elsewhere. This is important from a truck travel demand forecasting standpoint as CV surveys and establishment surveys do not paint a full picture of last-mile freight activity.
- Pick-up parcel delivery. This sector is often underrepresented or not captured at all in regional freight and truck planning studies. As observed in this effort, a lot of companies belonging to the local pick-up and delivery sector were captured.
- Identify parking restrictions. This is especially relevant for city planners and engineers to ensure there is enough parking for CVs while making deliveries, so that there is no illegal parking which may cause temporary traffic back-ups.
- Infrastructure management. The access routes and points can be better planned if last mile freight delivery activity is studied in more detail with regard to the various attributes that were collected in this study.
- Vehicle access restrictions. Owing to space limitations, certain types of vehicles like combination units may have to be restricted completely or during certain times of day .
- Time access restrictions. Time access restrictions may be imposed to better regulate freight deliveries with minimal adverse impacts on traffic flow and congestion especially in downtown areas.
- Traffic control. The data collected can also help city traffic engineers to better design traffic signals and improve other operational features in the urban core.

SPATIAL DISAGGREGATION OF WATERBORNE COMMODITY FLOW BY FUSING TRUCK GPS AND LOCK PERFORMANCE DATA

Magdalena Asborno
Sarah Hernandez
University of Arkansas

Background

As the United States moves towards a performance-based infrastructure asset management, developing new and fused datasets is key to support the estimation of performance measures. As stated by the U.S. DOT, stakeholders have discussed and identified the need for improved data to support freight performance measurement. While truck data is more broadly available, public sector officials encounter barriers to access proprietary information collected by private operators of rail and waterborne facilities, such as the volume (tonnage) of freight per market segment handled at inland waterway ports.

Innovations

This research proposes a methodology to fuse complementary mode-specific data sources, namely, anonymous truck GPS data and waterborne lock performance data. The novel, multimodal fused dataset helps to better understand commodity flow by providing a spatial disaggregation of waterborne commodity movements at port level. A data fusion approach constitutes a useful tool to public-sector agencies and officials to meet freight planning and freight performance measure requirements.

Contributions

The proposed novel, multimodal fused dataset helps to better understand commodity flow by providing a spatial disaggregation of waterborne commodity flow at the port level and targets inland waterway ports. From a freight planning perspective, understanding commodity flow is essential for estimating the demand for transportation facilities and services, safety risk, energy consumption, and environmental impacts. Specific benefits of the proposed fused dataset are to support location selection for waterborne transload or intermodal facilities along inland waterways, and to estimate multimodal freight-fluidity performance measures per market segment (commodity flow or industry served) for inland waterway ports. Notably, measuring freight fluidity and performance per market segment is needed to tie performance measures to economic impacts, and has been identified as a new trend during the recent TRB Workshop on Implementing a Freight Fluidity Performance Measurement System. Moreover, even though the proposed methodology has been conceived as a tool to help public sector transportation planning officials to overcome limitations associated with proprietary commodity data at the port-level, the private sector may benefit from the proposed methodology by observing freight movements made by other companies along a the inland waterway network.

THE QUESTIONS BIG DATA CAN ANSWER: COMMERCIAL TRAVEL ANALYSIS

Joan Lim
StreetLight Data

Stasa Zivojnovic
Fatemeh Ranaiefar
Fehr and Peers

Background

The efficient movement of freight is critical to many communities' quality of life—the delivery of goods can create jobs and fuel the economy—but an efficient and unsustainable goods movement system can create public health, air quality, safety, and road maintenance challenges. Unfortunately, some questions have always been difficult for planners and modelers to answer empirically: Where do trucks stop, if not at designated truck stops? How many stops do they make on their routes? Do rest stops provide the services they need, such as a safe place to rest? How do the travel patterns of different truck classes compare? With the rise of eCommerce and urban freight activities, answering these questions is increasingly important. These are the types of questions that big data can answer empirically, cost-effectively, and quickly.

Innovations

The intent of the study will be to create quantitative and easy-to-apply guidelines to truck parking planning based on a corridor's or an area's characteristics combined with aggregated GPS data. The guidelines are meant to provide more realistic truck demand estimation as compared to the FHWA Truck Parking Demand Equation, since it would use actual data (see https://www.fhwa.dot.gov/publications/research/safety/01159/3.cfm). Currently, studies that use GPS data use raw GPS points that require a great deal of complex analysis. These studies might also rely on survey methods with a small and unreliable sample size. This method is inconsistent, inefficient, and difficult to scale to the statewide or nationwide level. The goal of the guidelines would be to use GPS data at a simpler scale by aggregating it, which makes the process of truck parking planning faster and more user friendly.

Contributions

The study's goal is to provide more accurate, scalable truck parking demand estimations than the FHWA Truck Parking Demand Equation by using actual truck behavior data through aggregated GPS points. It also aims to provide faster and more straightforward methodology for truck parking planning than only analyzing the raw GPS data, as many studies are beginning to do. In turn, this will create faster and more cost-effective truck parking planning, allow for planners to monitor results and iterate solutions more quickly, and increase willingness for stakeholders to fund these efforts. This will also allow public agencies to be more independent in their truck parking planning efforts.

KEY TAKEAWAYS

New Data Sources

- CA-VIUS database with annual truck VMT, payloads, empty travel, and truck trip lengths.

New Methods

- Spreadsheet-based approach that fuses data and forecasts from a variety of commodity and econometric models to produce disaggregates for smaller geographies.
- Identification of freight activities using IDW interpolation analysis at the parcel level, freight-related employment and truck traffic to produce spatial visualizations.

- Vehicle typology to identify vehicles involved in waste management, delivery–pick-up of goods, emergency responses, service, and construction using cordon counts.
- Use of FAF to estimate routes for future Hyperloop routes.
- Fusing vessel activity data and truck activity data with port practices for assessments of impacts of vessel arrivals on adjacent highway networks.
- Combinations of emerging freight datasets made useful for behavior–agent-based freight models.
- Curb management data collection on local streets in urban centers.
- Fusing anonymous truck GPS data with waterborne lock performance data to understand intermodal commodity flow movements.
- Using actual aggregated GPS truck data to estimate truck parking demand.

New Challenges

- Ability to identify roadway segments that connect FAAs to major corridors.
- Being able to use CA-VIUS to influence air quality and emissions research.
- Developing periodic cordon count programs to monitor the performance of traffic operations and changes in travel demand over time.
- Advances in studies to evaluate Hyperloop technologies as a fifth mode of freight transportation.

Hot Topics

- Highly granular dataset for the identification of FAAs.
- Curb management.
- Multimodal movements and truck parking demand.

Machine Learning and Computer Vision to Collect and Improve Freight Data

SHERIF ISHAK
Old Dominion, presiding

CHIEH (ROSS) WANG
Oak Ridge National Laboratory, recording

Computer vision and machine learning offer new opportunities for improving the quality of freight data and for addressing persistent freight data gaps. This panel discussed recent applications of these approaches.

MACHINE LEARNING APPLICATIONS TO IMPROVE THE COMMODITY FLOW SURVEY

Christian Moscardi
Census Bureau

Background

One of fundamental datasets for freight analysis is the CFS. The surveying effort is a joint effort between the Census Bureau and the Bureau of Transportation Statistics (BTS). The survey collects numerous data elements including the Standard Classification of Transported Goods (SCTG) commodity code (provided in an accompanying booklet to survey participants), commodity description, and other clarifying information. The process of entering this information and ensuring its accuracy is a growing concern. This research addresses the question: Can the assignment of SCTG commodity codes be automated?

Innovations

The first attempt to automate the assignment of SCTG commodity codes used a logistic regression technique and was 50% accurate. An example of the complexity of the problem can be demonstrated with an attempt to automate Fasteners. Two codes—“40994” sewing and knitting needles and “33310” nails, screws, and bolts—both are considered fasteners. In the initial tests, the model predicted the right answer, but the human respondent gave an incorrect SCTG code. Using the data from this comparison, it is possible to see the workflow that led to the miscodings.

The early success with machine learning led to a POC experiment based on 170,000 unlabeled or invalid records. The next step was to attempt to use batch classifiers. The process requires uploading a CSV file and giving the top five matching commodity codes. Next, given a SCTC code, the computer was to return distributions of the top words used. Figure 12 provides an example of an analysis of the top words used.

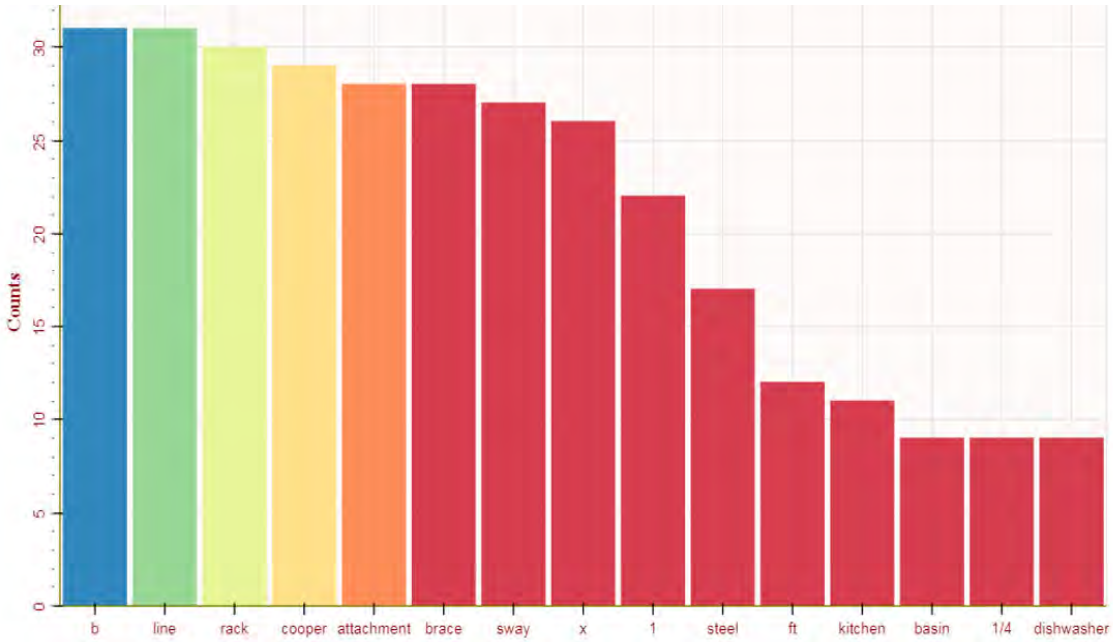

FIGURE 12 Analysis of top words used.

Contributions

Machine learning appears to provide a new way forward to improve the CFS. There are challenges, however. For example, there is a need for cleaner training data to teach the computer through machine learning lead to the application of mechanical turk from Amazon. This process starts with predictions from the current best model and then relabels approximately 15,000 records from a NAICS index. Turkers choose among the top 7 to 10 predictions from the model. The top predictions of the category is based on user input and helps improve the accuracy of the commodity code entered instead of sorting through the list of 520 commodity categories. During the implementation, the process was able to label 50 "gold standard" records.

The success of the first trials is encouraging. There remains the concern of how to reduce suppressions in current estimates and how to be able to provide more details for data users. To meet these needs will require more data. In addition, it is necessary to collect data more often than every 5 years (the current census schedule). Finally, steps are needed to simultaneously reduce respondent burden. The way forward appears to be the development of new methods for extracting shipment data from ERP–TMS; automation of the sampling of shipments; and the ability to accurately identify SCTG codes and enter the appropriate data into online questionnaires while reducing errors in the collection and processing of the data.

Input from the community of CFS users will assist BTS to understand better specific parameters for search and classification tools for SCTG purposes. Users need to inform BTS on their prioritization for improvements including more timely data and more granular geographies. Plans for currently underway for the next CFS Workshop to provide a forum for discussion and exploration of new strategies.

TRUCK TAXONOMY: CLASSIFICATION AND COMMODITY VIA MACHINE LEARNING

Joel Worrell
Florida Department of Transportation

Background

Transportation planners and researchers need to understand the volume and composition of traffic flows and have relied upon traditional traffic counting techniques to provide this information. Florida has some specific characteristics that require a better understanding of freight. With respect to geographic factors, Florida is the third most populous state in the nation with a population of more than 21 million. Florida is a peninsula and has no function as a regional hub. At the same time, it has nearly 3 million visitors per day. In addition, Florida is primarily a service-oriented economy and is lacking in manufacturing jobs. From a logistics perspective, Florida imports 146 million tons and only exports 85 million, with 43 million tons moving internally. The consequences of this imbalance is empty backhauls throughout the state.

Innovations

To address the need for a better understanding of how the Florida freight market functions, a conceptual model was development of a truck and commodity data collection system. The system begins with WIM data, a taxonomy of truck types, commodity information, video feeds and machine learning techniques. The project data requirements utilize traffic data, specifically PVRs as per federal requirements. Unfortunately, WIM data only provides weight per axle, but no commodity hauled information. Alternatives include using FAF, IHS or Transearch databases as proxies for actual commodity movements. These alternatives lack local granularity and are based on the CFS which is only updated every 5 years.

A technology solution to establishing commodity being hauled is the use of video imaging. The video is capable of capturing physical attributes that are not captured with traditional traffic equipment. The extraction of these characteristics from the video feeds requires machine-learning techniques, AI, and transfer learning. In addition, it requires the establishment of a video library of imagery. Finally, the truck taxonomy that results from the algorithmic findings of the video data can be used for Florida DOT's business needs including: freight planning; CV operations; ITS deployments; Strategic Intermodal System decisions; roadway design; maintenance; and external factors. A size and ratio analysis example is displayed in Figure 13.

Contributions

The research team is using an open source platform, with libraries for Pytorch, OpenCV, Dlib, Tkiner and ffmpeg. The GPU cards include: three NVIDIA TITAN X Pascal Graphic Card and one NVIDIA TITAN V Graphics Card. Python is being used as the programming language and Ubuntu 16.04 is being used as the operating system.

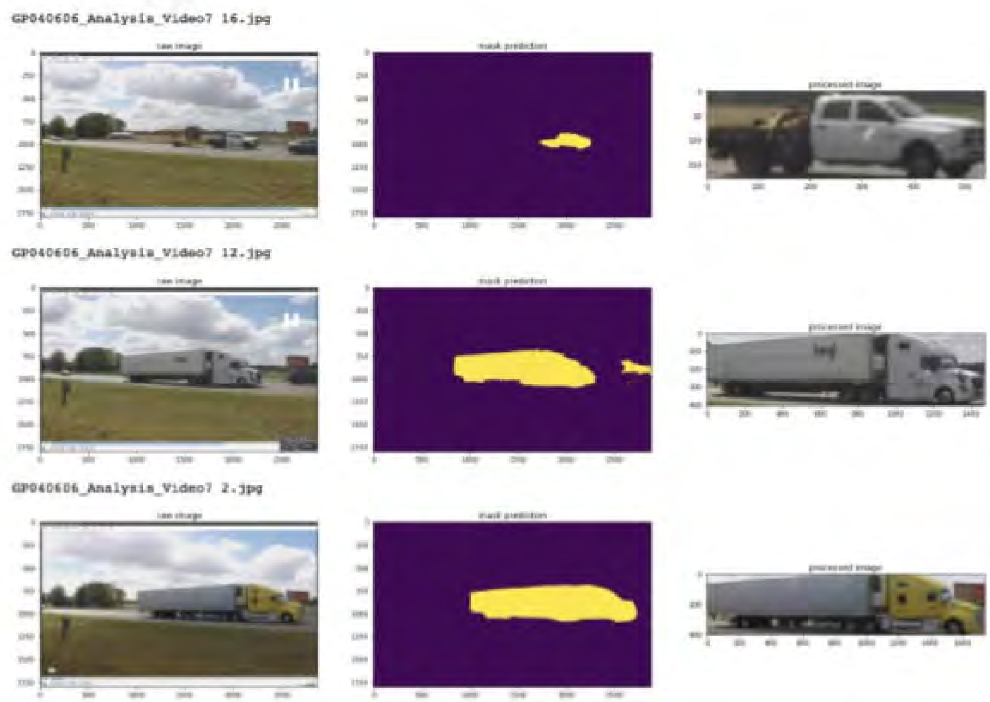

FIGURE 13 Size and aspect ratio analysis.

The truck taxonomy library uses the FHWA Scheme F Classifications and truck trailer type configurations. GoPro video imagery is used at the WIM site. In addition, the FAF4 SCTG commodity classifications are employed. The images database contains 15 million high-resolution images sorted into approximately 22,000 categories. The imagery is used to train the machine-learning algorithms, while actual field collected imagery is used to test the accuracy of the trained machine-learning algorithms. The truck classification process requires an architecture.

The research is using a YOLO annotation tool for transfer learning (refers to “you only look once” real-time objection detection system). Geographic features including size, aspect ratio, and number of trailers are used for classification purposes. The number of wheels in the video are used as a proxy for the number of axles on the vehicle. The algorithm follows a series of decisions to establish the correct identification of a truck type. The technology employed also is “reading” the logos on a vehicle using text detection.

The research team was confronted with a number of challenges. For example, efforts to capture CV configurations was a very labor-intensive element in the research. It important to establish the technical requirements and the hardware requirements as early as possible. Implementation of the research methodology remains unknown and public perspectives of the system will be a challenge. Due to the nature of the project, it is yet unclear how the data management and governance aspects will be implemented.

The near-term goals are to collect and annotate more data to increase the knowledge base of the machine-learning algorithms. More video equipment needs to be purchased and installed at WIM stations statewide (nearly 20 locations) to increase the geographic specific behaviors of freight. The database will need to enhanced to incorporate other commodity code systems [e.g., NAICS or Standard Industrial Classification (SIC) codes]. Research is needed to integrate the existing algorithms into the YOLO annotation tool. The research team is interested in soliciting support from the private sector.

TRACKING THE MARITIME TRANSPORTATION SYSTEM WITH THE AUTOMATED IDENTIFICATION SYSTEM

Patricia DiJoseph
U.S. Army Corps of Engineers

Background

The U.S. Army Corps of Engineers (USACE) has navigational missions to provide safe, reliable, efficient, effective, and environmentally sustainable waterborne transportation systems for the movement of commerce, national security, and recreation. To meet their mission, USACE requires quantitative and statistically robust metrics for waterway managers and stakeholders. Specifically, it is necessary to know who, what, where, when, and why users are negotiating transit on the waterways of the nation. These waterway statistics need to service the needs of planning, real-time operations, and retrospect studies. Example queries that require answers include: how long are vessels anchored; what factors impact vessel transit time; where are the bottlenecks in the system; how the Maritime Transportation System Level-of-Service (LOS) changed over time or after a particular event; and how much delay was experienced from a particular incident.

Almost all vessels are now required to maintain an AIS as a real-time shipboard broadcast system. The purpose of the system is to provide safety, security, and situational awareness. The information broadcasts vessel ID, vessel characteristics, timestamp, location (as a latitude–longitude coordinates from GPS), and speed. The broadcasts occur every few seconds. Receivers are located along the coast, at ports, on the inland waterways, and the Great Lakes in order to collect the broadcasted information. In addition, satellites are capable of collecting AIS data at sea and internationally. USACE maintains a national AIS (NAIS) that integrates the AIS receiver sites, provides for data storage, processing, and networking infrastructure. AIS data is available from USACE as a web-based tool (AISAP) for accessing and analyzing the NAIS data. In addition, there are commercial versions available (both free and as a subscription service). It is possible for individuals to collect their own AIS data.

Innovations

AIS data has a number of new uses. For example, it is possible to infer transit times using geofencing techniques at the origin and destination and to identify the time it takes to go from one location to the next using AIS. The transit times for all vessels can be organized to provide estimates for a variety of uses, including modeling expected transit times, validated with actual times. The calculated transit times provide quick and easy information sources for waterway stakeholders and policy-makers. These statistics make it possible to understand the state of the waterway system, to detect changes in the systems, and to make more-informed decisions. In addition, it assists in voyage planning and estimated time of arrival calculations. These calculations can establish the average travel time above a certain baseline (e.g., 20th percentile travel time) and provide congestion maps for inland waterways.

In addition to establish transit times, AIS can provide estimates of port dwell times. Specifically, it can be used to estimate how long vessels are docked in a port, including anchorage tie, channel transit time, and terminal time. Dwell time estimates provide better understandings of waterway usage, determine specific effects of events or operations decisions that impact vessel traffic, identify changes occurring over time, determine capacities of waterways, and provide inputs for multimodal supply chain applications. AIS also aids in the understanding of weather and incident related dwell time. Aggregating dwell time statistics over time (e.g., months, years) provides planners with trends. The process uses geofencing around a port area, with density plots and dwell time summaries by terminal. Figure 14 provides a map of AIS traces by vessel type.

Contributions

New techniques using AIS are supporting the metrics for the Port Performance Freight Statistics Program and are being used in the annual report that is required by Congress. The report is published by U.S. DOT BTS and is supported by contributions from USACE. Metrics in the report include port dwell time, throughput, and capacity statistics (see https://www.bts.gov/port-performance-2017).

Recent attention to resiliency is another opportunity for AIS to provide value. Data harvested from AIS are useful for anticipating, preparing for, and adapting to changing conditions. They can also be used to assist in understanding aspects of withstanding, responding

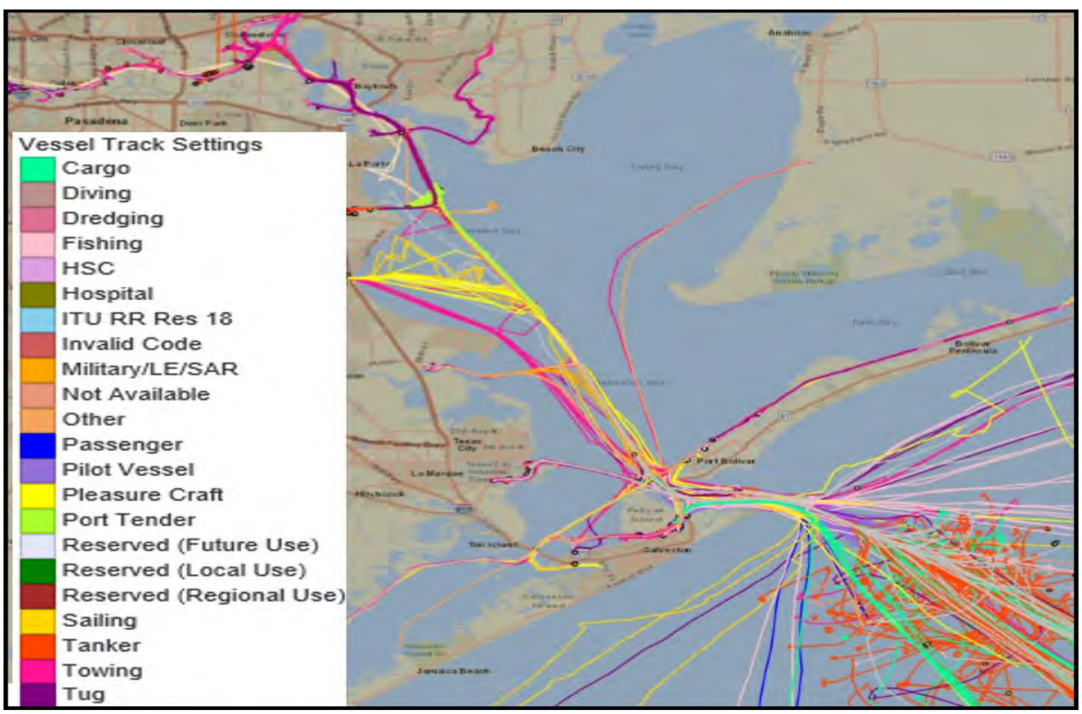

FIGURE 14 Visualization of AIS traces by vessel type.

to and recovering rapidly from, disruptions. AIS is a valuable asset for mining to establish pre-disturbance conditions (e.g., normal LOS), estimate the time to recover, and evaluate post-disturbance LOS. An example of the use of AIS for resiliency includes an analysis of Hurricanes Matthew (2016) and Harvey (2017).

Audience Dialogue

For the first speaker, a member of the audience wanted to know when the research team was using the automated turks and whether they randomized the order of the options presented given the tendency for respondents to select the first option when they see if it is “close enough”. The research team did randomize options to reduce this potential bias. A second question focused on how shipments with multiple commodities were captured in the survey. The response was that the commodity making up the most weight each week during the surveying period was used as the reported commodity. In addition, there is a category to capture truly miscellaneous mixed freight, which probably gets overused in practice.

The second speaker was asked about the image recognition on trucks of logos and the ability to infer commodity being hauled. The audience member asked about whether the research team also capture the company name on the side of a vehicle for large fleets. The researcher stated that both the logo and the company names are being captured and processed, with the understanding that inferring commodity for mixed commodity hauls is part of the next layer of questions and has yet to be conducted as part of the research effort.

With respect to the AIS presentation, an audience member asked whether the data that the researcher have for storm events can be used to estimate costs for resiliency. The research team replied that it can calculate the costs per hour and how much it costs for the vessel to be delayed by a storm as a total cost. Another audience member wanted to know if the research team separated vessel transit time and dwell time by vessel type. In response, the speaker said that in the recent BTS report, tanker vessels and container vessels transit and dwell times were reported separately. It is important to make these separations not only by vessel type, but also by commodity on-board as different commodities required specific timeframes for loading and unloading. In addition, tug and tows also have unique transit time and dwell times.

A second question pertained to working with the pilots’ associations and their perspective on prioritizing the who, what, when and where of vessels movements, what that coordination was like, and if there are any examples of where pressure was exerted for performance. The research team, in conjunction with TTI, conducted a study of the Port of Mobile to explore how different channel restrictions impacted transit time. For example, if the channel is not wide enough for certain classes of vessels, two-way traffic is not possible. The research looked at how anchorage times increased during different kinds of restrictions. Currently, they are looking at the Port of Baltimore. Each port is unique in the restrictions they have to deal with, requiring individual studies. To date, no pilots’ associations or ports have reported impacts due to the need to report performance. However, the reporting program is only a few years old, so there may be a need for research over time to see if there are impacts.

KEY TAKEAWAYS

Andre Tok
University of California, Irvine

New Data Sources

- Video imaging to develop a taxonomy library of truck types.
- Integrated information (AIS and weather)–data fusion products.

New Methods

- Machine learning and deep learning techniques to assist CFS SCTG commodity code entries.
- Algorithms to transform video imaging into truck taxonomy using vehicle features including logo and text detection of company names to classify trucks and infer commodities.
- Using AIS for infer transit and dwell times during normal and unique conditions.

New Challenges

- Need to reduce suppressions in current CFS estimates and be able to provide more details for data users, which will require more data.
- Need to collect CFS more frequently (currently every 5 years) while reducing respondent burden.
- Data management and governance aspects of data generated from video imaging of trucks.
- Need to expand an overall understanding uses of AI in freight transportation.

Hot Topics

- Reducing respondent burden for the CFS using machine learning.
- Developing an automated data collect and classification process for truck identification and future commodity inference based on configuration.
- Highly granular data for waterway activities.

Closing Session

ALISON CONWAY
City College of New York, Chair, presiding

WORKSHOP TAKEAWAYS

Alison Conway
City College of New York

In this final session of the workshop, our goal is to identify key takeaways from the various panels. Based on the first Innovations in Freight Data Workshop 2 years ago, we want to assess what advances have been made over these last 2 years, and what the remaining gaps are, and what the new challenges are going forward. In addition, this session will help identify the next steps for the Freight Data Committee, including what has been learned in this workshop that informs our activities immediately, and what should be done over the next two years to prepare for the next Innovations in Freight Data Workshop, which is already in the planning stage. Responses to this workshop experience will be captured in a post-workshop survey distributed immediately to gather feedback and comments to incorporate in this future workshop. Special thanks to everyone for their contributions to the success of this workshop, including the eight state department of transportation pooled fund supporters, led by Iowa DOT and FHWA. Thanks to the workshop planning committee and TRB staff for their leadership and support.

Panel moderators and workshop contributors will provide their thoughts on key takeaways from this workshop including answers to the following questions:

- What advances in data have been made?
- What's new that we haven't seen before?
- What are the new data sources?
- What are the new methods that we're using?
- Has progress been made on the critical challenges over a long period of time?

Seven years ago, the TRB Freight Data Committee sponsored a workshop where participants developed a freight data research roadmap, laying out the big picture research challenges were. Reviewing the summary table of the roadmap, there are some areas that where real progress has been made over the last 7 years. For example, workshop participants identified as a moderately difficult–moderately impactful topic the exploration of methods for passive freight data collection. There has been a revolution in the use of GPS and cellphone traces and other methods of passive data collection. Seven years ago, these technologies were seen as being far off into the future. Yet, we see examples of widespread use of them in freight. At the same time, key challenges remain—standardizing freight data metrics; defining supply chain data needs; and collecting supply chain data.

Finally, workshop participants wanted to capture the remaining research gaps that the collective research community needs to address as well as learning about the advances in practice. The previous freight fluidity workshop was more experimental than this workshop. Over the last 2 days, there have been more specific applications that can start to be replicated.

However, the applications will need to be replicate with standardized data, with checks on the quality of the data. It is also necessary to understand clearly the research questions being answered before moving into that analysis process.

Paul Bingham
HIS Markit

The key takeaways from the third panel focused on developing data systems to manage CV behavior panel, focusing on trucking activities. Trucking is, not surprisingly, the primary pain point for much of the freight system, but it important to consider a multimodal views and some linkages to them.

The first presentation by Marygrace Parker and Joseph Bryan covered the Freight Fluidity Monitoring Program to date, including how the data acquired is being assembled, the challenge of constructing the data, and innovations for getting participation from the private sector to contribute data which helps identify national performance. Parker and Bryan also acknowledged the limitations encountered. For example, there are only a limited numbers of lanes (or industries) included thus far in this project. Even with these limitations, they have been able to demonstrate that the concept. The program is up and running, with the ability to monitor the cost and performance on the network in significant ways, not just for the long term for planners in the public sector, but for industry itself. More research is needed to complete their project, including adding rail and maritime metrics. Their next steps will be to take the national perspective down to a regional network, with initiatives in Chicago and New York.

The other two presentations participating in this panel focused on truck activity pattern classification schemes. The first speaker used anonymous mobility sensors to examine truck activity on Arkansas highways. The researchers used GPS to uniquely model estimates of tours, stops, and the operations of those trucks on the network based on different truck types. The research is still in progress, with additional steps to be undertaken. Other GPS applications have used advanced methods, with processes for groundtruthing the results. The third presentation used truck GPS data to develop a truck tour typology, connecting long-haul and short-haul trucks in the Washington, D.C., region. The researchers processed the GPS data from INRIX, using an innovative segmentation strategy by vehicle type, segmenting the trucks by light medium and heavy-duty trucks. The researchers developed a clustering algorithm, with additional modeling capabilities, attempts to understand the differences in trucks uses and operations on the network. These behaviors have implications for planning and our understanding the reliability within the metro region. The research could be extensible to other metro regions in the country, but there could be more research to extend many of the dimensions of that analysis.

The research presented sets the stage for future models that could assist in understanding last mile and e-commerce. For example, GPS trace data could be used to advance our understanding of interactions between freight networks where more than one truck is involved in an actual delivery of a product into a region, and where the final-mile delivery is not performed by the long-haul carrier.

As far as what research gaps remain, current research efforts have revealed a number of weaknesses and limitations with respect to modeling efforts. While much of the current research is using data science techniques, questions remain regards how to deal with the number of observations available; outliers and gaps in the data; and bias in the samples being used for the modeling. All three of the presentations in this panel are facing these issues and future freight research will face these challenges going forward.

A key area of research will be identifying vehicles hauling freight from passenger and service vehicles on the network. Tackling this will require a combination of data science and the modeling world to better understand truck drivers and the characteristics of truck traffic. The research will need to focus at the national level down to the local level with measures for understanding performance. Answers will be needed about where the demand is coming from that produces the observed truck activities for planners to accommodate and anticipate how things are changing into the future. .

Nikola Ivanov
University of Maryland CATT Laboratory

The first presentation in the first panel discussed the need for better risk assessment for Hazmat transport. The approach for the research used a crowdsourcing strategy, including Flickr data. Perhaps a next step would be to move beyond these two sources and actually induce crowdsourcing by asking for these types of photos. Concern remains on data quality for this type of research including whether the photos were tagged and analyzed correctly. In addition, there is the overarching concern over bias.

The second presentation highlighted concerns of survey respondent burden, suggesting the need to better understand the incentive for a survey taker to provide data, efforts that can take place on a larger scale, and the sustainability of the approach. Concerns over the limitations of such an approach, particularly the bounds of cost/benefit of providing an incentive and getting the needed information. An additional question is what uses are there for the data and who is actually participating in the survey itself.

The third presentation focused on truck parking – a key need to better understand how best to investigation capacity expansion, provide parking information to drivers, establish policies, and develop partnerships. For example, the Trucker Path application research suggests opportunities for partnerships with private lot owners on a regional basis. The research also generated questions about innovation and integration of different data sources (e.g., ATRI data and other GPS data, combined with other information). What are other sources of data that could be integrated?

Looking more broadly at the panel sessions, there are opportunities to coordinate more closely with Canada, given their advancements with similar freight issues and the international nature of freight interaction across borders. Concerns remain regarding bias, self-selection, representation of responses (particularly for understanding truck parking), forecasting, and factors that impact the truck parking issues. Related questions include the following: What is the incentive for the private sector to share any of that information? What is it that the public sector could offer directly in return for that information? How do you protect the proprietary information? How to you protect the competitive advantage that is being collected internally? What do you provide in return for that?

Holly Cohen
Florida Department of Transportation

The second panel focused on three dynamic topics: empty backhauls in Florida, congestions in the top 100 locations in Texas; and local truck traffic in Hampton Roads with an MPO application of ATRI and Streetlight GPS data. The Florida research used WIM, used primarily for counts and weight enforcement to understand hauling behaviors. A decision tree assisted in the analysis of the utilization of each truck (e.g., full or empty haul). The research required extensive data preparation and QA-QC procedures. There remains further research to address gaps in the ability to detect trends or a temporary hauling behavior. Having only a snapshot from a single analysis suggests reaching out to industry representatives for more validation of the observations as a trend and an opportunity for partnering between the private and public sectors.

The second presentation used freight data to inform the Texas 100 mos- congested roads. The research utilized visualization tools to communicate to a particular audience, using data sources suited best for defining performance. Specifically, the focus was on total measures as opposed to individual measures (e.g., travel time index and the PTI). The objective was to understand the experience of the driver versus the total scale of congestion as an issue. Additionally, the research illustrated consistency benefits of providing data from a statewide scale, also useful for MPOs by using the same data and same tools. The research is challenged with limitations on commodity information, relying on estimates for some measures. While it is possible to provide metrics for performance for an existing network, it is more difficult and will require more research to define what the users, travelers, or shippers intended to do and whether they would have preferred to go on an alternative route. Why did they made certain route decisions or modal decisions that they would be preferred? With answers to these types of questions, planners could more effectively optimize the network to match these preferences.

With respect to the Hampton Roads research, questions about truck activities and the Port of Virginia were paramount for the MPO research team, with the need to identify freight patterns by utilizing big data. The research team used an iterative process that included gathering data from a variety of sources and using tools to attempt to validate findings. The challenge was how to use logic checks when there wasn't sufficient understanding of what the data represented. A research gap exists for practitioners regarding issues such as the appropriate data to use and the available sources. Currently, there is no one source where questions regarding big data resources can be assessed for various applications. Workshops offer one of the few opportunities for lessons learned from peers. For example, it is important to clearly determine which location is the origin and which is the destination of a truck trip when trying to analyze GPS truck data. While progress is being made, it seems that researchers are more focused on the data itself and new ways to use it, rather than being able to answer specific questions for planners. More attention needs to be paid to specific uses and practices for planning issues in order to assist in prioritizations, plans, and a set of tools that facilitate decision-making and analysis of outcomes to the decisions made.

Sherif Ishak
Old Dominion

The fifth panel focused on AI techniques. Compared to the previous Innovations in Freight Data Workshop, there are more examples of the use of machine learning and deep learning. For example, at least five presentations (three in this panel) used AI techniques. Some of the uses involved the data collection process, while others focused on classification strategies for trucks, types of commodities hauled, and uses with AIS. When using machine learning or deep learning techniques, the applications involved detection, prediction, object recognition, and uses with computer vision. For deep learning, vast quantities of data are used and attention must be paid to the quality of the data. The techniques assist in identifying network characteristics and complexities that would be too difficult to identify otherwise. The Standing Committee on Artificial Intelligence and Advanced Computing Applications is producing a primer on AI and it will provide an opportunity to apply AI to freight, with perhaps some examples from this workshop.

Alison Conway
City College of New York

The third panel provided a good example of a new data source for freight, with three presentations providing three very different uses of that data, with different perspectives of the uses and purposes for the data. In community board meetings, researchers and planners are finding that when they try to make the case for freight activities in ultra-urban areas, they are competing with representatives for cyclists concerns, who able to personalize the cyclist' experience. They may be asking for a bike lane that truckers don't want due to safety issues. However, it is often hard to tell the freight story and maybe ELD will become a method for telling the human story for truck drivers. Consider the data showing a truck driver having to drive into Manhattan every morning, sitting in congestions and trying to make a delivery to a large building. The ELD data can be used to illustrate how congestion impacts truck turn times. The final portion of the closing session will feature Joel Worrell providing key takeaways from a DOT perspective on the workshop.

Joel Worrell
Florida Department of Transportation

From the DOT perspective, it appears there is a focus on the same data with new issues, suggesting history is repeating itself. At the same time, technological advances emerging in state departments of transportation are opening new avenues for data, even if it is not known what or where the data will be useful. Florida DOT is telling the freight story as a first step, using models, analysis, new datasets from other modes from our federal partners, to our local studies. In addition, Florida DOT is synthesizing all of these sources of information to make them useful for public stakeholders, which is a very big challenge. It will continue to be a challenge as Florida DOT grows in capacity, reduces lanes, and makes considerations for policy programs (e.g., Complete Streets). More data is needed to provide important points, including turning down economic development opportunities, but maybe seeing them return in the future when they could be reconsidered. To keep on top of this dynamic environment, it is necessary to invest in data. These data are assets, requiring data governance and data management plans and as the systems, databases, and application change, it is necessary to make sure that data investments are available for future systems. What is being built today is not just for the current generation, but needs to be functional for future generations. For this, it is necessary to build in resiliency, make changes in management concepts, and transition the capabilities of personnel, with research guiding decision-making and innovation going forward.

Mario Monsreal
Texas A&M University Transportation Institute

The Research Needs Coordinator for the Freight Data Committee, along with other volunteers, assembled a preliminary list of research needs based on the outcome of the different sessions at this event. The previous speakers have covered much this list. Some topics have been of concern for some time, while others are new challenges. For example, commodity flow data is being captured in new ways, yet there is still a need for a cost-effective methodology to identify truck-specific hauls for some important needs. With respect to O-D data, there is still a need for higher resolution and higher frequency data. To date, it has been painful to obtain these data indicating that more research is needed on how to substitute, get more data, or generate estimates or inferences for the information that is needed. There are new forms of data processing, leading to advances in reporting. Many times research needs are identified individually, without moving forward to provide knowledge. It takes some time to overcome the inertia, to get research in this type of forum, this type of workshop, to facilitate the type of process that was the outcome of research.

Another research need is to focus on how to access private-sector data, as previously mentioned. While this topic is not new, it remains an area needing a new business model, creative ways to convince private sector to share data. Better still would be to have these data follow standards to facilitate the building of analytical tools, the data and processing need to be generic enough to be applied differently and in different settings, such an approach requires research to accomplish. Attention is needed to move exploratory research for descriptive purposes, but miss the desired outcome to make the advancements useful for decision-making. Finally, the merging and linking of different types of data, including land use data.

Alison Conway
City College of New York

In addition to hearing the continuing desire for standardization, throughout this workshop, and in the committee meetings, there was discussion topic of educating the workforce, workforce development, and how to train public-sector employees to be able to have the data analytics skills in line with the research advancements. Not only does the workforce need to be trained but the workforce will need to be retained and not picked off by other industries that require the same skills. This is another cross-cutting issues that applies to the greater transportation community as well as needs in freight research.

Audience Dialogue

A member of the FMS research team suggested aligning academic research more closely with what industry actually needs. Ongoing research is developing online modeling for hazardous materials shipments for oil, gas and other hazardous products by using an online discrete choice model as a behavioral model. There are opportunities for the development of dashboards (e.g., the FMS project) with an incentive to encourage companies to share their data. At this time, large companies have this capability in-house, but middle and smaller companies make up over 50% of the freight community. The development for dashboards would be within the companies and would need their buy-in to the research on platforms for data sharing with public agencies. The FMS project research team plans to obtain detailed behavioral data and merge it, using data fusion, machine-learning and deep-learning techniques, with commodity information (e.g., using the CFS).

An audience member from Transport Canada noted that GIS is a powerful tool, capable of providing analysis of different layers of information. Canada's Commercial Vehicle Safety Alliance [similar to Customs and Border Protection (CBP) in the United States], can use postal codes for ports to map where dangerous goods are traveling by, cross-referencing the locations of industrial parks. Researchers and planners may want to explore opportunities with CBP for similar data in the United States by using zip codes.

Regarding the use of video technology to detect trucks, the Ontario Ministry of Transportation conducts surveys of trucks entering and exiting highways. They take pictures of the back of the vehicle, including the license plate and match the plate number the next time the truck passes through a highway exit and is detected. The photo includes the hazard placard, providing high-quality data on the movement of hazardous materials on highways in Ontario. Another Canadian initiative is trying to estimate how much anhydrous ammonia is moving on roads in western Canada using data on the production of grain (e.g., wheat, barley, canola based on crop districts). Another source of data tied to agriculture tries to estimate fertilizer movements and pesticides movements. Efforts to standardize transportation statistics through the North American Transportation Statistics meetings attended by representatives from Canada, Mexico, and the United States.

An audience member stated that after seeing the advancements made in other states (e.g., Florida's detection research), that not every state has the same level of recognition of how important freight is or had the resources to explore freight problems. Having workshops where states can learn from other states serve the whole country.

The Workshop concluded with the chair reminding the audience that the opening speakers called for actionable research, not only decisions being made based on research findings, but actions being taken to solve real-world freight problems. Plans are already underway for the next Innovations in Freight Data workshop 2 years from now.

APPENDIX

Workshop Participants

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Rapik Saat
Association of American Railroads

Vivek Sakhrani
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