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Best Types of Commodity Flow Data for Freight, Railroad, and Ports and Waterways Studies

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16. Abstract (Limit: 250 words)

The understanding of freight movement is critical to economic development and competitiveness and to make decisions regarding the transportation system. Despite the increased interest in freight planning and modeling, freight data are limited in availability and granularity, and the existing sources are incomplete or outdated. This research analyzes various types of public and proprietary freight databases to determine which are most helpful for planning, programming, and designing future infrastructure on the truck, rail, air, and waterway networks within Minnesota and surrounding states. There are some comprehensive multimodal freight databases that provide different levels of data granularity. These are typically complemented with other data sources that are specific to a transportation mode. We also interview stakeholders involved in freight planning in Minnesota to identify data gaps and capture current and future data needs. Important needs include (i) mode specific freight data, especially for waterways and ports and air freight; (ii) equity considerations in freight transportation; and (iii) understanding the relationship between freight transportation and climate change. Additional freight data are much needed overall to inform economic development and funding prioritization, as well as to evaluate and minimize supply chain disruptions.

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LIST OF ABBREVIATIONS

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AAR	American Association of Railroads
ACS	American Community Survey
AGLPA	American Great Lakes Ports Association
ATA	American Trucking Association
ATRI	American Transportation Research Institute
BEA	Bureaus of Economic Analysis
BOL	Bill of Lading
BTS	Bureau of Transportation Statistics
Caltrans	California Department of Transportation
CFAC	California Freight Advisory Committee
CFS	Commodity Flow Survey
CSF2TDM	California Statewide Freight Forecasting and Travel Demand Model
DOT	Department of Transportation
DelDOT	Delaware Department of Transportation
ETC	Eastern Transportation Coalition
E-TRIMS	Enhanced Tennessee Roadway Information Management System
FAA	Federal Aviation Administration
FAC	Freight Advisory Committee
FAF	Freight Analysis Framework
FAST Act	Fixing America's Surface Transportation Act
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FMTP	Freight Mobility and Trade Plan
FLFAC	Florida Freight Advisory Committee

FTZ	Foreign Trade Zones
GLRTOC	Great Lakes Regional Transportation Operations Coalition
HPMS	Highway Performance Management System
HTS or HS	Harmonized Tariff Schedule
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IDOT	Illinois Department of Transportation
IMO	International Maritime Organization
IMPLAN	Impact Analysis for Planning
iTRAM	Iowa Travel Analysis Model
ISFAC	Illinois State Freight Advisory Council
LOS	Level of Service
LTL	Less than Truckload
LPMS	Lock Performance Monitoring System
LSC	Michigan's Commission for Logistic and Supply Chain Collaboration
MAASTO	Mid-America Association of State Transportation Officials
MAFC	Mid-America Freight Coalition
MAPSS	Mobility, Accountability, Preservation, Safety, and Service Program (WisDOT)
MARAD	Maritime Administration
MDOT	Michigan Department of Transportation
MDSP	Multimodal Data System Program
MHFP	Minnesota Highway Freight Program
MPO	Metropolitan Planning Organization
MRPT	Maryland Roadway Performance Tool
MSTM	Maryland Statewide Transportation Model
MRPT	Maryland Roadway Performance Tool
MSA	Metropolitan Statistical Areas

MSTM	Maryland Statewide Transportation Model
NASA	National Aeronautics and Space Administration
NAICS	North American Industry Classification System
NDA	Non-Disclosure Agreement
NFHP	National Highway Freight Program
NFSP	National Freight Strategic Plan
NHS	National Highway System
NPMRDS	National Performance Management Research Data Set
NVOCC	Non-Vessel Operating Common Carrier
PIERS	Port Import/Export Reporting Services
PPFSM	Port Performance Freight Statistics Program
RAR	Railroad Annual Reports
SCTG	Standard Classification of Transported Goods
SFAC	Delaware State Freight Advisory Committee
SIC	Standard Industrial Classification
STCC	Standard Transportation Commodity Code
STB	Surface Transportation Board
TAZ	Transportation Analysis Zone
TDM	Travel Demand Model
TEUs	Twenty-foot Equivalents
TMC	Traffic Messaging Channels
TOPS	Traffic Operations and Safety Lab
TPIMS	Truck Parking Information Management System
TTI	Texas Transportation Institute
UMRBA	Upper Mississippi River Basin Association
USACE	U.S. Army Corp of Engineers

VHT	Vehicle Hours Travelled
VIUS	Vehicle Inventory and Use Survey
VMT	Vehicle Miles Travelled
WCSC	Waterborne Commerce Statistics Center
WILMPACO	Wilmington Area Planning Council
WIM	Weigh-in-Motion

EXECUTIVE SUMMARY

The understanding of freight movement is critical to not only economic development and competitiveness but also to better construct a transportation system that decreases congestion and maintains safety. Despite the increased interest in freight planning and modeling, freight data are limited in availability and granularity. Further, significant gaps exist in the available datasets, in which data are missing, incomplete, or outdated. This research analyzes various types of freight databases to determine which are most helpful for planning, programming, and design of future infrastructure on the truck, rail, air, and waterway networks in Minnesota and surrounding states.

Freight Data Sources Available for Planning

Several data sources are used for freight planning and analysis. The most commonly used and comprehensive multimodal freight databases are Freight Analysis Framework (FAF) (public) and Transearch (proprietary). FAF's key advantages are that it covers all major freight modes, contains accurate information for international shipments, and the data can be accessed immediately at no cost. Conversely, Transearch's key strengths are its geographic detail down to the county level, greater commodity detail for the commodities in the dataset, and greater information on trip chains (e.g., truck trips from distribution centers to warehouses). While both databases are generally detailed in regard to commodity information and geographic granularity in comparison with other single modal freight data sources, they have some limitations. For example, while FAF does not contain as much commodity and geographic detail as Transearch, Transearch often lacks accurate information for international shipments and does not include totals for pipeline freight. Further, Transearch is updated more frequently (annually), compared to every five years for FAF. Other data sources are used to complement these sources and are specific to a transportation mode.

In terms of truck freight data, freight planners use American Trucking Research Institute (ATRI) data, Streetlight, National Performance Management Research Data Set (NPMRDS), and American Trucking Association (ATA) in addition to the multimodal sources. Each of these data sources has different characteristics that make it useful for freight analyses. ATRI and Streetlight data, for instance, are based on GPS data truck fleets. NPMRDS is another popular data source with information on both passenger and commercial trucks as well as historical data that are useful for comparative analyses of freight over time. Lastly, ATA contains a variety of information, such as truck types (e.g., for-hire, private motor carriers, and refrigerated trucks). However, there are limitations with some of the existing GPS-based data sources that must be scaled up or assumptions made to get full estimates. These limitations include a lack of persistent truck IDs and inaccurate truck counts.

The most popularly used databases for rail freight are STB Waybill data and Railroad Annual Reports (RAR). STB Waybill data contain information for the largest railroad operators in the U.S., which represents a significant portion of rail freight that travels within the country. In addition, STB Waybill contains geographic information for Canada, Mexico, and the U.S. (this last one at the Business Economic Area -BEA). RAR contains information for more commodity codes compared to STB Waybill. However, while the RAR database represents a large share of total freight, it represents a small fraction of the number of rail operators in the U.S., as it excludes railroads other than Class I and II and shortline operators.

Ports and waterways data are most commonly analyzed via the Port Import/Export Reporting Services (PIERS) data and the Waterborne Commerce Statistics Center (WCSC) data by the USACE. PIERS is considered one of the most detailed waterways/ports data sources as the information comes from Bills of Lading (BOL). The WCSC data have information on public ports for imports, exports, domestic shipments, and commodity information for ports and waterways freight but is incomplete as privately owned ports are not required to report to the USACE.

Lastly, the most commonly used database for air freight is BTS T-100. This database includes information on airports in the U.S. and Canada and data for both passenger totals as well as mail and freight tonnage data. However, there is a need for more air freight data as well as more commodity-specific data to identify cargo movement gaps.

Freight Data Needs in Minnesota

The researchers interviewed stakeholders involved in freight planning in Minnesota to identify gaps in current data sources and user experiences with public and private freight data and to capture current and future data needs. The following are freight data needs identified by stakeholders in Minnesota:

- *Need for mode-specific freight data — this* includes more data to support efficient freight flow through waterways and ports and more detailed commodity information for air freight to understand which commodities use air transport.
- *Need for equity considerations in freight transportation* —discussed in terms of impact and outreach. For instance, there are some concerns about the facilities that transport and store oil and hazardous materials and their impacts on nearby communities.
- *Need to understand the relationship between freight transportation and climate change*— this includes the carbon footprint of transporting specific commodities, trends of mode shift toward sustainable freight transportation, and the electrification of trains and the fleet of trucks.
- *Need for freight data to inform decision-making — p*articularly for economic development to attract new businesses to regions across Minnesota, funding prioritization to determine the most productive use of funds to increase the efficiency of Minnesota's freight flows, and commodity freight flow data to identify commodity shortages to evaluate and minimize supply chain disruptions.
- *Need to better engage the private sector* — to improve understanding of the freight transportation system and encourage collaboration to address freight challenges.

Overall, Minnesota stakeholders discussed several gaps in current freight flow data sources including lack of geographic granularity, inaccurate information on commodity flow for some industries, reliance on data modeling, lack of commodity data across transportation modes, and other data limitations specific to transportation modes.

Best Practices for Freight Data Collection and Planning across States

To determine the best practices for freight data collection and planning across states, the researchers use case studies of some states in the Great Lakes region, some coastal states, and a neighboring state. From the case studies, the researchers first determine that common practices include identifying freight data needs and identifying the limitations of current freight datasets. These are important as they allow states to examine where data gaps exist and how to overcome these gaps to achieve the desired freight planning outcomes. Second, the researchers determine several best practices for freight data collection:

1. *Use available data sources to address freight data needs:* A plethora of freight data sources exist that may could address data gaps, but they are underutilized or the benefits of the data source are not properly understood.
2. *Identifying appropriate data collection methods:* Both quantitative and qualitative approaches can prove useful in gathering necessary freight data.
3. *External engagement and collaboration between both the private sector and external transportation agencies:* These collaborations can create an avenue for potential data sharing and to further the knowledge of trends, challenges, and opportunities of freight to improve freight planning practices.

Recommendations for Generating and Collecting Freight Data Sources

Based on the research findings, the research team identified two sets of best practices. The first set is about generating and collecting freight data and the second set is about determining data sources helpful for planning, programming, and design of future infrastructure on the freight network.

The set of recommendations in the first group include:

1. Use existing data sources to address freight data needs
2. Strategize the purchase of proprietary freight data
3. Formalize interagency agreements to purchase proprietary freight data
4. Collect additional (quantitative and qualitative) freight data to supplement existing data sources
5. Approach private sector firms to understand their businesses and the freight-related challenges they face
6. Approach Freight Advisory Committee (FAC) members for specific data needs
7. Validate freight information

The set of recommendations in the second group weighs the advantages and limitations of the most commonly used freight data sources and asserts that existing data sources serve varying data needs.

CHAPTER 1: INTRODUCTION

Freight has grown exponentially over the past several decades in the U.S., especially with the advent of just-in-time shipping and distribution. Overall, the movement of freight represents enormous influence on the U.S. economy, with an estimated $14.38 trillion in value per year in rail, trucks, and air combined (BTS, 2018). In addition to the acknowledgment of freight's enormous financial impact, the passing of the Fixing America's Surface Transportation (FAST) Act in 2013 has placed particular emphasis on the improvement of freight practices with the establishment of a National Freight Strategic Plan (NFSP) that codifies processes for assessing the current state and performance of the freight system across fifty states. In addition, the FAST Act has progressed the study of freight significantly over the past several years through the development of the National Highway Freight Program (NFHP) along with several other initiatives. These factors have convinced policymakers and transportation practitioners alike over the past few decades of the importance of understanding the flow of freight at both a more holistic and a granular level. Further, the understanding of freight movement is critical to not only economic development and competitiveness but also to better construct a transportation system that decreases congestion and maintains safety.

Despite the increased interest in freight planning and modeling, freight data are limited in availability and granularity (Pan, 2006; Mani & Prozzi, 2004; Asborno, Hernandez, & Akter, 2020). Review of the current literature on the availability of freight data reveals a dearth of private and publicly available comprehensive, non-aggregated freight datasets that present difficulties in constructing freight flow models that give an accurate and complete movement of freight. Further, of the available datasets, research has noted that significant gaps still exist in which data are simply missing, incomplete, or outdated (FHWA 2015). The gaps necessitate models that can accommodate such missing data (Giuliano, Gordon, Pan, Park, & Wang, 2010).

This research aims to fill these gaps in the literature by analyzing various types of databases and to determine which of them are the most helpful for planning, programming, and design of future infrastructure on the truck freight, railroad, and ports and waterways networks within Minnesota and surrounding states. The researchers will also assess and recommend methodologies for generating and collecting freight data, freight trip generation, and service trips within the context of the Minnesota Department of Transportation's (MnDOT) freight studies.

CHAPTER 2: LITERATURE REVIEW

Overall, the movement of freight represents enormous influence on the U.S. economy, however, existing literature overwhelmingly suggests that freight data are limited in both availability and specificity. In addition, the complexity of freight movement presents challenges in accurately forecasting and understanding the movement of freight both within and across America's fifty states.

In their 2004 review of 30 freight data sources in the U.S., Mani and Prozzi (2004) assert that disaggregated data are necessary to "provide a clear picture of freight movements on a state's transportation system." Further, disaggregated data are important for predicting freight movement, improving safety, and improving transportation overall to allow for more efficient freight and passenger travel. However, this mix of local, state, and federal aggregated data from public and private data sources present difficulties in validating the data or extrapolating a solid understanding of current and future freight movement (Southworth F. , 2018; Asborno, Hernandez, & Akter, 2020). Asborno, Hernandez, and Akter (2020) highlight an example of this use of multiple data sources to analyze the multimodal movement of freight in which "the Federal Highway Administration (FHWA)' National Freight Fluidity Monitoring Program combines waterborne data from the U.S. Army Corps of Engineers (USACE), railway data from TransCore and the Carload Waybill Sample, highway data from the National Performance Management Research Data Set (NPMRDS), and supply-chain data from U.S. private companies. The result is a mapping tool that tracks the reliability, cost, and travel time for multimodal freight movements across selected supply chains on a quarterly basis" (Parker, 2019). Despite this use of multiple data sources and multimodal modeling accomplishment, this practice still does not reveal the quantity of freight movement, which makes future freight almost impossible to predict (Asborno, Hernandez, & Akter, 2020).

Furthermore, while mode-specific data exist, researchers have noted that generating multimodal indicators (those showing freight traveling via multiple modes) and datasets would better capture end-to-end supply chain information and allow states and policymakers better visibility into how freight moves not just from one destination to another, but from one mode to another (TRB, 2014; Turnbull, 2014).

Regardless of the fact that there are few accessible data sources, transportation practitioners and policymakers rely on many of the available public and private sources to produce freight flow models that capture and predict freight movement in order to better understand and plan for the transportation system.

2.1 MULTIMODAL FREIGHT DATABASES

The main method for categorizing freight movement is by "freight flows," which represent the spatial movements of goods between shipment origins and destinations between traffic analysis zones (TAZ) (Southworth F. , 2018). Flows can be expressed in numerous ways, such as tons shipped, the dollar value of the goods that are shipped, or by the number of trips taken by freight modes (Park & Smith Jr, 1997; Southworth F. , 2018). Currently, researchers have sought to understand freight movement through a categorical approach that designates freight flow databases into four main types: Trip-based, commodity-based, finance-based, and origin-destination (O-D) (Park & Smith Jr, 1997; Southworth F. , 2018). These database approaches are typically combined to better analyze freight movement.

Trip-based databases deal primarily with the total number of trips or vessels leaving a facility and are commonly used to predict movements on a particular transportation infrastructure (such as truck trips on highway networks). While trip-based can refer to any mode of freight, most states and urban freight modeling distills trip-based databases and freight flow modeling approaches into simply truck trip-based data based on employment or other economic aggregated data. A primary example of data using trip-based approaches is developed by Park and Smith who aggregated data for truck trips at the statewide level (Park & Smith Jr, 1997). Overall, the trip-based approach has limitations that are centered around the lack of reliable data, such as origin-destination survey data that are both expensive and burdensome to obtain. In addition, these data are often difficult to aggregate once collected due to the various ways freight is described across modes. Further, trip-based approaches do not rely on consumer demand, or consumption-related factors and thus do not provide information on the type of commodity. Lastly, trip-based approaches can be limited in multimodal modeling contexts as they focus on trips that have already happened (Holguín-Veras & Patil, 2008). These limitations restrict the understanding of the type of freight traveling throughout the transportation system and more detailed analysis such as supply chain patterns.

The commodity-based approach focuses on the movement of commodities. These types of data are used to understand supply chain patterns. Commodity-based databases address a weakness of the trip-based approach by providing information on the commodity type. However, commodity-based approaches do not automatically account for empty vehicle loads and assume trips are directly proportional to the amount of cargo (Holguín-Veras & Patil, 2008). Thus, not accounting for empty vehicle trips can make directional freight comprehension difficult as once commodities are distributed or delivered, there are still vehicles on transportation systems that are no longer carrying freight.

The finance-based approach, or the Input-Output (I-O) model is a more recently used development in freight flow modeling as aggregating freight transportation by mode can get complex. Instead, freight flow modelers use data such as dollar values and tonnage of commodities produced within a similar geographic zone to estimate the number of vehicle trips needed. Thus, this freight database assumes that, for example, an increase in demand for a product within a given industry results in an increase in production of that good, which sets off resulting actions, like increases in vehicle trips of that product (Southworth F. , 2018). The inputs and output pairs are available through tables developed by the Bureau of Economic Analysis (BEA). While this approach is useful in understanding the relationship between economic factors and an increase or decrease in freight usage, these types of databases do not contain a spatial component to it (Southworth F. , 2018).

The Origin-Destination approach is categorized by collecting data on the origin and destination of a freight mode. Oftentimes, granular data on the types of commodities or shipments is absent from the data, but the O-D approach remains useful in understanding generally where freight is flowing to and from. Despite its usefulness, using O-D databases for freight flow modeling is extremely difficult for many reasons, and as such, is not preferred as much as commodity-based and finance-based approaches. First, gathering survey data on the origin and destination pairs for freight modes and commodities is extremely costly and burdensome. Second, origin-destination information becomes difficult for certain modes, like rail and waterways, because of the “first-mile, last-mile” nature of freight that moves through these modes (Southworth F. , 2018).

2.2 MULTIMODAL PROPRIETARY AND PUBLIC SOURCES OF FREIGHT DATA

While mode-specific freight databases exist, there are several sources of comprehensive multimodal freight data sources that are widely used by transportation practitioners and policymakers, such as Commodity Flow Survey (CFS), the Freight Analysis Framework (FAF), and the Transearch database. In freight flow modeling, these databases are often used in conjunction with other sources of data, such as employment and demographic data, that can provide a more aggregated freight picture.

2.2.1 Commodity Flow Survey

The Commodity Flow Survey is the most commonly used and widely known commodity dataset. The CFS collects information via surveys distributed to about 100,000 companies in various industries such as manufacturing, mining, wholesale, and auxiliary establishments (Mani & Prozzi, 2004). The CFS, administered by the U.S. Census Bureau as part of its Economic Census, is a publicly available, free-to-use database that is conducted and updated every five years. Included in the survey are the type of product shipped, the origin and destination of the product, the product’s weight and value, and five modes of transportation (BTS, 2020). The CFS also collects additional, more granular data such as: “origin state, destination state, mode of transportation, shipment weight, value, commodity information for 45 commodity types (as per NAICS, 3-digit classification), distance routed, whether the shipment is for export, whether it contains hazardous substances, if it is temperature-controlled, and if it is a rush shipment” (Asborno, Hernandez, & Akter, 2020). Its comprehensive data collection makes it one of the most popular data choices -used widely by researchers, policymakers, and transportation practitioners across the U.S.- for analyzing freight flows.

While the commodity-based approach and the CFS are instrumental in understanding the movement of freight, the CFS still contains many limitations that present difficulties in understanding the full movement of freight. Specifically, the lack of commodity details available in the dataset is an obstacle for using the data to develop local planning and policies surrounding freight (Southworth F. , 2005). For example, one of the commodities captured in the CFS is “miscellaneous manufacturing.” While this information can be useful in the aggregate, it may prove useful to know which manufacturing commodities are traveling via specific modes or specific origin/destinations. In addition, the CFS narrows down the U.S. to only 132 geographic zones, in which some entire states, like Arkansas, represent only one geographic zone (Asborno, Hernandez, & Akter, 2020). Further, the CFS does not account for transnational shipments, such as shipments from Mexico to Canada, and thus the use of freight modes in the transportation system for this type of shipment cannot be analyzed. Lastly, the CFS is burdensome and requires a significant amount of information to complete and thus may not always elicit as many responses as possible (Mani & Prozzi, 2004).

2.2.2 Freight Analysis Framework

The Freight Analysis Framework is another commodity-based database that is developed and maintained by the Bureau of Transportation Statistics (BTS) in collaboration with the FHWA. The FAF is updated every five years in conjunction with the CFS and combines several data sources into one large database. In its current version (FAF4), the FAF utilizes 2012 CFS data combined with numerous other data sources, including the Census Foreign Trade Statistics, Economic Census data, USDA's Census of Agriculture, Port Import/Export Reporting Service (PIERS), Vehicle Inventory and Use Survey (VIUS), National Highway Planning Network (NHPN), Highway Performance Monitoring System (HPMS), and U.S. Energy Information Administration (EIA) (Asborno, Hernandez, & Akter, 2020). The advantage of the FAF database is that it provides freight data from four modes of freight transportation, such as air, water, truck, rail, and other/unknown for 44 commodities, with data that include information such as weight, weight-distance, and value. The primary disadvantage of the FAF database is that it utilizes the same geographic zones as the CFS, which allows for disaggregation of freight data geographically, but reduces entire states to one geographic zone, which limits a more specific understanding of freight movement throughout various geographic regions (Asborno, Hernandez, & Akter, 2020).

2.2.3 Transearch

Unlike both the CFS and FAF, Transearch is a proprietary, commodity-based multimodal freight database developed by IHS Global Insights. The database collects county-level information for over 3,000 counties in the U.S. for over 340 different commodities. A significant advantage of using the Transearch database is that it contains information for seven modes of freight transportation such as for-hire truck, less-than-load truck, private truck, truck/rail intermodal, rail, waterborne, and air (IHS Markit, 2021; Asborno, Hernandez, & Akter, 2020). Transearch is used widely by transportation practitioners, Metropolitan Planning Organizations (MPOs), and private sector shippers and carriers because of its comprehensive data availability (Asborno, Hernandez, & Akter, 2020).

Despite its many advantages, Transearch has several disadvantages that both limit its applicability and usability (Asborno, Hernandez, & Akter, 2020). First, because the database is proprietary, the cost to access the database ranges from $50,000-$100,000 per state for a single year of data. Second, the methods of collecting and sharing data are not disclosed due to their proprietary nature. Third, Transearch codes shipments to and from distribution centers as separate and unique trips, thus blurring the ability to track the complete origin and destination information for some commodities. Similarly, some freight that is moved within an inland waterway and then temporarily parked in another port before being sent to its final destination is also coded as separate trips. In addition, commodity trips from distribution centers are coded as "Secondary Traffic" in which the specific commodity transported is not disclosed. Lastly, as is consistent with other commodity-based databases, the lack of spatial characteristics within the database is a significant limitation.

While some databases show O-D information, the main type of multimodal databases are commodity-based as trip information and finance information can be inferred from commodity details. Still, there is not a comprehensive O-D database such as the CFS, the FAF, and Transearch that exists with commodity information. This presents difficulty given that commodity-based databases lack geographic detail sufficient to allow for complete and pointed strategies for reducing roadway congestion (TRB, 2003). While freight flow models can still inform policy from aggregated sectoral or high-level commodity information, researchers have pointed out that further economic development of certain industry clusters, such as Minnesota's medical device industry cluster, necessitate a well-functioning transportation system that identifies and plans for the movement of specific cluster-related commodities which may not be captured in current commodity-based databases (Munnich, Fied, Cho, & Horan, 2021).

2.2.4 Public and proprietary datasets for use in non-mode specific freight modeling

Several U.S. economic surveys provide information to estimate and analyze freight movement in the absence of data collected directly from the private sector. While private sector companies often have data that policymakers and transportation practitioners would find valuable in modeling freight movement, they are often unwilling to share such data for fear that competitive advantages may be diminished (Samimi, Mohammadian, & Kawamura, 2013). Additionally, the multimodal nature of the freight transportation system necessitates the involvement of numerous decision-makers, such as logistics providers, operators, and insurance companies, making data collection of all private sector entities extremely cumbersome (Asborno, Hernandez, & Akter, 2020). While not specifically capturing freight data, U.S. census data and other economic surveys have information that could be utilized to analyze freight movement. For instance, transportation practitioners may use employment, demographic, and census data, such as County Business Patterns (CBP), Quarterly Census of Employment and Wages (QCEW) database, and the Longitudinal Employer-Household Dynamics (LEHD) database within a region to estimate the number of facilities that would use freight carriers and utilize this information to aggregate a total number for freight vehicles. Similarly, data on the number of transactions and business locations may be used as a proxy for the exact commodity data. These databases are publicly available and can be used in conjunction with other freight databases to aggregate information needed for freight flow modeling.

Similarly, proprietary databases such as ArcGIS's Business Analyst, ReferenceUSA, and InfoUSA can be used to model freight flow. These are non-mode specific datasets that may not capture specific freight information but can be utilized to aggregate economic, employment, business location, or other types of data used in freight flow modeling. These databases can include information such as the number of employees in an organization, the industry code, the location of the business, and the business revenue. These data points can then be used in conjunction with mode-specific freight data or as a proxy to estimate the quantity and type of freight movement within a geographic area.

Lastly, there are a few notable databases that are used to compare the value of freight among countries. For instance, the World Bank database breaks down freight value by mode and country. In addition, a snapshot of historical freight value by mode and country is presented to show trends in freight modes over time, starting with 1970 through 2019. Users of this data can access data files for no cost and can utilize the DataBank data visualization tool on the World Bank website at no cost (The World Bank, 2021). While databases such as these are useful for comparison purposes, the lack of granular commodity and O-D information within the data files does not allow for usage in freight flow modeling activities.

2.3 SINGLE-MODE FREIGHT DATABASES

In addition to the availability of multimodal databases, there are many sources of single-mode freight data for trucks, air, rail, ports, and waterways. These databases come from a variety of sources and contain different measures and types of commodity data and other types of collected data.

2.3.1 Public and proprietary sources of freight truck data

Of all modes of freight transportation, trucks are by far the most widely used mode of freight transportation across the U.S., with about $10 trillion of value in shipment coming from trucks alone, and the remaining $4 trillion in other freight modes combined (BTS, 2018). The number of trucks on America's roadways has increased by 22.9 percent from 2010-2018 and is expected to continue to grow over the next several decades (BTS, 2018). Unlike freight rail that relies on a system of highly privatized systems and facilities, public sector and primarily private sector freight trucks almost exclusively utilize and thus tax the public transportation systems across all fifty states. Despite this, the data needed for policymakers to adequately assess freight movement on roadways within those states is inaccessible due to the proprietary nature of freight data (Anderson, Harris, & Harrison, 2010; Quetica, 2021). Further, trucks often originate outside of the geographic range of purview of transportation planners, unlike passengers' trips which most often occur within the same geographic region (Anderson, Harris, & Harrison, 2010). The sheer number of truck trips that originate on local roads as a result of international shipments that come through ports has significant impacts on road congestion and infrastructure.

One of the most commonly used proprietary databases is available through American Transportation Research Institute (ATRI). The database provides GPS-based spatial and temporal information for a large sample of trucks with onboard, wireless communication systems in the U.S. Data include geospatial (coordinates) and temporal (time/date stamp) information for the corresponding trucks. Other information such as spot speed and heading are also provided in the data. The data do not provide information on commodity type. ATRI updates its databases monthly and the cost to access the data is variable depending on the quantity and type of information needed.

As recently as 2010, truck GPS data have been utilized to forecast future freight movement. Researchers at the Puget Sound Regional Council (PSRC), Washington State Department of Transportation (WSDOT), and the University of Washington (UW) have collaborated to collect and analyze GPS truck data from commercial, in-vehicle, fleet management systems used in the Puget Sound region. This type of data, updated in real-time via GPS, is instrumental in developing the trip-based approach modeling discussed previously (Bassok, McCormack, Outwater, & Ta, 2011). Many sources of truck GPS data, however, are proprietary, such as Streetlight, InfoUSA, NAVTEQ, and ESRI. Additionally, the FHWA collects Annual Average Daily Traffic (AADT) estimates for single use and combination trucks for certain non-local roads and total Vehicle Miles Traveled (VMT) data for nine separate truck classifications (Mani & Prozzi, 2004).[1] These databases do not collect commodity information or origin-destination data which presents difficulty in understanding the movement of freight trucks throughout the transportation system.

In addition to full truck-load freight shipment databases, the American Trucking Association (ATA) maintains the proprietary Less Than Truckload (LTL) Commodity and Market Flow Database. LTL is categorized by any truckload that carries less than a standard full truckload, or 10,000 pounds. This database is updated monthly and contains data on commodities categorized by “Standard delivery time, Nonstandard delivery time, and Special equipment or handling” (Mani & Prozzi, 2004) and collects O-D data, shipment weight, volume, number of shipments, and number of pieces, and revenue and tonnage-mileage information. The data are geographically represented on a national, state, and metropolitan basis. A primary limitation of this database is that it only collects LTL information for the ATA subscribers, not all LTL carriers. In addition, the data are only available to subscribing carriers that complete the data collection procedure (Mani & Prozzi, 2004).

2.3.2 Public and proprietary sources of freight rail data

With over 140,000 miles of freight routes, the U.S. freight railway system is the largest in the world. Almost a third of all freight travels by rail, with an economic impact of about $80 billion. Additionally, railroads are distinct when compared to other forms of freight modes in their characteristics, such as reducing roadway congestion and greenhouse gas emissions, and reduced cost to public infrastructure. Additionally, railroads, unlike other freight routes, are privately owned, operated, and maintained (USDOT FRA, 2020). Despite this, many of the most robust sources of freight rail data are available through U.S. federal sources. For example, the North American TransBorder Dataset, from the BTS, is a publicly available and free source of rail data that show freight flow data by commodity type for imports and exports to and from Mexico and Canada. The user of this data can build a query by time period, commodity type, import/export, transport mode, and export the results (USDOT FRA, 2021).

A more granular dataset is U.S. Waybill data, a confidential data source that shows railroad waybills utilized to develop a database of railroad shipments. The confidential waybill sample data include data such as origin, destination, commodity, car count, weight, revenue, and length of haul among others. By law, certain users, such as federal agencies, states, and transportation practitioners can request access to the confidential waybill data through a written request to the Office of Economics (OE), Surface Transportation Board. Aggregate, non-confidential data are available in the public-use version (USDOT

[1] Non-local roads are part of the National Highway System (NHS). Trucks are defined as vehicles of classes 4 through 13 in the FHWA’s vehicle classification system (FHWA, 2018).

FRA, 2021). While the Waybill database is widely used, it does present several limitations. First, because of the threshold for reporting, some Class II and Class III railroads[2] are not reported in the Waybill data. Second, the method for estimating total shipments is based on an expansion factor in which shipments are aggregated based on the local population size and the railroad sample size. This expansion factor often results in an overestimation of railroad freight (Mani & Prozzi, 2004).

A proprietary source of freight rail data, the Freight Commodity Statistics, is maintained and collected by the American Association of Railroads (AAR). This database collects detailed commodity data for Class I railroads on a quarterly and annual basis. While the commodity information collected is expansive and updated regularly, the database does not collect information on origins or destinations, and more importantly, excludes Class II and Class III railroads (Mani & Prozzi, 2004). The cost to access quarterly reports from this database range from $175 to $1,200 depending on the type of report and data desired.

2.3.3 Public and proprietary sources of air freight data

The availability of granular air freight data is perhaps one of the most significant gaps in state and national freight data collection. This gap is primarily caused by the proprietary nature of products and their movement via aircraft. In addition, the air freight industry is utilized by a variety of heterogeneous operators from many different companies and agencies, thus making uniform data difficult to create (Reynolds-Feighan, 2013). However, a more complete picture of air freight data is critical given the explosion of air freight modal usage in the previous few decades. Currently, the impact of air freight is enormous on the U.S. economy, with approximately $6 trillion of value in U.S. goods traveling by air each year, which accounts for approximately 35 percent of worldwide trade by value (IATA, 2021). It is estimated that air freight will continue to grow by approximately 3-6 percent each year (Reynolds-Feighan, 2013; Bauml & Hausmann, 2018). Further, air freight has grown significantly in the U.S. in the past few years, with a 9.9 percent increase from 2019 to 2020, and is expected to continue to grow steadily as the rise of e-commerce continues (IATA, 2021), thus expanding air freight’s influence on the transportation system, underscoring the need to better understand air freight flows. Though some databases are available to the public, the lack of available granular commodity information and for total shipment O-D tracking for air freight prohibits an understanding of the movement of certain key types of freight that most often travel by air, not truck or rail, such as medical devices (Munnich Jr, 2015) which are typically high-value, low-weight products. Data that are granular enough to quantify and categorize commodities that travel by air is often proprietary and thus not available to the public for analysis (Samimi, Mohammadian, & Kawamura, 2013).

Public sources of freight data include the Airport Activity Statistics of Certificated Route Air Carriers, the BTS T-100 database, and the Air Carrier Activity Information System (ACAIS). The Airport Activity Statistics of Certificated Route Air Carriers is a public data source created and managed by the U.S.

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[2] Class I carriers are any carriers earning revenues greater than $250 million; Class II carriers are those earning revenues between $20 million and $250 million; and Class III carriers are those earning revenues less than $20 million.

Department of Transportation that collects data from large, certified aircraft carriers (LCACs). The information is broken down solely by the tonnage of freight and mail on each airplane trip at the airplane's origin airport and is updated on a monthly, quarterly, and annual basis. However, this database does not capture information on the commodity group or type. In addition, the shipment/origin is only tracked at the enplanement process, not the airplane's final destination or route information (Mani & Prozzi, 2004). The ACAIS is also a public database maintained by the U.S. Department of Transportation, Federal Aviation Administration (FAA) and updated annually. In addition to the data on large aircraft carriers, the FAA asks each airport to report their annual landed cargo totals for allocation of Airport Improvement Program (AIP) cargo entitlement funds (BTS, 2018; USDOT FAA, 2021). For each report, the database shows total tonnage broken down by airport and percentage change of cargo weight from the previous year. Similarly, the BTS database maintains and updates monthly data on U.S. air carriers traveling within U.S. airports. Information in this database includes: "scheduled and non-scheduled passenger, freight and mail traffic and capacity are reported along with aircraft type, service class and a variety of operational characteristics such as ramp-to-ramp and airborne aircraft hours" (Reynolds-Feighan, 2013).

Two main proprietary sources of air freight data are the International Air Transport Association (IATA) database and the International Civil Aviation Organization (ICAO) database. The IATA captures data by airline for scheduled traffic and capacity of the aircraft itself for international air travel. The ICAO offers several different databases updated on an annual basis, depending on the information desired, such as departure information for select airlines and airports, low-cost carrier O-D datasets, and passenger revenue information. The ICAO offers data solutions for a variety of inquirers, however, the data are often limited to select carriers and airlines. In addition, while information about the cost to access these databases is not readily available on the ICAO website, researchers have noted that its significant expense is a key limitation in utilizing the data for agencies and transportation practitioners alike (Reynolds-Feighan, 2013). Similarly, the IATA is limited in both its lack of expansive data for all airlines and carriers and its expense to access the data.

2.3.4 Public and proprietary sources of port freight data

Though trucks are the most widely used mode of freight transportation, seaports are one of the primary sources of truck trips (Al-Deek, 2002; Lange, Schwientek, & Jahn, 2017) and thus seaports are significant to the entire transportation system and the total movement of freight. Imports and exports as well as the transportation activity resulting from port activity result in approximately 25-26 percent of the U.S. GDP (Ronan, 2019), with double-digit gains in economic impact over the past several years. In fact, the nation's largest port, the port of Los Angeles, moved 9.34 million standard-sized containers in 2017 alone (Ronan, 2019). It is expected that port traffic will continue to grow and thus continue to expand its impact on the total transportation system.

However, most of the commodity flow data collected by ports are proprietary and thus not publicly shared. The FAST Act requires the annual collection of data about the 25 largest U.S. ports via the Port Performance Freight Statistics Program. As such, data on total tonnage, containers, and dry bulk tonnage are collected and made publicly available through the U.S. Bureau of Transportation. While the collection of port data is useful, it is limited in that it excludes data on inland waterway ports (Asborno, Hernandez, & Akter, 2020). Thus, the current state of port data collection includes primarily publicly available economic data, such as the Census Bureau's U.S. Port Data, the CFS, and mode-specific datasets (e.g., the National Performance Management Research Data Set or the Waterborne Commerce Statistics) (Asborno, Hernandez, & Akter, 2020). These datasets provide an overall picture of the type and quantity of freight flowing in and out of ports. However, these data sources lack spatial characteristics, which can make freight flow analysis difficult.

A primary proprietary source of port data is the Port Import/Export Reporting Service (PIERS) database. This database collected import-export information from over 20 million bills of lading in 2015 alone (IHS Markit, 2021). The PIERS database offers information such as origin and destination data, shipment weight, value, and description, and consignee/shipper information. While the PIERS database's expansive and comprehensive data collection is certainly an advantage, PIERS data are not publicly available, but instead offered in a tiered subscription format, with the cost of data dependent on the type of information desired by the user (IHS Markit, 2021).

2.3.5 Public and proprietary sources of waterway freight data

Within the national boundaries of the United States, there are about 12,000 miles of commercial waterways that contain a system of 239 lock chambers and dams maintained by the USACE (Sriraj, et al., 2020). While not as large economically as ports, freight that travels by waterways is estimated at approximately $700 million of value. Further, port activity in the U.S. accounts for $31.2 billion in the GDP and provides approximately 275,000 jobs (The American Waterways Operators, 2021). Many of the current publicly available databases used to track freight that moves among the thousands of miles of the country's inland waterways are maintained by the USACE. For example, the Waterborne Commerce Statistic Center (WCSC) provides "waterway freight data (by geography) for inbound, outbound, and intrastate. Inbound tonnage is counted for trips that originate outside of [a waterway] and have an endpoint within it. Outbound tonnage is counted for trips that have an origin within [a waterway] but end outside it. Intrastate tonnage is counted for trips that have both an origin and a destination point within [a waterway]" (Sriraj, et al., 2020). Despite the availability of this type of data, inland waterways and their subsequent freight movements in and out are not well understood. Further, though the FAST Act requires the development of a Freight Performance Evaluation Program, many states have not adequately addressed the performance and total usage of their waterways (Sriraj, et al., 2020). In order to combat this, researchers have undertaken efforts to better understand waterway data both from an economic perspective and to combat the aging and deterioration of inland waterway systems. Thus, databases should continue to develop that present a more complete picture of freight that travels within the U.S.'s waterways.

2.3.6 Commodity-specific freight databases

In addition to databases that are modal-specific, there are several databases available that are multimodal and commodity-specific, such as the Fresh Fruits and Vegetables by Commodity dataset updated and maintained by the U.S. Department of Agriculture (USDA). The database "captures detailed information on the seasonal variations in domestic (intra- and inter-state), export, and import tons of fresh fruits and vegetables in the U.S." (Mani & Prozzi, 2004) for air, rail, truck, and boat modes of shipment. In addition, the database collects O-D information for the types of commodities reported in the database. The database itself is updated annually and publicly available at no cost. Similarly, the USDA publishes and maintains the weekly reported Grain Transportation Report (GTR), which unlike the Fresh Fruits and Vegetables database does not include O-D information, but does collect and disclose data such as the type of freight mode used (truck, water, or rail), volumes of grain, vessel movements at U.S. ports, and freight rates for ship charters (Mani & Prozzi, 2004). The Grain Transportation Report is free and publicly available.

While both databases contain multimodal entries, both are limited in their ability to understand intermodal freight flows. First, the Grain Transportation Report does not report O-D data, which presents difficulty in visualizing the movement of grain. Similarly, while the Fresh Fruits and Vegetables dataset collects O-D data, the method of data collection for each mode is different, which makes aggregation of freight movements difficult (Mani & Prozzi, 2004). This commodity-specific data collection, however, provides a clear example of how commodities can be tracked throughout the transportation system.

2.4 STATES WITH WELL-DEVELOPED FREIGHT MODELS

The area of freight data suffers from numerous deficiencies, including a lack of inexpensive, publicly available data (Fried, Munnich, Horan, & Hilton, 2018). This data deficiency severely limits the ability of policymakers to properly plan for and leverage freight movement for economic purposes. This is especially critical in Minnesota, a state with a thriving medical industry cluster that contributes to the state's overall economic health through the export of high-value, low-weight medical devices. The continued strength of the industry cluster in the state depends on the state's ability to understand the movement of these devices in and out of the state (Munnich Jr, 2015). As such, many researchers have attempted to fill gaps in existing commodity-based databases by supplementing them with other datasets (Giuliano, Gordon, Pan, Park, & Wang, 2010). However, the process of combining and synthesizing multiple datasets is arduous and can be expensive. Many of these databases are difficult to interpret, burdening the user with the task of deciphering both the data itself and how the data are sourced. Additionally, databases are not updated at the same time, which means that flow models may have to estimate or aggregate data, thus rendering it unable to be validated. As such, there remains a need for a more comprehensive freight data source that can be utilized to understand with greater precision the current and future commodity movements for infrastructure investment purposes.

Despite these difficulties, several states have emerged as freight model leaders in their data collection and modeling practices that inform comprehensive and sound transportation practices. For example, the California Statewide Freight Forecasting Model (CSFFM) forecasts commercial vehicle and commodity flows in California by rail, truck, and air.[3] This tool is developed to enhance policymakers' ability to predict commodity flow within the state and adjust transportation plans accordingly (TMIP FMIP, 2021). Primarily, the CSFFM relies on truck GPS activity pattern data and time of day O-D modeling. In addition, the CSFFM utilizes a Direct Demand Input-Output Model in which inputs represent "socioeconomic data, exports/imports (commodity flows), commodity to vehicle distribution, transportation networks, transshipment data," and outputs represent "spatial commodity flows, spatial commodity productions and consumptions, vehicle flows by mode (truck, rail, air)" (TMIP FMIP, 2021).

The data sources for the model include:

- Caltrans (AADTT; Motor Vehicle Stock Travel and Fuel Forecast)
- Bureau of Transportation Statistics (Border Crossings Data; County Business Patterns; Transborder Surface Freight Data; Vehicle Inventory and Use Survey)
- Department of Finance
- California Air Resources Board (Estimated Annual Average Emissions)
- FHWA (FAF2)
- Pacific Maritime Association (Hours, Wages, and Shifts Report and Tonnage Report)
- EPA (National Emission Inventory)
- STB (Rail Carload Waybill Sample)
- RAND California (Major Airport Operating Statistics)
- Association of American Railroads (Rail Performance Measures Weekly Performance Report)
- USCG (Marine Casualty and Pollution Investigation)
- U.S. Customs Vessels Entrances and Clearances
- Waterborne Commerce Statistics Center
- Waterborne Transportation Lines of the United States Vessel Characteristics

The Florida Statewide Multimodal Freight (FSMF) Model was developed for a similar purpose as the CSFFM, which is to predict freight movement within the state. However, the FSMF utilizes supply chain information on firms to determine what products are sold from suppliers and where those products are shipped. This allows the Florida Department of Transportation (FDOT) to better "support freight plan development, evaluate potential large-scale infrastructure investments, provide inputs to more detailed project-level evaluations, and provide inputs to regional transportation planning models (TMIP FMIP, 2021). As mentioned previously, the FSMF is an additional example of how freight flow models often include a variety of proprietary and public data sources to create the model itself. The data sources for the FSMF Model include:

- FHWA Freight Analysis Framework Version 3 (FAF3) (public)
- 2007 Benchmark Input-Output Account (public)

[3] The flow modeling is based on 96 TAZ in California, 7 TAZ in neighboring states, 46 TAZ in the U.S. and 8 international TAZ, and 51 air, water, and rail transshipment logistic nodes. It also includes 14 commodity groupings - 2-digit SCTG commodity classes (TMIP FMIP, n.d.).

- County Business Patterns (public)
- InfoUSA (proprietary)
- Quarterly Census of Employment and Wages (public)
- Longitudinal Employer-Household Dynamics data (public)
- U.S.DOT Waybill data (public)
- NAVTEQ (proprietary)
- Transearch (proprietary)
- ATRI (proprietary)
- PIERS Database (proprietary)

Iowa has also been a leading state in comprehensive freight modeling. In an update to its 2007 model, the Iowa Statewide Freight Model now includes a “disaggregation of Freight Analysis Framework rail commodity flows that includes long-distance rail passenger movements in conjunction with the freight flows” (TMIP FMIP, 2021). As recently as 2016, Iowa DOT partnered with Quetica, a private company, in the development of a freight model that blended both private and public sources of data to track “forecasted demand, transportation and inventory capacity, and quantitative performance measurements” (Quetica, 2021). The development of this dataset and computer model created actionable insights that Iowa DOT could utilize to better plan infrastructure investments, such as adding rail and bridge freight access to reduce the number of trucks on Iowa’s roads (Quetica, 2021).

CHAPTER 3: SCANNING OF FREIGHT DATABASES

The research team conducted a scanning of public and proprietary freight flow data sources. This chapter discusses the methodology used in the scanning of databases and the findings from the most frequently utilized public and proprietary freight databases. The report also describes the most commonly used software tools for freight analysis and planning.

3.1 METHODOLOGY

The researchers used a document review approach to review a total of 11 public freight data sources,[4] six proprietary data sources, and seven software/modeling tools from proprietary sources. While the list of databases analyzed in this report is not exhaustive, the researchers have prioritized the most commonly used as well as the most comprehensive databases. In addition, the researchers prioritized review of the databases commonly used by states compiled in the Mid-America Freight Coalition Report (Perry, Adams, Oberhart, & Zietlow, 2016).

An online search was conducted to gather information about the freight databases. Data sources include database websites, FAQ sections, user guides, and additional literature review. The researchers downloaded the databases to collect all variable information when the information was not available on the website. Overall, proprietary databases were more difficult to review, as much of the information about the specific variables in the databases or the reference guides are hidden behind paywalls. In addition, most of them require data users to contact the organization to get further information. Lastly, researchers gathered contextual information about the databases from additional literature review. Researchers documented several important characteristics of the databases. Table 3.1 presents the characteristics included in the review and their definitions.

[4] The Airport Activity Statistics of Certificated Route Air Carriers, a widely referenced publicly available database, is not included in the review because it was last updated in 2000. The database is developed by the Bureau of Transportation Statistics, contains high-level data on the number of U.S. enplanements by airport carrier, and total number of enplaned passengers by airport and carrier.

Table 3.1 Database variables and accompanying definitions

Characteristics	Definition
Developer	Entity in charge of collecting, updating, and maintaining the database
Transportation Mode	Modes of transportation represented in the database (includes truck, rail, waterways, ports, and air and their respective levels of detail)
Commodity Type (Classification)	Classification of commodity types (e.g., NAICS, SIC codes). Includes level of Classification
Frequency of Update	How often the database is updated
Geographic Granularity	Designation of U.S., International, state, geographic zones, etc.
Variables	List of all variables in the database (including units)
Cost to Access	For proprietary datasets, an estimated cost to access data

3.2 FINDINGS

This section presents the overall findings about the reviewed freight databases. Overall, both public and proprietary sources vary in their level of detail and comprehensiveness, and it is a common practice to combine databases in freight flow modeling. In addition, many databases define variables, such as geography and commodity, differently. These issues can complicate data use and increase the costs of access and analysis. While the report goes into further detail on the findings separated by public and proprietary sources, the below findings refer to a more general overview of freight data sources.

The research team reviewed four multimodal freight databases, three public sources and one proprietary source. These are used as the basis for freight analysis. Table 3.2 discusses the advantages and weaknesses of each data source. Overall, multimodal public sources are comprehensive in the amount of high-level commodity detail that goes to 2-digit level. However, limited geographic granularity is one of the main weaknesses. These data sources lack geographic detail, particularly at the local levels (county and city). Transearch, the proprietary source, provides information down to the county level, but is expensive. In terms of commodity classification, FAF and CFS contain compatible classifications, but they may not be easily comparable with the classifications provided in Transearch.

Table 3.2 Pros and cons of multimodal freight databases

Multimodal Data Sources	Advantages	Weaknesses
Freight Analysis Framework	-Publicly available and free -Freight transportation modes: Truck, rail, water, air, pipeline, multiple modes & mail -Provides information for 44 commodity types (SCTG codes, 2-digit) -Includes trade information	-Updated infrequently (every 5 years) -Narrows down the U.S. to 132 geographic zones – Some states represent only one geographic zone
Commodity Flow Survey	-Publicly available and free -Freight transportation modes: Truck, air, water, rail, pipeline, and multimode. -Provides information for commodity types (45 NAICS codes, 3-digit; 43 SCTG codes, 2-digit)	-Updated infrequently (every 5 years) -Narrows down the U.S. to 132 geographic zones – Some states represent only one geographic zone -Does not account for transnational shipments
TransBorder	-Publicly available and free -Provides freight data from 7 modes of transportation -Provides information for 98 commodity groups	-Difficulty tracking international multimodal shipments from their initial entry point to their final destination -Geographic granularity is limited to countries (U.S., Canada, Mexico, and Foreign Trade Zones only) -Will not be updated starting October 2021
Transearch	-Provides county-level information for over 3,000 counties in the U.S. -Provides freight data from 7 modes of freight transportation -Provides information for over 340 commodities (STCC)	-Limited ability to track trip chains -Expensive

Single-transportation mode databases vary in terms of the commodity information they contain. For instance, none of the databases specific to freight traveling by truck contain commodity information. Similarly, in terms of freight traveling by air, BTS T-100 data (public) and ICAO data (proprietary) only distinguish plane contents as passenger, mail, or freight. Conversely, databases specific to rail and port contain some commodity details. In most cases, the commodity classifications used in these databases are easily comparable. Overall, the level of commodity detail is a weakness in freight databases as freight often travels via multiple modes to arrive at its final destination. Thus, if air travel does not provide commodity-specific detail similar to that available for trucks (in the multimodal databases) and ports, for example, it can be difficult to fully comprehend the movement of freight.

More comprehensive databases that are publicly available are updated every five years, but proprietary databases are updated more frequently. For instance, the most comprehensive and widely used multimodal public databases, the CFS and FAF, are updated every five years, whereas many of the single-mode databases are updated daily and users can download data as often as monthly or quarterly.

In general, public data sources are more transparent regarding their source of information than proprietary data sources. Public entities provide many supporting resources to help users navigate the data and get the most out of their analyses. For instance, the CFS and FAF have landing pages that contain robust user guides, FAQs, and data tools that can help users decide which specific data they need to download. The NPMRDS landing page contains links to webinars that occur throughout the year that provide publicly available and free technical assistance to data users. Conversely, most proprietary data sources require data users to contact the organization to get information.

3.2.1 Public Freight Data Sources

There is variation in the information public databases collect and publish. The public data sources analyzed in this report are the Freight Analysis Framework (FAF), Commodity Flow Survey (CFS), TransBorder, National Performance Management Research Data Set (NPMRDS), Carload Waybill Sample, Railroad Annual Reports (RAR), BTS T-100, U.S. Port Data, Port Performance Freight Statistics Program (PPFSP), and the Waterborne Commerce Statistics Center (WCSC) (see Table 3.3). Additional information about the methods used to create databases, the data links, the user guides, and use cases, is available in Appendix A.

Public databases are developed by federal agencies such as the U.S. Census Bureau, the U.S. Department of Transportation, the U.S. Army Corps of Engineers, and other independent federal agencies such as the Surface Transportation Board. Federal sources are comprehensive as a result of legislation that requires the collection and management of types of data. For instance, the Interstate Commerce Act requires railroad companies of Class I to file annual reports (Legal Information Institute, 2021) that are the basis for the Railroad Annual Reports.

Of the 11 publicly available databases reviewed, three include multiple modes of transportation: FAF, CFS, and TransBorder. FAF is the most comprehensive database of them as it compiles information from multiple datasets including the CFS. The FAF integrates additional data to estimate information from industries that are not covered by the CFS, including foreign trade (BTS, 2021). Other databases were based on a unique transportation mode.

- Truck: The National Performance Management Research database collects information in 5-minute intervals on the travel time, mileage, and road identifiers for trucks and vehicles across the entire national highway system. While this database does not contain commodity-specific information or freight information, it can be utilized in conjunction with freight planning and performance measurement activities, such as assessing congestion-prone areas and uses for transportation infrastructure investment that enhance the entire roadway system and thus improve the movement of freight (FHWA, 2021).
- Rail: RAR contains a greater number of commodities in its data collection but only for Class I railroads, while the Carload Waybill Sample contains information on total carloads by 2-digit commodity type. Further, the Waybill data contain information for the U.S., Canada, and Mexico, which can be used to understand domestic freight travel.

- Air: The BTS T-100 contains single modal information for air freight. In comparison to the other databases, the BTS T-100 is the least detailed, as it does not contain specific commodity information. This database simply distinguishes plane contents as passenger, mail, or freight.
- Waterways and Ports: The three primary sources of waterways and ports data reviewed in this report are updated on at least a monthly basis and contain some level of commodity detail. U.S. Port Data contain over 4,000 commodities with details down to the 5-digit level and information from 240 countries and territories. The Waterborne Commerce Statistics Center is another valuable source of freight data as the database contains information for both ports and waterways. Lastly, while the PPFSP data contain user-friendly visual representations of the activity occurring at the busiest U.S. ports, the overall usability of the data in terms of downloads is minimal because the information presented is a high-level description of the port itself, with information such as the top commodities coming through the port, total number of cargo throughput, and total vessel numbers by year. The data are only available for the top 25 busiest U.S. ports, of which Duluth, MN and Two Harbors, MN ports are represented.

In terms of commodity information, most multimodal databases use NAICS or SCTG codes of classification. According to the BTS, SCTG codes are based on the Harmonized System (HS) and were designed to be comparable with categories in the Standard Industrial Classification (SIC) and the NAICS codes, however, a number of product categories -especially residual categories- contain goods produced by more than one industry (BTS, 2012). Since these are based on HS codes can be used for international comparisons (international shipments). On the other hand, rail commodity data are grouped differently in accordance with the Standard Transportation Commodity Code (STCC) of the Association of American Railroads (AAR) and are not easily comparable with SCTG and NAICS codes (Statistics Canada, 2017; U.S. Census Bureau, 2021). Lastly, commodity classification from the WCSC data is based on the Standard International Trade Classification (SITC) commodity code (NCFRP, 2015).

In terms of frequency of update, multimodal databases tend to be updated less frequently than databases specific to each transportation mode. While FAF and CFS are updated every five years, most single-mode databases are updated monthly. The Transborder multimodal dataset is updated monthly but contains less geographic detail than the other multimodal databases reviewed, which is a disadvantage to using the database.

In regard to geographic granularity, few public databases have county- or city-level information. More commonly, geographies are represented in zones, or general regional areas, as is the case with FAF, CFS, and Carload Waybill Sample. These zones or regional areas may be defined slightly differently across databases, which can make the combination of data from different sources complex. Minnesota, for instance, is broken down into the “Minneapolis-St. Paul-St. Cloud” area and “Remainder of Minnesota” in the CFS data, and into the “Minneapolis-St. Paul, MN-WI” area and “Remainder of Minnesota” in the FAF data.[5] Waybill data provide information based on business economic areas, including the areas of

[5] CFS regions are then built upon in the FAF database, which includes a combination of CFS areas and other defined FAF regions, such as census metropolitan areas (CMAs), which are metropolitan areas that span across multiple

“Minneapolis-St. Paul, MN-WI-IA”, “Rochester, MN-IA-WI”, and “Duluth-Superior, MN-WI” in Minnesota.

Public databases are most often free to access. Of the public data sources presented in this report, only the Carload Waybill Sample and the U.S. Port Data have a cost. The cost is not prohibitive but could be a limitation. While the Carload Waybill Sample costs $200 for database access and $50 for each additional user of the database per access, the U.S. Port Data offer products from $200-$400 depending on the information and data detail requested.

In addition, data from these public sources are available free of charge but may be subject to confidentiality constraints. For instance, the Commodity Flow Survey is available in two versions: a Public Use File and a restricted file (Title 13 - T13 dataset). Both provide shipment-level detail but are different in structure due to data protection (see Appendix A for more information). The restricted dataset requires the researcher or data user to request access and receive special sworn status clearance (BTS, 2021a). While the FAF builds upon and contains similar data as the CFS, the FAF only contains public data. It is possible that the additional adaptation and aggregation of CFS data further anonymizes the data, making data restrictions unnecessary. Similarly, limited data from the Rail Waybill Sample are made available in a public use file, but more detailed commercially sensitive data can be provided to certain parties upon approval by STB (STB, 2021).

Lastly, many public data sources contain visualization tools. These sources are the FAF, CFS, Transborder, U.S. Port Data, and the Port Performance Freight Statistics Program. These visualization tools often complement the data downloads as an additional way for users to analyze data. Overall, most public databases have useful and easy-to-access user-supportive tools (such as FAQs and how-to-use- resources). Of the reviewed data sources, the data links of the WCSC contained a long list of excel files in a sequence that was not intuitive to utilize or organize to determine the dataset that is needed.

states that may or may not be CFS designated areas. For instance, FAF’s region number 341 is coded as “New York-Newark, NY, NJ, CT, PA” in which only NJ is a CFS area.

Table 3.3 Public freight data sources

Database Name	Developer	Transportation Mode	Commodity Classification	Frequency of Update	Geographic Granularity	Variables
Multimodal						
Freight Analysis Framework (FAF)	Bureau of Transportation Statistics (combination of databases)	Truck, Rail, Water, Air (includes truck-air), Multiple modes, Pipeline, Other and unknown	44 SCTG codes (2-digit)	Originated in 1993, Updated every 5 years (most recent version 2017)	U.S., State, Regional Economic Zones, International (Canada, Mexico, Europe & Africa, Asia & Oceania, Rest of Americas)	Foreign region of O-D, Domestic freight movement O-D, SCTG, Transportation mode (incoming foreign mode, domestic shipment mode, outgoing foreign mode), Trade type (domestic, import, export), Weight (Tons), Constant value (FAF5 - base 2017 dollars), Current value (dollars)
Commodity Flow Survey (CFS)	U.S. Census Bureau (shipper survey)	Single-mode (truck (1), rail, water (1), air, pipeline, other), Multiple modal (Parcel, Non-Parcel, Multiple mode)	45 NAICS codes (3-digit) 43 SCTG codes (2-digit)	Originated in 1993, Updated every 5 years (most recent version 2017)	U.S., Region, State, CFS Areas International (Canada, Mexico, Europe & Africa, Asia & Oceania, Rest of Americas)	Shipment ID, O-D for State, metro area, CFS area, NAICS, SCTG, Transportation Mode, Shipment Info: Weight (pounds), Value (dollars), Distance (miles), Route. Temperature control designation, Export (Y or N), Export country, HAZMAT code, Weight factor
TransBorder (2)	Bureau of Transportation Statistics	Water, Air, Mail (U.S. Postal Service), Truck, Rail, Pipeline, Other	98 HTF codes (2-digit); Commodity descriptions	Originated 2006; Updated monthly	U. S., State, Canada, Mexico, Foreign Trade Zones (FTZs).	Trade type, Port code, Commodity, Mode of transportation, Country, Value (dollars), Shipping weight (kg), Freight charges, Domestic/Foreign code, Month, Year

Truck						
National Performance Management Research Data Set (NPMRD) (3)	U.S. Department of Transportation-Federal Highway Administration (anonymous data from a fleet of probe vehicles)	Truck, Passenger car data	N/A	Origin unknown; Updated monthly	National Highway System-TMC level (about ½ mile to 1 mile in urban/suburban areas and 5-10 miles in rural areas)	Speed, Travel time, Static AADT
Rail						
Carload Waybill Sample (4)	Surface Transportation Board (stratified sampled waybills)	Privately-owned railroad car, Railroad-owned car	39 STCC codes (two-digit)	Origin unknown; Updated annually	U. S., Canada, Mexico, 172 Business Economic Area Codes	Carload, Revenue (dollars), Tonnage
Railroad Annual Reports (RAR)	Surface Transportation Board (required from railroads)	Class I Railroad	450 STCC (two- to five-digit)	Updated quarterly, annually	N/A	By railroad: Financial/operating statistics, Total carloads by commodity code, Annual cars loaded and terminated, Carloads and tons across state, Employment and wage data, Fuel surcharges
Air						
BTS T-100	Bureau of Transportation Statistics (required from air carriers)	Air carriers operating airports within the U.S. and its territories	N/A	Originated in 1990; Updated monthly	U. S., Canada, Airport name	Total passengers, Total freight (tons), Total mail

Ports and Waterways						
U.S. Port Data (5)	U.S. Census Bureau (combination of databases)	Air and Vessel Ports	4,370 SITC & HS Codes (2-digit & 5-digit)	Originated in 1994; Continuously collected; Updated monthly, quarterly, annually	Country name & Subcode (240 countries and territories), U.S. Customs code, Districts	Imports, Exports, Imports & Exports, Frequency of data (annual, monthly, quarterly, year-to-date), Port codes, Commodity codes, Country detail
Port Performance Freight Statistics Program (PPFSP)	Bureau of Transportation Statistics (combination of databases)	Port	*Dashboard:* N/A *Port Profiles:* Top 5 commodities (categorical description ex coal, wheat, etc.)	*Dashboard*: Updated monthly *Port Profiles:* Updated annually	*Dashboard:* Top 10 U.S. Ports *Port Profiles:* Top 25 U.S. Ports	*Dashboard:* Date, Port name, Total loaded and empty TEUs *Port Profiles:* By port (Annual total tonnage, Annual container throughput, Annual dry bulk tonnage, Annual roll-in/roll off units (Ro/Ro), Annual vessel calls by vessel types), Top 5 commodities, Top 5 food and farm product commodities, Average container vessel dwell time, Average Ro/Ro vessel dwell time, Average liquid bulk vessel dwell time
Waterborne Commerce Statistics Center (WCSC)	U.S. Army Corps of Engineers (information from vessel operating companies)	Ports and waterways	41 LPMS	Originated 2000; Updated monthly, annually	National, Port name, State (6)	Port name, Export tons, Import tons, Commodity tonnage, Origin and destination

Notes: *(1) Further detail is available. (2) Effective October 26, 2021, the BTS will no longer update the database to reduce data redundancy. (3) Licensing is required but there is no cost for DOTs and MPOs. (4) Costs $200 to access the database and $50 for each additional user. Use is limited by Railroads, Federal Agencies, States, Transportation practitioners, consulting firms, and law firms in specific proceedings. All users of the data are subject to a confidentiality agreement before receiving the data. (5) Additional data are available through an online order form for $200-$400, depending on the data file requested. (6) Includes information for U.S. territories*

3.2.2 Proprietary Freight Data Sources

In addition to the many public sources of freight data, there are many proprietary sources of freight data. For the purposes of this report, the researchers prioritized the most commonly used and/or the most comprehensive, though many other proprietary sources are likely to exist. The proprietary databases reviewed in this report are Transearch, American Transportation Research Institute (ATRI), American Trucking Association (multiple reports), International Air Transport Association (IATA), International Civil Aviation Organization (ICAO), and Port Import/Export Reporting Services (PIERS) (see Table 3.4). Additional information about the database, the data links, and use cases are available in Appendix B.

Proprietary databases can be more detailed than public databases because they can utilize private sector data under non-disclosure agreements (NDAs). For instance, they can go down to county-level information. In addition, proprietary databases are often updated more frequently than publicly available data sources. Three out of six proprietary databases reviewed have daily freight information. For instance, the PIERS database is detailed in its data and comprehensive in its variable offerings because it processes approximately 60,000 bills of lading (BOL), which are exact details of transactions issued by a carrier to a shipper that contains information on the commodity exchanged and its destination. This type of detail may be useful in tracking specific products and is most likely the result of protected confidentiality agreements between IHS Markit and various private sector companies.

Proprietary data sources tend to be mode-specific (focus on single transportation modes) and few report commodity information. Of the six proprietary data sources reviewed, Transearch is the only multimodal database and provides details down to the county level. Transearch and PIERS are the two databases that contain commodity information, and the commodity classification codes they use are easily comparable with those used in some public data sources, particularly Waybill and U.S. Port Data. Most notably, the proprietary sources analyzed for air freight contain little commodity-specific information. While the ICAO database designates non-passenger cargo as either freight or mail, it is still more descriptive than the IATA database that has no commodity classification.

Geographic granularity is a strength of some proprietary databases over public sources of data. As mentioned previously, proprietary databases are often more detailed as they can contain precise BOLs or private sector information, and thus provide greater detail about the origin and destination of freight. However, the designation of regional areas in public databases differs from those in proprietary databases. For example, the Transearch database contains a list of Business Economic Areas, which are regions that represent an area larger than counties, but smaller than states, usually covering a metropolitan area.

Lastly, all private databases are available for a price. These databases vary widely in cost and cost schedules, such as subscription services, packages of data for purchase, or single data blocks, where a year of data can be purchased for a certain amount. Often, the cost to access databases is not very clear or transparent on the website and requires communication with the proprietor to determine the cost and need. This can also be a deterrent to accessing data as they are not readily available, but must be planned for and purchased ahead of time.

Table 3.4 Proprietary freight data sources

Database Name	Developer	Transportation Mode	Commodity Classification	Frequency of Update	Geographic Granularity	Variables	Cost
Multimodal							
Transearch	IHS Global Insights (combination of databases)	For-hire truck, LTL, Private truck, Truck/rail Intermodal, Rail, Waterborne, Air	340 Commodities (STCC)	Originated in 2012; Updated annually	Country, State, U.S. Counties (3,000), Business Economic Areas (172), Canadian Province/Municipalities	Year; Origin region; Destination region; STCC; STCC Description; Equipment; Trade type; Mode; Tons; Units; Value	$50-100,000 per annual datafile
Truck							
American Transportation Research Institute (ATRI)	American Trucking Institute (real-time GPS information for 800,000 U.S. freight trucks)	Truck	N/A	Originated in 2022; Updated monthly	Geographic coordinates	GPS Data (coordinates, time/date stamp)	Licensing required, cost unknown. Some reports available on the website
American Trucking Association (ATA) (multiple reports)	American Trucking Association (survey of truckload and LTL carriers)	Truck: For-hire, Private Motor Carriers, Refrigerated Trucks	Non-refrigerated vs. refrigerated	Annually, depending on report (e.g., Salaried report from 2013)	Miles traveled total, not segmented by a particular geography	Tonnage, Revenue (dollars), Miles traveled, Forecast information	$99-$1,000

Air							
International Air Transport Association (IATA)	International Air Transport Association (sourced directly from airlines)	Full-service and low-cost carriers, IATA member and non-member airlines, Mixed and cargo-only operators, Global and regional carriers	N/A	Historical data range unknown; Updated every 22-45 days	Airline, Region International carriers	Traffic capacity, Cargo type, Airline, Carrier type, International traffic flow	$3,000-$14,000
International Civil Aviation Organization (ICAO)	International Civil Aviation Organization (reported by the national Civil Aviation Authorities of Member State)	Carrier type and name	Freight is classified as Freight or Mail	Historical data for as early as 1973; Data received daily and refreshed weekly	States, International (All 195 countries, Territories)	Carrier traffic, Flight O-D, Carrier finances, Airport traffic, Aircraft mass, Total passenger data	$1,600-$8,000 for a 1-year license
Ports and Waterways							
Port Import/Export Reporting Services (PIERS)	IHS Markit (BOL files with U.S. Customs)	Port, Vessel, Ocean Carrier/Shipping Line	HS code (6-digit)	Historical data back to 2003; Updated daily	All U.S. ports, International (13 countries in Central & South America, India, China, and Vietnam; Importer and Exporter names from Central and South America, Mexico, India, and Vietnam; Import/Export data	BOL number, Vessel name, IMO code, voyage number, Ocean carrier/shipping line, Shipper, Location and country of lading and destination, Departure date, Port of discharge/transshipment port, Description of goods, Weight, HS code, Estimated value (dollars), Vessel country of registry, Containerized, Refrigerated, potentially hazardous RO/RO cargo	$149-$799 a month depending on subscription level

					from Central and South America)		

3.2.3 Commodity Specific Data Sources

In addition to databases that are modal specific, there are several databases available that are multimodal and commodity specific. Table 3.5 provides databases that are often used in conjunction with other databases, such as the CFS, in freight flow planning and modeling. All these databases are free and publicly available for use by any user.

Table 3.5 Commodity specific databases

Database Name	Developed By	Freight Type	Geographic Granularity	Frequency of Update	Variables
Annual Coal Report	U.S. Energy Information Administration	N/A	Basins: Northern Appalachia (MD, OH, PA, WV) Central Appalachia (KY, VA, WV, TN), Southern Appalachia (AL, TN), Illinois (IL, IN, KY), Powder River Basin (MT, WY), Uinta (CO, UT), Counties within Basins	Annually	Coal (tons), Number of mines, Productive capacity, Recoverable reserves, Employment, Productivity, Consumption, Stocks, and Prices
Grain Transportation Report (GTR)	U.S. Department of Agriculture	Truck, Rail, Barge, Port	Port Regions (PNW, Mississippi Gulf, Texas Gulf, Atlantic/East Coast, Cross-Border to Mexico), Mississippi River Region, State	Weekly	Grain transport cost indicators, Export price spreads, Rail deliveries to ports, Railcar auction offerings, Tariff rail rates, Bids/Offers for railcars delivery, Railroad fuel surcharges, Barge rates, Grain barge movements, U.S. export balances, Top 5 &10 importers by commodity, Grain inspections for export, Number of grain inspections by port, Gulf vessel loading activity, Grain vessel rates
Fresh Fruits and Vegetables by Commodity Dataset	U.S. Department of Agriculture	Rail Truck, Air, Boat	National, County	Monthly	By Import & Export: Value, Volume, Unit value, Value by county, Volume by count

3.2.4 Software/Modeling Tools

In addition to the many freight databases described above, there are several comprehensive freight software tools that are useful in freight flow analyses. Overall, these software tools have significant advantages in their availability of information and usability, however, they are often expensive and thus not easily accessible. These software/modeling tools include Transportation Economic Development Impact System (TREDIS), Transight from Regional Economic Models, Inc (REMI), CASS's Freight & Cass's Truckload Linehaul Indexes from CASS Information Systems, benefit-cost analyses and economic impact analyses from EBP (formerly EDR Group - Economic Development Research Group), freight truck base rates from Czarlite LTL Base Rate from Czarlite Solutions, PC*Miler software, and INRIX transportation-related software and visualization tools.

3.2.4.1 Freight tool from TREDIS

TREDIS is a proprietary software tool that has several use cases for transportation practitioners and policymakers alike, including predictive analytics, and cost-benefit and financial analyses. It is marketed as a "decision-making tool" that can assist in evaluating the impact of programs and policies. Further, it is also marketed as the only system that has all modes of transportation represented in the analysis tools (passenger and freight via air transport, marine and rail modes, truck, car, bus, bicycle, and pedestrian travel). For example, a use case highlighted for the TREDIS freight tool is the proposed closing of the Upper St. Anthony Falls Lock in Minnesota, which is one of the waterways in the state that carries freight. Through TREDIS forecasting, the Metropolitan Council in Minnesota was able to estimate the economic and transportation infrastructure impacts of closing the lock (TREDIS, 2021).

TREDIS utilizes Transearch data for its TREDIS Freight tool, however, TREDIS generally is not designed to be utilized as a database for which users can download data and do their own analyses. While useful, TREDIS can cost $25,000-$30,000 per annual use. In addition, they have several 30-day free trial options for users to explore and utilize their tools.

3.2.4.2 Transight from REMI

REMI specializes in input-output economic models for a wide variety of uses, including a transportation-specific tool called Transight. This tool estimates the total economic effects of transportation policies by using alternative scenarios or variables to evaluate short-term and long-term effects on a variety of economic factors. Transight users span consulting agencies and state DOTs, and can be applied to several types of projects, such as Michigan's 5-year transportation program which includes freight mobility analyses. REMI software comes with a steep price tag, approximately $700,000 for the initial purchase and $300,000 to maintain access. While REMI's tools are useful for producing economic insights, its hefty price tag may be a hindrance to its broad applicability across transportation practitioners and government agencies.

3.2.4.3 CASS's Freight & Cass's Truckload Linehaul Indexes from CASS Information Systems

CASS Information Systems is a proprietary source of freight information that operates as an IT management company, providing freight-specific tools and solutions. Their users cannot necessarily download freight data for analysis on their own. However, users can pay for access to CASS's Freight Index, which provides data for North American freight volumes and expenditures, and Cass's Truckload Linehaul Index, which provides indicators of per-mile truckload pricing based on CASS's own clientele's invoices (Cass Information Systems, Inc, 2021). The cost to access the CASS Information Systems programs is not readily available on the website, but typically is dependent on length and depth of use.

3.2.4.4 Benefit-Cost Analyses and Economic Impact Analyses from EBP

EBP offers primarily economic impact analysis models and benefit-cost analysis tools for a variety of uses. It provides users with guidebooks and web-based calculation tools to properly use their models. EBP lists their freight offerings for their analysis tools as:

1. "Forecasting implications of emerging economic trends and alternative scenarios on markets, commodity flow patterns and productivity,
2. Documenting the economic role of freight rail, marine port and air freight facilities, and industry dependence on them,
3. Evaluating the economic importance of freight-generating industries and their supply chains, and
4. Calculating the economic benefits and impacts of proposed new freight facilities."

EBP has provided services and guidance for governmental transportation organizations, such as the Federal Highway Administration (FHWA) Office of Freight, the American Association of State Highway and Transportation Officials (AASHTO), and many other groups. The cost of the services is not available on their website, but is estimated to be "$15,000 annually for 1 login, $500 for additional logins, $10,000 for additional state data for adjacent states" (Perry, Adams, Oberhart, & Zietlow, 2016).

3.2.4.5 Czarlite LTL Base Rate from Czarlite Solutions

Czarlite is an additional software solutions provider that sells a variety of transportation-related services. For freight specifically, Czarlite collects shipment and freight bills from the 33 largest less-than-truckload (LTL) carriers in the U.S to develop a standard benchmark base rate for LTL carriers. Users of the Czarlite solutions can incorporate this shipment information into their overall freight analyses. For example, the state of Iowa utilizes shipment data from Czarlite in conjunction with other data sources for its freight analyses. The cost to access Czarlite data can vary, but is about $5,000 for LTL base rate information.

3.2.4.6 PC*Miler Software

PC*Miler is an organization that specializes in route optimization for freight carriers. PC* Miler offers software-based web applications and downloadable excel add-ins for a variety of route analyses. For example, a user of PC* Miler could "leverage their existing infrastructure" by accessing PC* Miler's rail tools that map out the best routes to access the rail system that avoids congestion. While the cost of PC* Miler's services may vary depending on the software package purchased, the Iowa Department of Transportation purchased PC* Miler's products for its freight needs at a cost of $2,656 annually.

3.2.4.7 INRIX Transportation-related Software and Visualization Tools

Lastly, INRIX is a popular data-driven organization that provides a wide variety of software and visualization products, such as INRIX IQ, Traffic, Parking, Safety, and Consumer Apps. INRIX users span from state DOTs, cities, and clientele from several industries, including retail, financial services, logistics, automakers, and many other businesses. Further, states can utilize INRIX data for freight planning and analysis. While not directly freight-related, the data can be useful in analyzing how the roadway can be improved to assist in making more efficient freight movement. Additionally, INRIX data can be used in conjunction with other data sources that may be more freight specific to give transportation practitioners a more holistic view of the transportation system and how traffic influences it. Iowa, for example, utilizes INRIX traffic data for the identification of bottlenecks in the transportation system to assist in highway improvement project prioritization. Similarly, Maryland DOT uses INRIX Trips with Waypoints data and INRIX XD truck data to identify bottlenecks and measure truck parking. This information is conflated with FAF data to create a commodity value and to assess the cost of congestion.[6] In addition, the Department uses Bureau of Economics (BEA) and census data to determine trade or economic statistics and commodity opportunities. This information is evaluated with INRIX to assess freight flow.[7] INRIX may be useful and contain a significant amount of granular data in its products, however, its high cost is a limitation in its usability. While the cost can vary depending on the product purchased, Iowa's use of INRIX data in its freight practices costs the state $778,248 annually.

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[6] The Maryland DOT uses a methodology created by Texas A&M Transportation Institute (TTI) to assess the cost of congestion.

[7] This information is coming from the survey researchers administered to states.

CHAPTER 4: SURVEY OF STATE DATA PRACTICES

4.1 SURVEY METHODOLOGY

The research team developed a survey that was administered to all states across the U.S. The survey was administered to collect information about freight flow data practices across states as well as the benefits and challenges of using different data sources. The questionnaire consisted of a total of 25 questions that included single-choice, multiple-choice, open-ended, and rank order questions (see questionnaire in Appendix C). States were asked about the freight databases they currently use as well as the freight models they have developed. In addition, the survey included questions about the advantages and limitations of the data sources they use, whether they collect additional data, their collection methods and schedules, and the level of detail included in their data among others.

The survey was developed in Qualtrics, a web-based survey tool, and distributed through the email list of members and friends of the American Association of State Highway and Transportation Officials (AASHTO) Freight Planning Task Force and the Committee on Planning, and the Mid-America Freight Coalition (MAFC) contact list (available only to members). The AASHTO email list reached 60 stakeholders, while the MAFC list reached 50 stakeholders, all of them across the 50 states, and the District of Columbia. These two lists represent planning and engineering staff that work on freight concerns in each state and are qualified as lawyers, freight logisticians, or public administrators. The survey was available from October 11, 2021, to November 5, 2021.[8]

4.2 SURVEY FINDINGS

The research team received a total of 41 responses. Among them, ten responses were empty, incomplete responses, or from duplicate states and therefore excluded from the analysis.[9] A total of 31 respondents from 26 states completed the survey (Figure 4.1). The states of Arkansas, Idaho, South Carolina, Utah, and Wisconsin each has two representatives that took the survey. In Arkansas, Idaho, and Utah, one representative completed the survey while the other responded to a few questions. In such a case, only completed surveys were analyzed. In Wisconsin and South Carolina, two representatives filled different portions of the survey and the responses were combined. Respondents from 20 states were affiliated with the State Department of Transportation, six of whom are associated with the planning office. The representative from Rhode Island is affiliated with the Division of Statewide Planning, which is part of the Department of Administration.

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[8] The research team granted additional time to one state that requested it to complete the survey. The survey was closed as they completed it.

[9] Removed responses include those from Alaska, Arizona (2), California, Indiana, New Hampshire (2), Hawaii, Rhode Island, and MAFC.

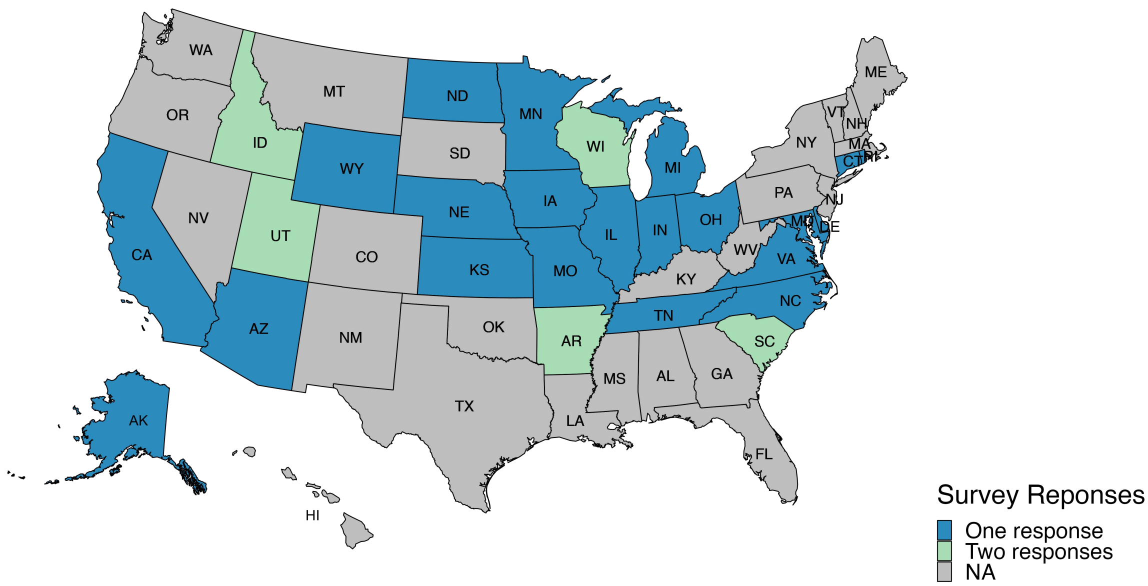


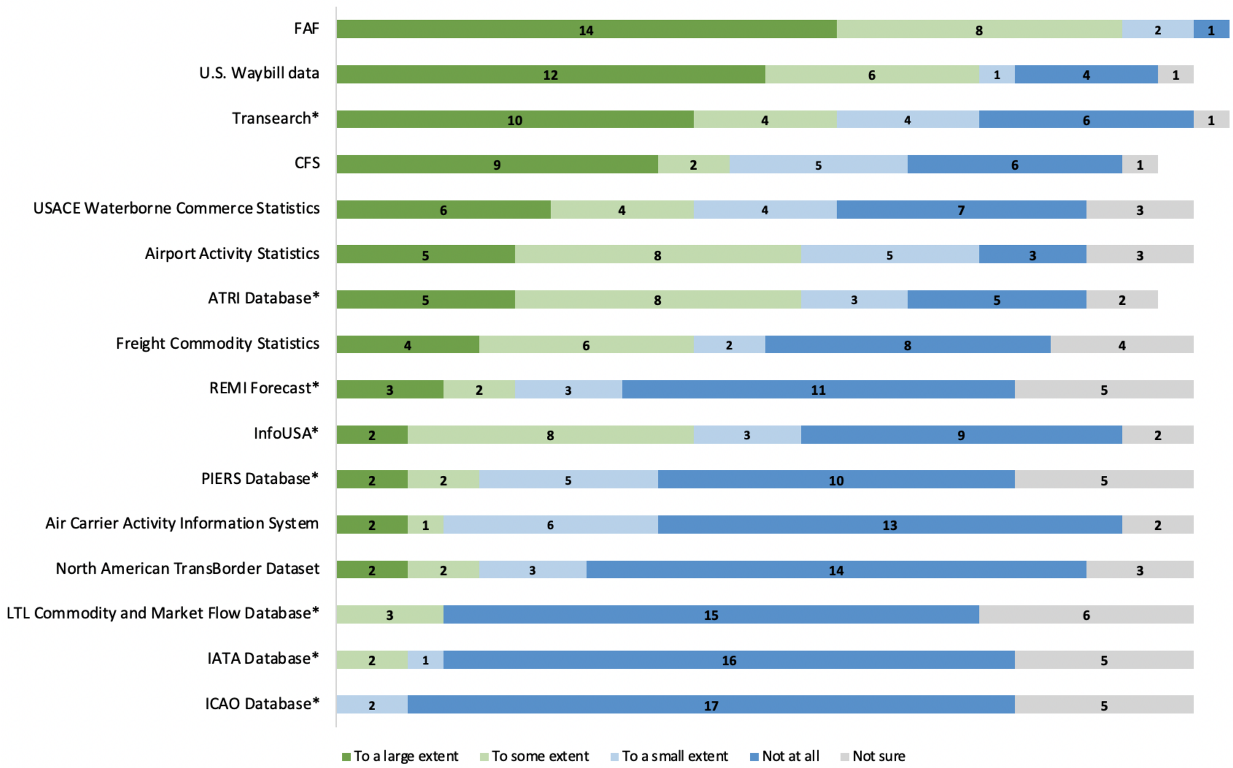
Figure 4.1 States participating in the survey

4.2.1 Freight Flow Data Sources

States were asked about freight flow databases they use in their State Freight Plan and/or State Rail Plan. A total of 25 states responded to the question.[10] The databases widely used in state freight planning across states are Freight Analysis Framework (FAF), U.S. Waybill data, Transearch, Commodity Flow Survey (CFS), USACE Waterborne Commerce Statistics, Airport Activity Statistics, and American Transportation Research Institute (ATRI) (Figure 4.2).

A majority of the states indicated that databases such as International Civil Aviation Organization (ICAO) and International Air Transport Association (IATA) are not used at all. Appendix D presents the extent of use of the four widely used data sources by state.

[10] The states of Arkansas and Idaho had two representatives responding to the question, however, we consider the responses of those who finalized the survey.



Note: **Proprietary datasets*

Figure 4.2 Extent of use of freight flow data sources

States were asked about other freight flow data sources they use in addition to the data sources listed above as well as the extent to which they are used. A total of 18 states reported other sources of data.

With regards to data by modes of transportation, nine respondents listed other data sources they use related to trucks, rail, ports and waterways, or air.

- *Trucks:* Delaware, Iowa, and Ohio mentioned using traffic counts. According to the representative from Delaware, there is a large portion of truck-based freight traveling through the state due to the geography and proximity of the nearby metro centers, therefore they use truck counts to try to monitor it.
- *Rail:* Kansas, Iowa, and Michigan reported using other existing railroad data. While Kansas uses shortline railroad carload data (annual and monthly), Iowa uses data from railroad annual reports. Similarly, Michigan reports that in the past they used shortline railroad movements that were not reported in the waybill data to supplement rail data to a small extent.

- *Ports and Waterways*: While Virginia uses Port of Virginia statistics, Michigan supplements its water cargo statistics with information from a few marine ports that do not report to ACOE to a small extent.
- *Air:* Illinois is the only state using an additional source of air data. Particularly, they use the T-100 database for air cargo from the Bureau of Transportations Statistics (BTS).

Similarly, seven states reported using models, tools, and databases from private sources such as Streetlight, Impact Analysis for Planning (IMPLAN), INRIX, Airsage, and IHS Global Insights. Arkansas, California, and North Dakota use Streetlight in a different capacity. For instance, California uses the data for the calibration and validation of the state freight model and North Dakota uses it to analyze freight movements and highways used. Similarly, North Dakota and Connecticut use IMPLAN. North Dakota uses the economic model for future freight modeling, while Connecticut uses the model to conduct economic impact analyses to quantify the role of freight in the state's economy. Maryland uses INRIX trips with waypoint data and truck INRIX XD data to see bottlenecks and to measure truck parking. California uses AirSage in the calibration and validation of the state freight model. Lastly, Ohio uses IHS Global Insights Forecasting (does not provide more details).

Nine states also mentioned using other federal, state, and local data sources. In terms of federal data sources, Arkansas uses data from the U.S. Department of Agriculture, and Forest Service, to a small extent. Maryland uses data from the Bureau of Economic Analysis (BEA) and the Census to determine trade of economic statistics and commodity opportunities. Wyoming uses the National Performance Management Research Data Set (NPMRDS) travel time data. In terms of state data sources, Arkansas reports using data from the State Oil and Gas Commission. Idaho reports using data from the State Departments of Agriculture, Commerce, and Labor. Tennessee has an internal Enhanced Tennessee Roadway Information Management System (E-TRIMS) system[11] and uses this to show truck volumes. California uses the California Vehicle Inventory and Use Survey (CA-VIUS) in its state's freight model.[12] Nebraska mentions it is currently working on an advanced dataset that will marry with its current Travel Demand Model. Lastly, Ohio and North Dakota use data and models from their Metropolitan Planning Organizations (MPOs).

Only Rhode Island reports receiving data from annual reports by transportation mode from their Freight Advisory Committee (FAC) members. They receive data for things such as passenger and cargo volumes at their central airport, imports and exports for certain commodities moving throughout ports, and some data on freight generators and employment.

[11] Primarily used for Highway Performance Monitoring System (HPMS) reporting

[12] CA-VIUS is the largest statewide commercial vehicle data collection effort in the U.S. (Khan, et al., 2019; Cambridge Systematics, 2019).

4.2.1.1 Measures taken to address data gaps

States were asked about ways they address gaps in their freight flow data. A total of 17 states responded to this question. In addition to combining information from several data sources, respondents listed various methods to address data gaps. This includes data disaggregation and data imputation, as well as collecting additional data through interviews or with the help of consultants. Two states acknowledged data gaps and opportunities for improvement, but do not take specific measures to address them.

Table 4.1 presents details regarding the measures taken by states to address data gaps. A total of seven respondents reported using data disaggregation to address their freight flow data gaps. Three states, California, Nebraska, and Utah provided data disaggregation examples using the FAF data. California reported using its existing data as a base to estimate missing data. For instance, they disaggregate the 7 FAF zones into 120 FAZ zones, and then re-disaggregate the 120 zones into 5,550 TAZs. Similarly, Nebraska reported disaggregating FAF data to the county level. Utah disaggregates FAF data as part of their freight component of their statewide travel demand. Virginia reported using disaggregated IHS data within MPO boundaries to meet urban density. Tennessee indicated relying on Transearch data to fill gaps and mentioned one instance of receiving a request for a disaggregated analysis from one of the communities. Minnesota purchased Transearch and InfoUSA data to disaggregate data in the past, but the cost of these databases is a barrier for their ongoing use. Currently the state relies on FAF for updates to commodity flows and is developing a "Freight Network Optimization Tool" that may disaggregate data to small geographies across the state. Only one state reported using data imputation to address data gaps. According to a Wyoming respondent, there are data gaps to complete their freight plan. As an example, they addressed gaps in truck traffic forecasts by estimating truck volume growth based on FAF estimates.

Table 4.1 Measures taken by states to address data gaps

State	Measures taken to address data gaps
Alaska	Re-examines data and looks for explanation in other sources
California	*Works with the existing data and documents the gaps. *Forecasts missing data using the current data as a base *Disaggregates the 7 FAF zones into 120 FAZ zones, then they re-disaggregate the 120 zones into 5,550 TAZ zones.
Idaho	Uses multiple data sources.
Illinois	*Uses multiple datasets *Has used disaggregation to drill down on the data.
Iowa	Data disaggregation to some extent
Kansas	Compare with internal data

Maryland	*Uses multiple data sources *INRIX Trips data are used to help see freight flows. INRIX data are conflated with FAF to create commodity value as well as to assess the costs of congestion using a methodology created by the Texas A&M Transportation Institute. *MDOT SHA also created the Maryland Roadway Performance Tool (in beta form), which helps in that a commodity value is assigned to each highway performance monitoring segment.
Michigan	*Supplements rail and water with department contacts when possible. *For air cargo, they use multiple datasets. *For trucks, Transearch is the main source for freight movements, but they will also use their travel demand model for total truck volumes of smaller trucks that are not included in the Transearch. *Working with IHS to get accurate cross-border movements from Transearch data.
Minnesota	*Conducts a systematic review of economic specialties in each region *Conducts one on one interviews as part of the Manufacturer's Perspectives Studies. Through this process, the DOT gains direct feedback from specialized manufacturers, carriers and freight generating businesses. *Conducts District Freight Plans to connect and extend the work conducted in the Manufacturer Perspective's Studies by ranking, prioritizing, and identifying future freight related investments that could be conducted by the DOT or private sector partners in each area of the state. Some base data is collected as part of the District Freight Plans that help inform public investments and will be aggregated to connect and inform the State's Highway Investment Plan in the future. *In the past, the DOT purchased Transearch and InfoUsa data to disaggregate data to the regional level economic specialties and estimate freight flows. However, the ongoing costs of them are barrier for their ongoing use.
Nebraska	*Disaggregates the FAF data to the county level. *Collect desensitized BOLs through a consultant service and pair them with FAF data *In the process of collecting additional O/D pair information. (These are all part of their supply chain optimization model)
North Dakota	Conducts interviews
Ohio	Conducts interviews
Tennessee	Mainly relies on Transearch to fill gaps. In one instance, their Freight Planning Office had only one request for a disaggregated analysis from one of the communities in Middle Tennessee.
Utah	Disaggregates FAF data as part of the update to the freight component of the statewide travel demand model.
Virginia	Has had IHS data disaggregated within MPO boundaries to meet urban density.

Wyoming	Estimates truck volume growth based on growth rates estimated from FAF to fill gaps in truck traffic forecasts

Similarly, four states report supplementing data with information gathered through interviews. Michigan reports supplementing rail and water data with information from their contacts in some marine corps. Minnesota and North Dakota conduct one on one interviews. Minnesota reaches out to specialized manufactures and carriers and freight generating businesses, while North Dakota reaches out to leading freight companies. North Dakota also conducts shortline railroad interviews and outreach to discuss each railroad's outlook. According to them, this is the primary way to gather missing data since a lot of the federal freight data sources are not suited to low-population states or are heavily aggregated. Similarly, Ohio collects specific air cargo data from Ohio air hubs through interviews and conducts specific interviews with businesses (trucking firms, shippers, ports) to check trends and business practices.

Two states work with consultants to collect additional data. For instance, Michigan is working with IHS to get accurate cross-border movements from Transearch data. Nebraska uses a consultant service to collect desensitized Bill of Lading (BOL) data and pairs this with FAF data. In addition, they are in the process of collecting additional O/D pair data. According to the respondent, these efforts are part of their supply chain optimization model.

Two states acknowledged data gaps but did not report measures taken to address them. According to the respondent from Wisconsin, the state tries to identify and acknowledge data gaps and issues but does not have the resources to improve the data. The respondent believes that they may not have gaps as far as federal requirements for planning as they have sufficient coverage with Transearch data related to geography (county level) and commodity details (STCC 4). Similarly, the representative from Arkansas acknowledged existing gaps and opportunities for improvement in seasonal activity (such as agriculture) and natural resource activity (such as forestry) data, but did not indicate whether they are addressed.

4.2.1.2 The extent to which freight data are reviewed as part of transportation plans

States were asked about the extent to which their State Freight Advisory Committee (FAC) reviews freight data as part of their transportation plans. A total of 22 states responded to this question.[13] A total of 18 states reported that their FAC reviews freight data as part of their transportation plans. Of these, 16 states seem to have a history of their FAC members reviewing the data, while two states (Alaska and North Dakota) indicated that their FACs are starting to review data. North Dakota notes that

[13] Two representatives of Arkansas provided similar responses to this question. Their responses were used to complement one another.

its FAC is fairly new to this, and this will be the first time FAC members will have the opportunity to use freight databases in the development of the freight and rail plan.

Table 4.2 presents the 16 states in which the FAC members review freight data as well as details of their involvement. Most of these states report that their FACs review high-level information such as freight data provided at the aggregate level, graphics, and analysis results. Typically, FAC members do not review specific datasets. Nine state DOTs[14] reported presenting this information to their FAC members in organized events such as freight summits, freight meetings, and workshops or through planning draft documents. In addition, seven states[15] report their FACs responding or providing feedback to the data presented. Only Rhode Island indicates that they ask their FAC members to provide certain data tables related to the industries they represent.

[14] Arkansas, California, Delaware, Illinois, Maryland, Ohio, Utah, Wisconsin, and Wyoming.
[15] Arkansas, Illinois, Kansas, Maryland, Rhode Island, Utah, and Wyoming.

Table 4.2 State Freight Advisory Committee data review

State	FAC Data Involvement
Arkansas	FAC receives high-level briefings on freight data analysis. The data are provided at a summary level for review and feedback during plan development.
California	The freight office presents data about specific sections (e.g., economics chapter) via presentations. They don't go deep into the specifics of the datasets.
Delaware	Has a summer freight summit and a winter freight meeting, at which data-oriented presentations are made to the FAC.
Idaho	FAC reviews all datasets prior to SFP being published
Illinois	Data are presented during workshops to obtain feedback on trends and/or other observations needed in the development of the freight plan.
Iowa	The review of specific datasets is limited. The FAC primarily reviews analysis results.
Kansas	The FAC reviews data and provides input.
Maryland	The State FAC is reviewing freight flow data along with asset, safety, environmental, and other data as part of the freight planning process. They receive the information in presentations and in draft document form and are asked to respond to it.
Michigan	The FAC does not really review the data, they review all the output that is a part of the freight and rail plans. They have been more useful in policy, workforce, CAV, and multimodal supply chain issues for their planning.
Minnesota	The FAC reviews freight plans on a quarterly basis and FAC members are invited to serve on technical advisory committees to review and inform final transportation plan products.
Nebraska	The FAC reviews freight data as part of periodic state freight plan development and updates
Ohio	Data and information are presented at each meeting to discuss
Rhode Island	The FAC members have been asked to provide and review certain data tables relating to the industries that they represent. For instance, the port representatives review import and export data, airport commission representatives provide all air freight and passenger data for the plan, and economic development commission member reviews macroeconomics data (jobs, unemployment, growth projections, etc.)
Utah	SFA reviews freight at only a high, aggregate level. They are presented summary graphics and asked to respond.
Wisconsin	The WI State Freight Advisory Committee reviews freight data as they are reported in our planning documents. They do not review data separate from how they are analyzed and presented in planning activities.
Wyoming	SFA reviews freight only at a high, aggregate level. They are presented with summary graphics and asked to respond.

Finally, four states report that freight data are not being reviewed by their FAC. Connecticut, for instance, has not established a FAC yet. They have an internal freight working group that includes the FHWA and the Connecticut Airport and Port Authorities, but they primarily depend on consultants to analyze freight data. Tennessee reports that their FAC is informal in nature at this point. The DOT has shared data with FAC members for informational purposes but has not asked them to review any of the state plans/approve them. FAC members have been only asked to prioritize major freight projects by region and provided feedback related to these projects. The respondent also notes that the FHWA's recent PHFS re-designation was another opportunity for the informal committee to respond via survey on their choice of re-designation. North Carolina and Virginia did not provide further details.

4.2.2 State Freight Flow Data Collection

States were asked whether they collect any freight flow data either in-house, through subcontractors, a combination of both, or with other methods. Figure 4.3 presents the responses. Overall, 14 out of 25 states that responded to the question, reported collecting freight flow data. Eight states reported collecting data through a combination of in-house efforts and contractors, three reported collecting data in-house, and two reported using only contractors. Only one state (Indiana) reported collecting freight flow data through the Annual Report for the Railroads, however, they mentioned that this is a "very basic collection and not in-depth". The remaining 11 states do not collect any freight flow data.

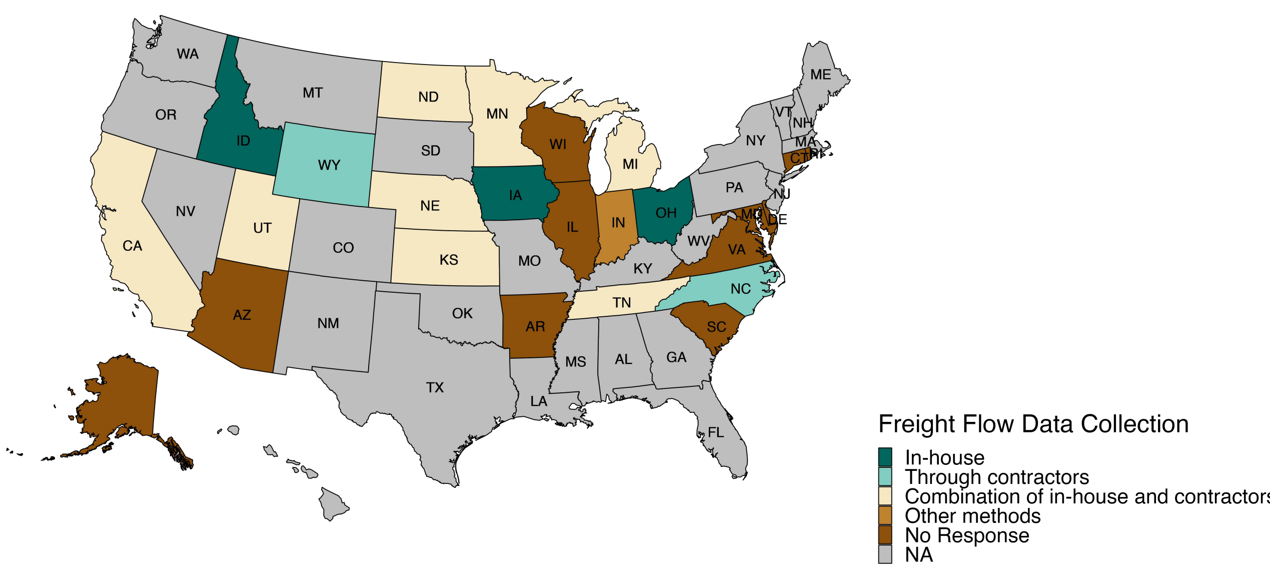


Figure 4.3 Freight flow data collection

States that indicated their states collect data through a combination of in-house efforts and contractors were also asked about their staff capacity and tools as well as the terms of the contract to collect the data. A total of six states provided details about their in-house staff capacity and tools. Overall, states reported having dedicated full-time employees with specific skill sets as well as staff involved from other divisions. The involved employees are typically planners, modelers, GIS specialists, and data analysts. Four states provided details about the terms of contracts they use to collect data. Overall, they all purchase data from private consultants for a cost and two of them use on-call contractors to run their freight planning operations.

In-house data collection efforts in two states involve traffic counters and modelers. In Nebraska, the state has approximately 10 to 15 staff in their traffic counter shop that collect truck-specific data in addition to their other duties. Two modelers also operate and maintain their travel demand model that incorporates truck data. A freight manager is responsible for managing projects related to freight data, modeling, and planning. Similarly, in-house data collection in Tennessee is handled in the Long-Range Planning Division that involves approximately 20 employees who are mostly traffic counters, GIS technicians, or planners. The state DOT also has a forecasting office with three modelers/planners that can utilize the Transearch data to research commodity flows. In addition, the Department's Freight & Logistics Division is implementing Weigh-In-Motion (WIM) sites across the state for future data collection for various divisions including the Long-Range Planning, Traffic Operations, Freight & Logistics, and Maintenance.

Two states reported having economists involved in their in-house data collection efforts. Michigan reported having one freight movement specialist assisted by other staff and students when needed. In addition, the state indicated that the freight policy, statewide model, and socioeconomic data, and a myriad of GIS specialists; rail office staff with rail contacts; and operations staff are involved. The operations staff procure INRIX traffic data through the RITIS tool. The state uses TransCAD and ArcGIS as part of their in-house data collection. Similarly, North Dakota reported having five full-time employees in the Planning/Rail section of the Planning and Asset Management Division of the state DOT. According to the respondent, three of the staff are planners,[16] one is a rail manager, and another is an economist. The staff has a mixture of ArcGIS, modeling, planning, grant-writing, data analysis skillsets.

Kansas reported having five full-time employees with data analysis and freight modeling skills dedicated to the task.

Finally, California reported the involvement of various divisions and offices of CalTrans, but did not specify their staff skill sets. The involved divisions and offices include the Divisions of Transportation Planning, Traffic Operations, IT, Rail and Mass Transit, Aeronautics, Resources and Innovations and Transportation System Information, among others with over 20,000 employees.

Of the five states that provided details about the terms of contracts with private consultants, two states reported purchasing data from private sources and using on-call contractors or consultants for running their freight planning operations. In Nebraska, the freight planning operations are run through an on-call planning service where projects last anywhere from three months to multiple years. In terms of data

[16] Long-range transportation plan (LRTP), freight and rail, and active transportation.

needs and analysis, the state has utilized various consultants, but relies on Quetica and HDR for the majority of the work. Currently, Quetica provides most of their supply chain work and HDR provides the travel demand modeling work. Similarly, in Tennessee, the Department purchases data from vendors and has consultants that are used on an on-call basis. According to the respondent, responsibilities, skills, programs, contract periods, and costs vary from consultant to consultant.

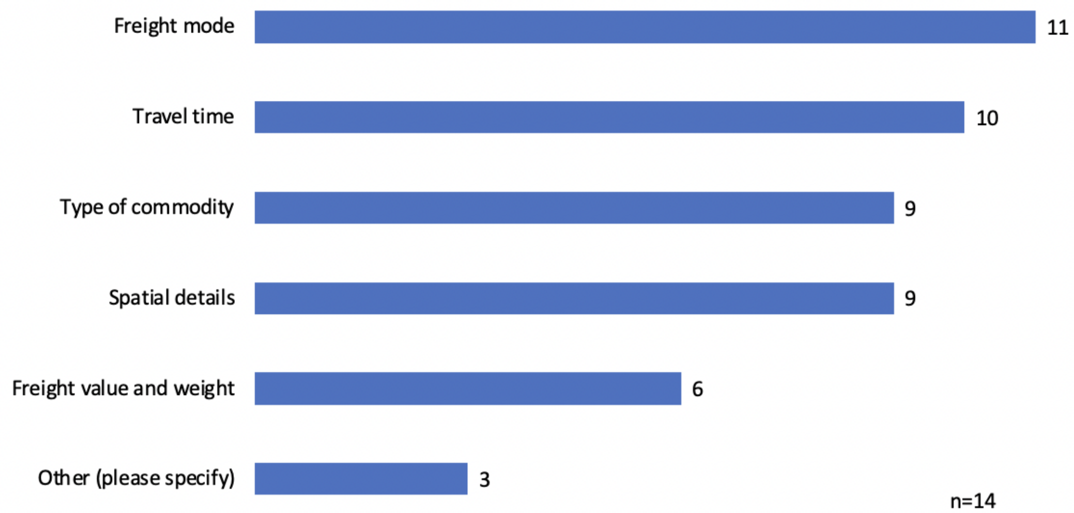
The DOT in Minnesota has several contracts. They have contracts with vendors to conduct in-situ surveys of railroad lines, railroad crossings and safety concerns. In addition, they have contracts with Streetlight Insight and the CATT Lab at the University of Maryland for data on truck freight movements and truck travel time reliability index. According to them, these online software as service products are becoming more common and more costly over time. Furthermore, specialized training and knowledge is required to use these tools successfully.

Only one state provided details about costs and terms of the contract and required skills and programs when collecting data through contractors. Michigan reported using Waybill, Transearch, and the RITIS tool. The state procures Waybill data through State Transportation Board (STB) annually at around $300, depending on the number of additional contact access that is needed for a given year. Transearch costs $180,000 every three years for all modes in, out, within, and through the state with annual updates and five-year forecasts for the next 25 years. RITIS tool is run through the Department's operations division and for an annual cost. The programs used are ArcGIS, TransCAD, Excel, and MS Access and the required skill sets are GIS and database management skills.

Finally, North Dakota indicated that their contracts follow the state procurement guidelines. According to this respondent, consultants and their specific responsibilities are subject to RFP, scope of work, costs, and required criteria. In addition, proprietary data are subject to the state Open Records Law that needs to be reviewed by the NDDOT Legal Division to ensure compliance.

4.2.2.1 Data Collected

Most of the states that collect freight flow data collect three or more characteristics. The most commonly collected characteristics are the freight mode, travel time, the type of commodity, and spatial details (Figure 4.4). Only one state (North Carolina) reports collecting one characteristic: type of commodity. Representatives from Indiana, Kansas, and Michigan mentioned collecting the top two commodities for each individual railroad, short line carload data, and industry employment and safety/crash data, respectively.



Notes: *Other includes top two commodities for each individual railroad, short line carload data, and Industry employment, safety/crash data.*

Figure 4.4 Details in the data the states collect

Freight Mode: Eleven of the respondent states collect freight mode. Table 4.3 provides details regarding the modes included in the data collected by states. The majority of states collect freight data transported by roadways (trucks) and by railways, while very few states collect information on freight data transported on waterways and pipelines. Only California and Michigan collect data for all types of freight modes, followed by Idaho that collects all modes except for pipelines.

Table 4.3 Freight transportation modes collected

State	Freight Modes				
	Roadways (trucks)	Railways	Airways	Waterways	Pipelines
California (1)	✓	✓	✓	✓	✓
Idaho (2)	✓	✓	✓	✓	x
Iowa (2)	x	✓	x	x	x
Kansas (1)	✓	✓	x	x	x
Michigan (1)	✓	✓	✓	✓	✓
Nebraska (1)	✓	✓	x	x	x
North Dakota (1)	✓	✓	✓	x	x
Ohio (2)	✓	x	x	x	x
Tennessee (1)	✓	x	x	x	x
Utah (1)	✓	x	x	x	x
Wyoming (3)	✓	✓	x	x	x

Notes: *(1) Collects data through a combination of methods. (2) Collects data in-house. (3) Collects data through contractors.*

Idaho is the only state that collects data in-house and collects information for multiple freight transportation modes, the other two states collecting data in-house only collect one type of freight transportation mode. States using a combination of methods typically collect multiple freight transportation modes, except for Tennessee and Utah.

Type of Commodity: Nine of the respondent states collect information regarding the type of commodity, however, six of them provided details about commodity classifications, the level of grouping employed, or the number of commodities included in the data collected by the state.[17] Overall, the majority of the respondent states indicated using NAICS classification. Three respondents were not specific about the commodity classifications used in their fright data.

A total of four states reported using NAICS classification in the data collected by their states. Of these, two states specified the level of classification. The Iowa representative reported using NAICS at the 2-digit level, while California uses NAICS at the county level. The North Carolina and North Dakota respondents indicated using NAICS classification and NAICS and SCGT2 classifications, respectively, but they did not specify the level.

Two respondents were not specific about the commodity classification used in their freight data. While Kansas reported having commodities at the 2-digit level, the type of classification was not clear. Finally, Idaho indicated that they focus on the top 10 commodities that the state produces such as forestry and minerals for their Statewide Freight Plan (SFP).

Spatial Details: Nine of the respondent states collect spatial details (Table 4.4) Most states collect origin and destination data and only two states collect intermediate points. Utah mentioned collecting spatial details but did not provide more information.

Table 4.4 Spatial details collected

State	Origin & Destination	Intermediate Points
California (1)	✓	x
Idaho (2)	✓	x
Kansas (1)	✓	x
Michigan (1)	✓	✓
Minnesota (1)	✓	x
North Dakota (1)	✓	x
Tennessee (1)	✓	x
Utah (1)	x	x
Wyoming (3)	x	✓

Notes: *(1) Collects data through a combination of methods. (2) Collects data in-house. (3) Collects data through contractors.*

[17] Nebraska and Michigan were excluded as they indicated classifications from the data sources they used.

4.2.2.2 Data Collection Methods and Schedules

States were asked about their data collection methods and schedules. A total of eight states provided details about data collection methods,[18] while six states provided details about their schedule of collection.[19] A majority of the respondent states reported using counts or surveys to collect freight data. Data collection schedules vary across states.

Five states reported collecting traffic counts data through various methods. A Tennessee respondent reported collecting traffic count data via electronic devices as well as manual counting.[20] Similarly, a Wyoming respondent indicated that truck volume data are collected via traffic counters. According to this respondent, rail data are collected from railroads and rail safety data. Utah reported using multiple methods— continuous count stations, short-term spot counts, and WIM stations— to collect traffic count data. California also reported using several traffic count methods such as render purchases, inductive loop detects and hoses, CCTV, and using Miovision technology. While Ohio indicated collecting traffic counts data, they did not specify their methods. According to the respondent, the state has collected data since the creation of the agency in the 1900s in paper format while more recent data are collected in electronic format.

Three states reported conducting surveys to collect freight data. Of these, Iowa indicated using annual reports or surveys that started in the 1980s or 1990s. Ohio also reported conducting statewide modal surveys. Similarly, California reported conducting surveys. According to the respondent, the state Highway Division has collected data since its creation. However, data collection schedules vary by data type with some data being collected on an ongoing basis.

Finally, two states listed multiple methods of data collection. According to the Michigan DOT respondent, the state downloads datasets from federal agencies; conducts online google research for facilities and uses google maps for reviewing transload locations, warehousing, and specific industry information; and uses their regions and MPOs for local information when needed. These data have been continuously collected for 30 years. In Minnesota, the Ports and Waterways Manager calls members of the ports association for data on waterway cargo flows as well as the opening and closing of waterways during the winter and spring for frost out periods on the Mississippi River and Lake Superior. The state also conducts in-situ inspections of rail stock, railroad cars and contracts for inspections and data collection of railroad crossings, rail line locations/geometry, and safety crossing concerns. These data have been continuously collected since 2007 and most of the data products are collected seasonally (updates are spaced 4-6 months).

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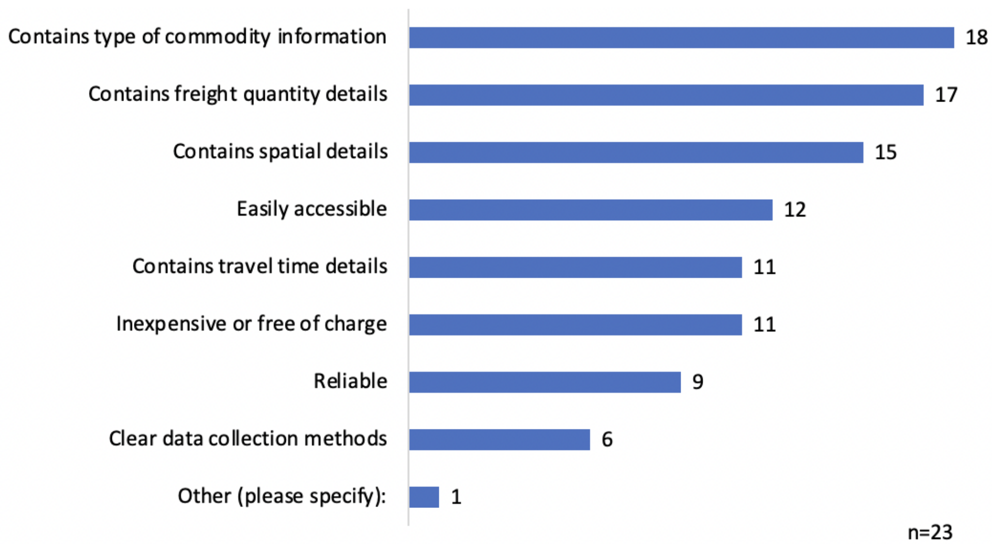
[18] Responses from Idaho, Nebraska, North Dakota, and Kansas were excluded as they referred to methods of collecting data from existing data sources.

[19] Responses from Idaho, Nebraska, North Dakota, and Wyoming were excluded as they referred to collection schedules from existing data sources.

[20] These data are collected by the Tennessee DOT's Long Range Planning Division. Since the respondent represented the Freight & Logistics Division, they were not sure when the state began collecting these data.

4.2.3 Advantages and Limitations of Freight Data Sources Currently used by States

States were asked about the advantages and limitations of the freight data sources they currently use. A total of 23 states reported advantages of using the data sources (Figure 4.5). The majority of respondents believe current freight data sources were advantageous for four reasons: they contained the type of commodity information, freight quantity details, spatial details, and were easy to access. Only the state of Virginia selected the *other* option and mentioned that the current data helps to estimate truck tonnages.



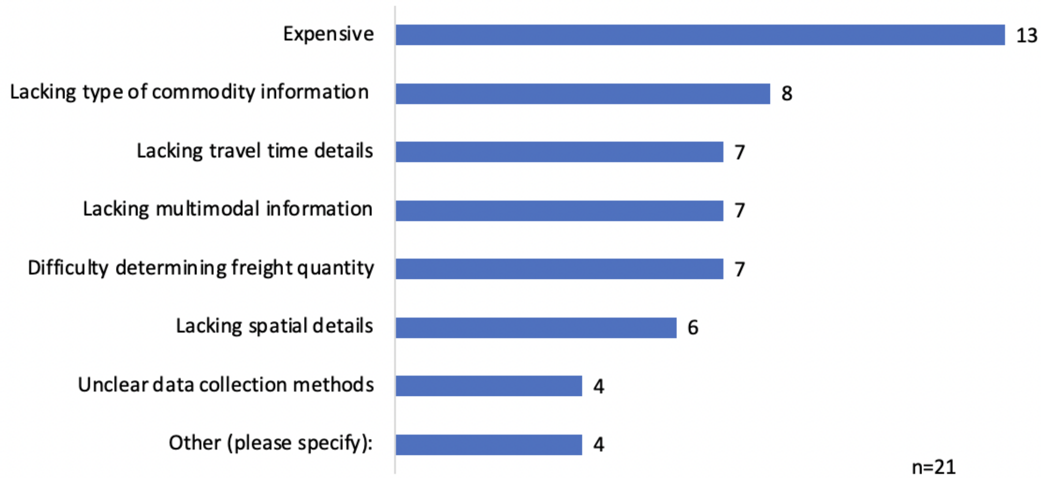
Notes: *The Other option includes the data source helps estimate truck tonnages.*

Figure 4.5 Advantages of freight data sources currently used

Similarly, a total of 20 states reported limitations of the current data sources (Figure 4.6). The states of Kansas and South Carolina mentioned advantages but did not mention any limitations. More than 60 percent of respondents believe the databases are expensive.[21] Around one-third of the respondents reported lacking type of commodity information, lacking travel time details, lacking multimodal information, and difficulty determining freight quantity as limitations. Lastly, four states mentioned other limitations including gaps in data (California), difficulty determining modality (Nebraska), harder

[21] According to their responses in other questions, Connecticut and Maryland believe Transearch is expensive.

manipulation given the size of the records contained in an area of disaggregation (Tennessee), and the all or nothing route choice model that makes estimated flows questionable (Virginia).



Notes: *Other includes gaps in data, difficulty determining modality, harder to manipulate due to the size of the records contained in an area of disaggregation, and questionable estimated flows.*

Figure 4.6 Limitations of freight data sources currently used

States were asked whether they believed the freight databases they use are sufficient to generate the needed information. A total of 20 states responded.

Overall, 12 states believe the freight databases they use generate sufficient information. The representatives of Alaska, Idaho, Kansas, Michigan, Ohio, Rhode Island, Tennessee, Virginia, and Wisconsin reported that the current data are sufficient to generate the information they need, but most of them did not provide further details.[22] Similarly, the representatives of Connecticut, Maryland, and Utah believe that the current data are sufficient, but having more would be more beneficial and preferred.[23] Further, the representative of Maryland believes the current information is sufficient to tell the freight story and align with the highway performance monitoring system network to put things into context for assessment of the network. According to this respondent, the Maryland DOT is able to get great information from other sources including the Maryland Performance Tool (MRPT), the FHWA Freight Mobility Trends Tool, and the Support for Urban Analysis Pooled Fund tool among others.

[22] Virginia and Tennessee believe the data are adequate at this point. Tennessee added that they have not had many requests for commodity flow data.
[23]Maryland indicated additional information (such as from Transearch) would be nice to have but it is expensive.

Other seven states highlight limitations of the current data available. First, the combination of various datasets is not always compatible, mentioned by the representatives of Delaware and Illinois. According to them, better alignment of FAF and Transearch sources would be helpful (Delaware) and the alternative to purchase a complete dataset from the private sector is expensive (Illinois). Second, the granularity of the current data, mentioned by the representatives of Arkansas, Minnesota, and Wyoming. Arkansas has large agricultural and forestry sectors that are not captured easily. Minnesota does not have a good source of data for truck and air cargo commodity flow. In Wyoming the FAF data are aggregated statewide and do not provide subarea details. Third, the difficulty of access to real-time freight statistics, mentioned by the representative of North Dakota. According to them, these data would be useful to measure border wait times, but there would be issues with confidentiality and privacy. Fourth, the reliance on old datasets and unreliability of data, mentioned by the representatives of California and Minnesota. According to the California DOT, the state relies on old data for truck volumes and counts, and while they are able to collect real-time volumes (for all vehicles on urban freeways), they are not able to determine whether these are cars or trucks.

The representative of Minnesota also highlights that they do not have a good data source that would provide a precise estimation of greenhouse gas emissions and environmental impacts are not available on an ongoing basis.

Lastly, a Nebraska respondent noted that their DOT is always exploring additional ways to expand their datasets and fill gaps to make their overall freight data more reliable.

4.2.4 Development of Freight Flow Models

States were asked if they have developed a freight flow model. Out of 24 respondent states, 12 have developed a freight flow model (Figure 4.7).

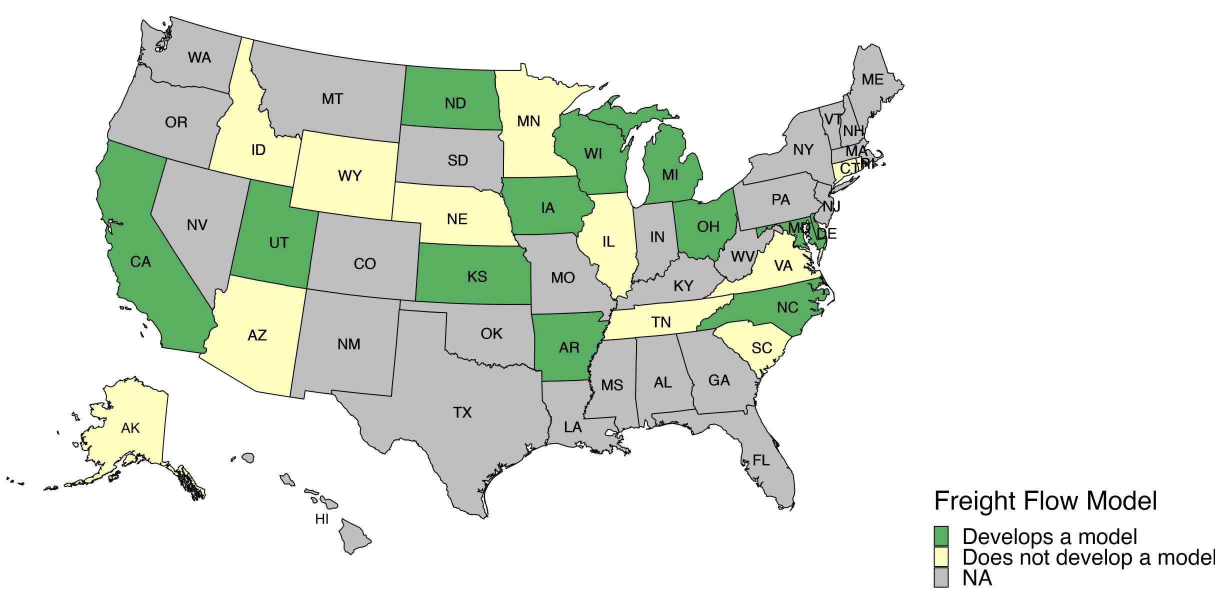


Figure 4.7 Development of freight flow models by state

Table 4.5 presents the details included in the state freight flow models. States use a combination of several data sources in their freight flow model. Most of them use FAF (9 states), U.S. Waybill data (8 states), and Transearch and CFS (7 states). Of the 12 states, nine include information on the type of commodity, and nine include spatial details in their models. California and Iowa include spatial details that go down to the county level. Highway and railroads are the most common freight transportation modes included in the models. California, Delaware, Iowa, Kansas, and Ohio incorporate other transportation modes.

Table 4.5 Details included in the freight flow model by state

State	Databases Used	Type of commodity	Spatial details	Freight value and weight	Freight mode	Travel time
Arkansas	FAF, Transearch, U.S. Waybill data, Other	✓	Travel demand model with select link functionality	✓	Highway, Rail	✓
California	CFS, FAF, North American TransBorder Dataset, Airport Activity Statistics, U.S. Waybill data, LTL Commodity and Market Flow Database, Freight Commodity Statistics, Air Carrier Activity Information System, PIERS database, InfoUSA, USACE Waterborne Commerce Statistics	✓	O/D down to county level	✓	Air, Rail, Truck, Pipeline, Water ways, Sea ports.	x
Delaware	CFS, FAF, Transearch, U.S. Waybill data, InfoUSA, REMI	✓	TAZ	x	Truck, Ports, Rail, Air	x
Iowa	CFS, FAF,Transearch, U.S. Waybill data, ATRI Database, Freight Commodity Statistics, InfoUSA, USACE Waterborne Commerce Statistics	✓	County to county	✓	Highway, Rail, Water	x
Kansas (1)	CFS, FAF, U.S. Waybill data, ATRI Database, Freight Commodity Statistics, PIERS database, USACE Waterborne Commerce Statistics	✓	x	✓	Motor carrier, OSOW, Class 1 RR, Short line RR, Air Cargo	✓
Maryland	FAF, Transearch, Freight Commodity Statistics	x	x	x	Truck	✓
Michigan	CFS, FAF, North American TransBorder Dataset, Airport Activity Statistics, Transearch, U.S. Waybill data, ATRI Database, Freight Commodity Statistics, InfoUSA, USACE Waterborne Commerce Statistics, REMI	✓	Statewide TAZ level	✓	Mode share split, then trucks are used with the passenger vehicles when assigning in the model	✓
North Carolina	CFS, FAF, U.S. Waybill data, ATRI Database, PIERS database	x	x	x	Percentage by mode	x
North Dakota	Other	✓	Grain Elevator Locations	x	Road and Rail	x
Ohio	CFS, FAF, Airport Activity Statistics, Transearch, U.S. Waybill data, ATRI Database, LTL Commodity and Market Flow Database, Freight Commodity Statistics, Air Carrier Activity Information System, InfoUSA, USACE Waterborne Commerce Statistics, REMI	✓	mapping	✓	All modes	✓
Utah (2)	Transearch, Other	x	Volume by roadway segment	x	Truck	✓
Wisconsin	Transearch, InfoUSA	✓	TAZ	✓	Truck	x

Notes: *(1) OSOW: Oversized and Overweight. (2) Other sources refer to the Utah Department of Workforce Services.*

The representative of Arkansas notes that the model reported is a statewide travel demand model with a standalone freight module that represents highway and rail, while the representative from North Dakota notes that the model is used by the Upper Great Plains Transportation Institute at the North Dakota State University in Fargo. The model in North Dakota started as a way to model oil-field traffic but has expanded to include both agriculture and energy.

Several methods could be used to develop freight flow models including the O-D factoring method, truck model, four-step commodity model, tour-based model (also known as activity-based freight demand model), and economic activity model. Overall, respondent states use two methods or more (selected by 11 out of the 12) (Table 4.6). Only Wisconsin uses one method (four-step commodity model). The truck model method is the most used with 10 states using it. Of these, eight states also use the O-D factoring method, of which six combine them with another method (either the four-step commodity model or the tour-based model). The economic activity model and the tour-based models are the least used, selected by three and two states, respectively.

Table 4.6 Methods used by states to develop freight flow models

State	O-D factoring method	Truck model	Four-step commodity model	Economic activity model	Tour-based model
Arkansas	✓	✓	✓	x	x
California	✓	✓	x	x	✓
Delaware	✓	✓	✓	x	x
Iowa	✓	✓	x	x	x
Kansas	✓	x	x	✓	x
Maryland	✓	✓	x	x	x
Michigan	✓	✓	✓	x	x
North Carolina	x	✓	✓	x	x
North Dakota	✓	✓	x	✓	✓
Ohio	✓	✓	✓	✓	x
Utah	x	✓	✓	x	x
Wisconsin	x	x	✓	x	x

The models the states have developed generate several outputs including total freight vehicle-miles traveled (VMT), zone-to-zone and link-level flows, total freight vehicle-hours traveled (VHT), travel times, and emission levels. Freight VMT and zone-to-zone and link-level flows are the outputs that are most commonly used, while emissions levels are less commonly used (Figure 4.8).

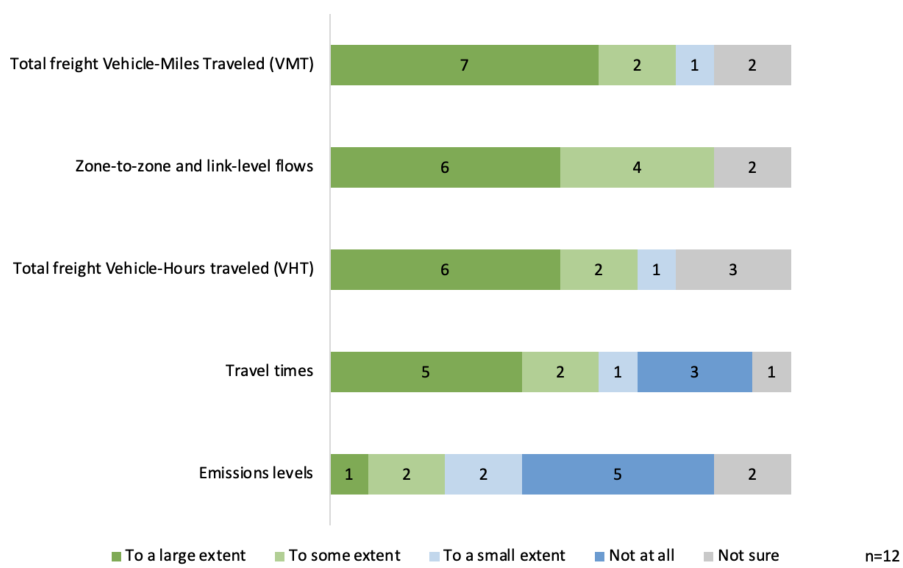
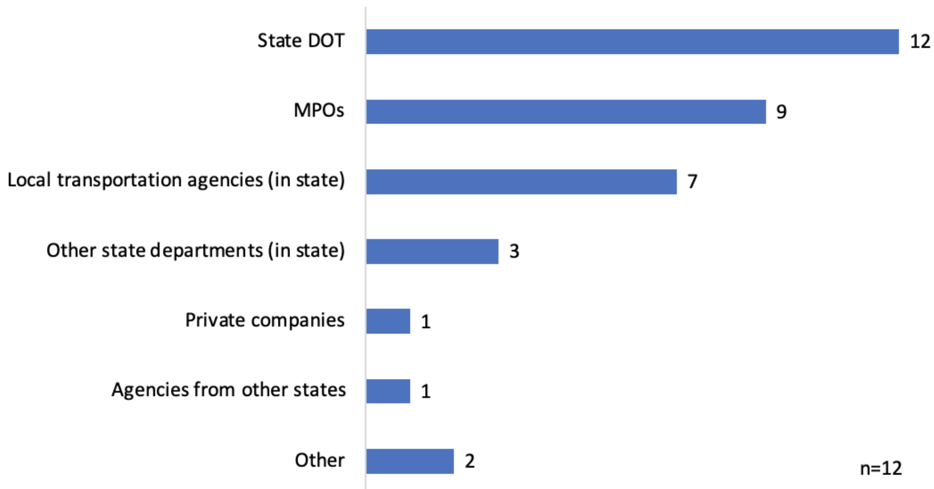


Figure 4.8 Extent of use of outputs available from freight flow models

State DOTs are the primary users of freight models and their outputs, however, other stakeholders such as MPOs and local transportation agencies in the state also use them (Figure 4.9). In three states other state departments (different from the state DOTs) use the model or the outputs. For instance, the Air Resources Board and the California Energy Commission use the model/outputs in California, while in Iowa and Kansas the Departments of Economic Development and Agriculture use the model/outputs. California is the only state reporting that private companies and agencies from other states use the model/outputs developed. North Dakota reports that these are used by the State Legislature and Ohio reports that they share information with others (but does not provide further detail).



Note: *The Other option includes the state legislature and others.*

Figure 4.9 Stakeholders using the freight flow models and/or their inputs

There is no clear pattern regarding when the freight flow models the states develop are updated. The frequency of updates ranges from annually to every five years and as needed. Kansas, Maryland, and North Dakota update their models on an annual basis, while Wisconsin mentions they update it continually, but does not offer further details. Less frequent updates include California and Delaware, which update them every four years (Delaware mentioned they do so prior to updating the state freight plan); and Arkansas and Iowa that update the model every five years. The respondent from Michigan explains that they completed a new statewide model in 2019 and look to update it annually. The respondent also mentions that some updating of parts of the model are continuous or whenever employment is updated, road networks get updated. They explain they will update the freight model with new Transearch data in 2022. Lastly, Utah updates its model as needed and North Carolina updates it when the plan is updated (but does not provide further detail).

4.2.5 Additional Comments

Eight states provided additional comments regarding their freight data practices. Three states commented on their freight planning. According to a North Dakota respondent, their updated Freight and Rail Plans will be more data-driven than in the past. Similarly, Rhode Island plans to update its State Freight Plan in 2022 with a new freight commodity flow analysis with projections to 2040 with the help of a contractor. The updated Freight Plan will include a new statewide truck parking study as an Appendix. A Connecticut respondent also notes that the state relies primarily on consultants and a mix of public and private data sources for its freight planning efforts. The respondent reported Transearch, NPMRDS, and HPMS as the main sources of data used for freight planning. According to this respondent, while Transearch is costly, it provides more granular and complete commodity flow data. The state will continue using Transearch data for the next update of the Freight Plan, but is exploring using FAF disaggregated data in the future, which may alleviate the cost. According to the respondent, the Eastern Transportation Coalition has developed a methodology assisting members to disaggregate the FAF data.[24]

Two states respondents noted they focus on truck freight data. According to a Virginia respondent, the state produces a statewide truck model, which helps provide a gauge on trends. Similarly, Ohio reported collecting highway data primarily.

Similarly, a Minnesota DOT representative noted that the state is involved in several data collection efforts for trucks. These include *(i)* monitoring truck weights through active weigh-in-motion sensors across the state as well as oversize-overweight systems that track the permitted movements of oversize and/or overweight vehicles for safety, and *(ii)* collecting truck parking data as part of its ongoing multi-state Truck Parking Information Management System (TPIMS).[25] In addition, the state collects data through the application cycles of the competitive Minnesota Highway Freight Program (MHFP) solicitation. The representative notes that while these data are used to inform the MHFP decisions, they are not actively shared with or used by other district offices in their decision-making. According to this representative, District Engineers often do not have an easily available system that provides comprehensive freight data at the local level. The representative notes that the Metro District Scoping Database has the potential to be improved if it is modified and updated to contain freight needs and freight data.

The Minnesota DOT representative also highlighted some of their limitations. The state revisits many of their data sources in updating their freight plans or studies, which results in a larger cyclical update that wanes over time. The state is also limited in identifying and communicating freight data that can inform discussions around complete streets and road diets. While the current Complete Streets practices

[24] The Eastern Transportation Coalition is a partnership of 17 states and D.C. focused on connecting public agencies across modes of travel to increase safety and efficiency (ETC, 2022).
[25] The TPIMS information is collected every 15 seconds and provided live to a central feed that can be used by navigation providers such as Google, Waze or DriveWyze.

primarily focus on pedestrian and bicyclist users, they do not have the necessary data to understand the impacts of trade-off decisions made around this area. The representative noted that the DOT is going to participate in future research to better explore this area.

A respondent from Alaska notes that the state's freight is very multimodal with movements being fairly well-defined and compared to other areas of the country, the volumes are low. According to this respondent, the biggest concerns are height or weight restrictions on key routes. The respondent believes that there is a need to modernize the Port of Alaska in Anchorage, from which 90 percent of cargo by volume enters the state.

Lastly, a Tennessee respondent noted that Tennessee DOT practices are influx, and the state hopes to become more proactive in generating commodity flows in the future, but is not there yet.

CHAPTER 5: MINNESOTA STAKEHOLDERS INVOLVED IN FREIGHT AND PLANNING

5.1 METHODOLOGY AND DATA

The research team conducted individual and group semi-structured interviews with stakeholders involved in freight planning in Minnesota to identify gaps in current data sources and user experiences with public and private freight data, and to capture current and future data needs. Researchers used a snowball sampling methodology to identify stakeholders involved in freight planning in Minnesota. The research team conducted a total of 12 interviews with 15 individuals, representing 10 organizations. Stakeholders interviewed for this report include planners and practitioners from the public sector including the Minnesota Department of Transportation (MnDOT), the Minnesota Department of Employment and Economic Development (DEED), and the Metropolitan Council, two nonprofit organizations (Greater MSP and American Transportation Research Institute -ATRI), as well as from the private sector including Quetica, SRF Consulting Inc, Access to Solutions, and HDR. The research team also interviewed MN State Legislators involved in transportation decision-making and MN State Legislature research staff. The interviews were conducted online (through Zoom).

The research team interviewed stakeholders that MnDOT's freight office does not regularly interact with regarding commodity flow data. Initially, the research team tried not to interview stakeholders already involved in several freight processes (such as the State Freight Plan, State Rail Plan, the Freight Network Optimization Tool effort, and District Freight Plans) including members of the Minnesota Freight Advisory Committee (MFAC) and MnDOT's freight office staff. However, some members of MFAC were interviewed as some interviewees referred us to them due to their freight work.

5.2 INTERVIEW FINDINGS

Interviewees discussed several gaps in current freight flow data sources, their experiences with the use of public and private freight data sources, and current and future data needs.

5.2.1 Gaps in Freight Data

Most interviewees use public and private freight data as part of their daily activities and identified several gaps in freight data. These gaps include lack of geographic granularity,[26] inaccurate information

[26] Geographic granularity refers to the extent to which data can be broken down to smaller geographic levels, for instance, to the county or city level.

of commodity flow for some industries, reliance on data modeling, lack of commodity data across transportation modes, and other data limitations specific to transportation modes.

First, several of the interviewees brought up geographic granularity as a limitation of public data sources. While data granularity at the state level is better at providing an overview of freight flow in the state, at the county, district, or subregional level the commodity flow data is very inaccurate. For instance, the Freight Analysis Framework (FAF) dataset is not useful for metropolitan level planning due to its limited geographic granularity and because it is hard to disaggregate. In addition, at the local level, the value of goods is not very reliable nor accurate for this data source.

Some private data sources provide more geographic granularity but bring other limitations. For instance, Quetica conflates shipping records (BOL) to commodity-based data sources such as Transearch and FAF. This can help determine which commodities are moved across localities. However, given that BOL are based on stratified sampling, the sample size and sample bias affect the statistical validity of the sample (which is currently unknown). In addition, given the sampling methods, it could be possible that some commodities may be better represented than others. Similarly, while Transearch is useful for understanding freight movement at the county level, there are limitations with this dataset. First, this dataset is cost-prohibitive to use. Second, it only includes North American flows and excludes imports and exports to other countries. Lastly, all Transearch datasets are estimates from models and are not based on real data.

Second, some interviewees discussed limitations related to out-of-scope commodities[27] in public data sources. These data sources may provide inaccurate information with regards to the commodity flow of certain industries such as agriculture and retail that may have a significant amount/volume of shipping activity and may be an important revenue source for the economy of a state. For instance, information from the Commodity Flow Survey (CFS) attributes most of grain freight activity to states like Texas, Washington, and Louisiana, while based on information from the U.S. Department of Agriculture, top grain producers are the states in the Midwest (including Minnesota).

Third, some interviewees discussed limitations due to the reliance on data modeling rather than on real data. This limitation was brought up for Transearch, FAF, and the National Performance Management Research Data Set (NPMRDS). Regarding FAF, an interviewee noted that the routes and modes are based on modeling because shippers (those surveyed) have good information about the commodities transported but not about the routes and modes. However, the interviewee also noted that there is potential for improving this data source through blending it with the Vehicle Inventory and Use Survey (VIUS) when it is revived.[28] With regard to NPMRDS, an interviewee noted that old guidelines did not

[27] Out-of-scope commodities in the CFS include farm-based, fishery, logging, municipal solid waste (MSW), construction and demolition (C&D) debris, retail, service, crude petroleum, natural gas, and foreign trade shipments as well as household and business moves (HH&B) (FHWA, 2020; BTS, 2022).

[28] This survey was discontinued in 2003. The Bureau of Transportation Statistics has announced the return of this survey in 2022 (BTS, 2022).

allow data imputations, but new guidelines allow it and now this data source has a lot of modeling built into it.

Fourth, several interviewees brought up commodity granularity as a gap. Overall, commodity granularity is crucial for states to understand the movement of key commodities and inform investment decision-making. According to some interviewees, more commodity-specific data and data analysis will be needed to help determine/forecast shortages and to understand the flow of raw materials coming into Minnesota and the final products going out of the state.

Commodity granularity was also identified as a gap across most modes, especially for air and waterways modes. According to the interviews, commodity-specific data for air freight is limited in current public and private data sources. This is attributed to the proprietary nature of cargo data. In addition, they highlighted instances where efforts to get more detailed commodity information are limited given that some carriers like FedEx and UPS are not required to have a Bill of Lading (BOL). Similarly, some interviewees pointed out the data gaps on waterways. They highlighted the need for more accurate detailed data on commodity flows on inland waterways. While the Marine AIS transponder information has some overall activity data, it does not contain information about the commodities being carried. Some of the commodity flow can be estimated with the Army Corps of Engineers data, which gives annual estimates of tonnage or value by type of commodity. The FAF can also provide some commodity information, but this data source is not very reliable for non-highway modes.

Lastly, interviewees brought up other data limitations of the existing databases specific to each transportation mode and provided examples of shortcomings of certain data sources unique to both rail and truck freight modes. In terms of rail freight, one interviewee noted that they currently use the STB waybill data for statewide rail plans. However, they highlight that these data represent a small fraction of the rail commodity flow data that can be useful for specific locations of intermodal facilities.

In terms of truck freight, interviewees highlighted issues with some of the existing data sources such as StreetLight, ATRI, NPMRDS, and VIUS. For example, one interviewee noted that current GPS truck data must be scaled up[29] or made assumptions to get full estimates.[30] Regarding Streetlight, an interviewee mentioned that the data do not have persistent truck IDs and it is hard to determine the full trajectory of a truck. StreetLight assigns a new truck ID whenever a truck does not move for over five meters in five minutes. Another limitation is that the StreetLight dataset does not provide information on commodity types. Similar to StreetLight data, ATRI does not provide information on commodity type,[31] however, it

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[29] Scale up refers to increasing the sample size.

[30] Interviewees noted that more robust real-time data will be needed in the future with increasing demand for information about trip generation for trucks. According to an interviewee, it would be ideal to have the exact number of trucks arriving and departing certain areas, their final destination, and speed. Second, there is a need for data about the trajectory of trucks coming in/out of the region.

[31] ATRI is currently experimenting to crosstab GPS data with commodity data from the FAF. According to an interviewee, this blending will provide more accurate data for planning and trend analysis. However, they also

has persistent truck IDs.[32] Regarding NPMRDS, an interviewee mentioned that the dataset includes not only freight trucks, but also commercial vehicles which inflates their "truck speed" data, while also relying heavily in data modeling and data imputations,[33] which degrades the reliability of the dataset. Lastly, the Bureau of Transportation Statistics is bringing back the VIUS. However, this data source has not been updated since 2003 and would have a two-decade gap in data.[34]

5.2.2 Freight Data Needs

Interviewees also identified current and future freight data needs (new freight information or statistics that are desirable and should be collected), discussed some studies that could be performed using freight data, and identified opportunities where freight data and analyses can be used.

Waterways freight data needs: Some interviewees noted the need for more data for waterway studies to make long-term investment decisions. Interviewees highlighted the congestion in ports and supply chain issues accentuated by the COVID-19 pandemic. According to one interviewee, while current freight movement on inland waterways seems cost-prohibitive, there is a need for more data and research on alternative options including moving shipments through inland waterways as a potential solution.

Air freight data needs: In terms of air freight, interviewees discussed the need for commodity-specific data to identify cargo movement gaps. One example commonly cited by interviewees was the lack of commodity-specific data for the transportation of medical technology and products. Currently, raw materials come to Chicago and are transported via trucks to Minnesota. Similarly, the final products are being transported to Chicago via trucks, which are then flown to Europe. With more detailed data about the type of products and their final destinations, freight experts hope they can cut the truck trip to and from Chicago.[35] However, obtaining the data is challenging as private companies (shippers) are not willing to share these data due to their business interests.

Equity considerations in freight transportation: Some interviewees discussed that equity considerations in freight transportation are becoming more important in recent years. For instance, an interviewee expressed concerns about the transportation of oil and hazardous materials in densely populated areas

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noted that the blending for Less Than Trucks will be problematic as there could be multiple types of commodities in a truck.

[32] Freight analysts, for instance, have used this dataset for truck parking studies.

[33] Data imputation refers to the process of replacing missing data with substituted values.

[34] The 2021 VIUS is a survey of 150,000 vehicle owners of class 1 through 8 trucks. The survey will be conducted from February through October 2022 and the results will be released in Fall 2023 (BTS, 2022) (BTS, 2012).

[35] As part of these efforts, the Global Wellness Consortium (GWC) has created a partnership with a regional airport in the Golden triangle (Frankfort, Paris, and Amsterdam) to run a pilot cargo line from Liege to MSP, and back with medical technology and products. To accomplish this, there is a need for more detailed data about type of products and their final destinations for instance.

and methods to ensure safe transport of these commodities. Another interviewee mentioned that the current rail plan in Wisconsin is focusing on equity and outreach, with emphasis on the impact of rail on the populations within close proximity to the rail facilities.

Freight transportation and climate change: Some interviewees discussed the importance of looking at the use of renewable energy in freight transportation becoming more prominent as a result of the recent UN Climate Summit. Some topics that could be analyzed include the carbon footprint of transporting specific commodities, trends of mode shift toward sustainable freight transportation, and the electrification of trains and the fleet of trucks.

In terms of the analysis of mode shift, interviewees highlighted the importance of considering changes in market demand. According to information from the interviews, while rail seems to be more favorable in terms of energy efficiency, it may not be suitable for all freight movement. In particular, the rise of e-commerce in recent years, demands faster and on-time deliveries that the rail industry cannot meet.

While some interviewees believe electric vehicles may be promising, they raised some concerns that would need to be incorporated in the analysis. These concerns are related to the energy sources utilized to power electric vehicles and the existing capacity. For instance, one interviewee noted that most of the electricity in Minnesota is generated from natural gas and nuclear power, while a small percentage is generated from renewable sources such as solar and wind. In addition, according to this interviewee, while hydrogen power has the potential to resolve these issues, currently, the existing resources/infrastructures cannot support mass electrification of vehicles. The interviewee also brought up an example of a trucking company's attempt to develop a truck terminal with charging stations for 50 trucks in the City of Peoria, Illinois. According to the interviewee, the city did not approve the plan as the charging stations would draw more electricity than the entire city.

Freight data to inform decision-making: Interviewees discussed the need for freight data to inform decision-making regarding economic development, funding prioritization, and commodity shortages.

First, in terms of economic development, interviewees highlighted the need for information to attract businesses into the region. On the one hand, economic development organizations need information about supplier connections to identify gaps in regional linkages and thus attract targeted businesses that address gaps in the supply chain. On the other hand, economic development organizations need freeing information to inform site selection. Some of the data needs will come from conversations with private investors and will depend on their needs, but some of the information identified includes freight facilities/services within a certain distance (miles/time) from available properties, understanding rail routes and air cargo routes.

Second, in terms of funding prioritization, interviewees mentioned freight data that could inform general transportation decision-making. Some interviewees mentioned that typical freight considerations in decision-making are related to the value of time and cost to individual drivers and vehicles, but not related to the commodity being transported. Similarly, some expressed interest in knowing the economic value of transportation infrastructure improvements (such as highways and regional airports) related to the commodities being transported.

Several interviewees specifically refer to developing concerns regarding the regional balance in the Corridors of Commerce program, especially the funding division that benefits metropolitan area projects over those in Greater Minnesota. Currently, there are some discussions about adjusting the scoring criteria[36] and interviewees highlighted the freight as a key component for this program, in addition to the need to consider more freight information as part of the decision-making process. Lastly, interviewees highlighted the need for commodity freight flow data to identify commodity shortages.

Additional Freight Analyses: Some interviewees highlighted the need of creating freight analyses with data currently available. Additional studies that could be conducted include weight relative to value per corridor.

5.2.3 Approaches to Engage Private Companies to Fill Freight Data Gaps

Interviewees emphasized the importance of engaging private companies to address data gaps. However, they noted the hesitancy of private companies to share their data with public organizations as a limitation to address data gaps. According to one interviewee, this hesitancy can be attributed to three factors: First, the private sector is afraid their data will fall into the hands of their competitors. Second, they are afraid their data will be used against them in some way in litigation. Third, they are afraid the government will use their data to create new regulations or come up with policies for modal diversion. This interviewee noted that if the government guarantees that private sector data will not be used in these three ways, they would be more likely to share their data. However, currently with the Freedom of Information Acts (FOIA) in place, they are in a vulnerable position.[37]

In addition, interviewees highlighted the importance of earning the trust of private companies. According to them, building that trust requires ensuring that private data would be kept confidential and not shared in any way that would put the company at risk as well as explaining the benefits the private company will get for sharing their data. One successful example brought up by an interviewee involved the Greater MSP and Metropolitan Airports Commission. The organizations were trying to determine gaps in nonstop service from Minneapolis-St. Paul airport to key destinations around the world, which required passenger movement data. However, airlines were not willing to share the data for proprietary reasons. The organizations set up the Regional Air Service Partnership (RASP) as a third-party neutral group to gather data from private companies and keep it confidential within the group. The data was used to create new route services where nonstop service gaps were identified, which benefited the

[36] As of January 2022, the scoring criteria include (i) return on investment, (ii) economic impact, (iii) freight efficiency, (iv) safety improvements, (v) regional connections, (vi) policy objectives, (vii) community consensus, and (viii) regional balance (Minnesota Statutes, 2021; MnDOT, 2022). The component of efficiency in the movement of freight includes measures such as the annual average daily traffic and commercial vehicle miles traveled, and measures of congestion (or travel time reliability) (Minnesota Statutes, 2021).
[37] The Freedom of Information Acts (FOIA) allow for full or partial disclosure of information from public agencies with some exceptions.

private companies. Such an example shows the potential for data sharing in a similar manner to identify cargo movement gaps.

CHAPTER 6: CASE STUDIES

This chapter presents best practices in generating and collecting freight data based on case studies of state freight practices. We first present the methodology and data used for the analysis, then we present case study findings. Lastly, we summarize best practices.

6.1 METHODOLOGY

Case studies were selected based on the literature review and suggestions from the TAP members. A total of nine states were selected for the study. Selected states include states within the Great Lakes region, a neighboring state, and coastal states. States within the Great Lakes region were selected as they share economic and demographic commonalities with Minnesota. This includes Wisconsin, Michigan, Illinois, and Ohio. Iowa was selected as a neighboring state. Coastal states were selected due to their heightened freight activity. This includes Florida, California, Maryland, and Delaware. Both Florida and California were selected as these are home to two of the busiest ports in the U.S. and some of the world's leading import and export locations. The states selected as case studies were also identified by ATRI as states with the strongest freight plans. Table 6.1 presents an overview of freight movement in selected case studies.

Table 6.1 State overview of freight movement

State	Measure	Truck	Rail	Water	Air	Pipeline	Total
States in the Great Lakes Region							
Michigan	Tonnage	57.79%	19.10%	5.10%	0.03%	17.98%	734,766
	Value	85.73%	9.21%	0.06%	1.33%	3.66%	$900,638
Illinois	Tonnage	64.75%	9.47%	6.70%	0.08%	19.00%	1,157,639
	Value	83.76%	2.63%	1.81%	6.87%	4.92%	$1,282,504
Ohio	Tonnage	65.70%	6.89%	6.43%	0.03%	20.96%	906,710
	Value	89.91%	2.63%	0.60%	2.14%	4.73%	$946,233
Wisconsin	Tonnage	80.29%	11.69%	0.52%	0.01%	7.48%	561,379
	Value	94.09%	2.20%	0.01%	2.01%	1.70%	$490,739
Iowa	Tonnage	72.05%	8.74%	1.26%	0.01%	17.94%	627,115
	Value	87.79%	4.23%	0.52%	1.12%	6.34%	$335,535

Coastal States							
California	Tonnage	75.65%	5.30%	3.26%	0.16%	15.63%	1,299,016
	Value	83.93%	2.94%	1.16%	9.00%	2.97%	$2,247,464
Florida	Tonnage	83.07%	6.58%	2.31%	0.07%	7.96%	790,456
	Value	88.60%	2.35%	1.32%	6.14%	1.59%	$834,383
Maryland	Tonnage	79.32%	7.87%	1.12%	0.02%	11.68%	274,279
	Value	91.94%	3.88%	0.16%	1.93%	2.10%	$311,064
Delaware	Tonnage	35.12%	4.86%	1.15%	0.07%	58.81%	133,773
	Value	90.09%	4.15%	0.56%	1.54%	3.66%	$76,086

Notes: *The above table contains both tonnage and value amounts for shipments within, outbound, and inbound for selected states. In addition, these totals include shipments by trade type, such as domestic only, import, and export.*
Source: *Freight Analysis Framework Data, Version 5, 2020*

The research team conducted a document analysis and in-depth interviews with relevant stakeholders across the case studies. First, the research team analyzed publicly available documents from each state such as state DOT websites including state freight plans, freight studies, and Freight Advisory Committee (FAC) websites and minutes. Second, the research team developed an interview questionnaire and conducted interviews with state DOT representatives, freight coalitions, and MPOs. The research team conducted a total of 11 interviews. All interviewees were involved in their state's freight efforts in some capacity. Information from Wisconsin is solely coming from the document review as the research team was unable to interview a representative from the state's freight planning department.

6.2 DETAILED FINDINGS OF CASE STUDIES

This section presents detailed findings from the case studies. For each case study we present information on their freight planning practices, data collection practices, freight advisory committee, and freight collaborations. Case study findings from the states in the Great Lakes region are presented first, followed by Iowa, and the coastal states.

6.2.1 States from the Great Lakes Region

The Great Lakes region is an economic powerhouse and significant contributor to the U.S. economy. The Region comprises the states of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin in the U.S. and the province of Ontario in Canada. Home to approximately 107 million people, the Great Lakes region sees the majority of trade across the Canadian border, with approximately 50 percent of the nation's exports to Canada flowing through the region and 30 percent of the total economic activity between the U.S. and Canada occurring in the region. Driven largely by the significant number of waterways, locks/dams, and ports in this region; close to 300 million tons of cargo is moved through the region annually, underscoring the enormous need for efficient transportation of freight in, out, and through the region. Of the cargo that moves through the Great Lakes, approximately 80 percent is dry-bulk commodities (such as iron ore, grain, stone, and coal) and the remaining 20 percent being a mixture of non-bulk commodities (such as finished products, containerized cargo, and liquid products) (U.S. Department of Homeland Security, 2014).

While many of the efforts to analyze freight data occur in siloed state boundaries, there are cross-state groups that include states in the Great Lakes region that are established to collaborate on freight issues. The following are groups in the area:

- Great Lakes Regional Transportation Operations Coalition (GLRTOC): Includes Michigan's neighboring state DOTs (Illinois, Indiana, Wisconsin, and Minnesota), and toll authorities in Indiana, Illinois, as well as the province of Ontario, Canada.
- Mid-America Freight Coalition (MAFC): Includes the states of Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.
- Transportation Border Working Group: Formed by the U.S. Department of Transportation and Transport Canada to increase the coordination between these two countries on transportation along the shared border.

These groups are important not only in the coordination of multi-state projects, but also for freight data sharing. MAFC member states, for instance, are currently developing cost-sharing strategies to reduce data costs for individual states. A strategy that is being discussed is the group purchase of Transearch data. Similarly, some MAFC states are working together to develop a real-time truck parking information management system (TPIMS).

6.2.1.1 Wisconsin

Wisconsin's first statewide freight plan was published in 2018 and an updated version is slated for 2022. The statewide freight plan contains a multimodal overview of freight for the state. However, WisDOT also publishes a separate rail plan that is updated every five years as well as an airport plan that was last published in 2015.

DATA COLLECTION PRACTICES

The Wisconsin Department of Transportation (WisDOT) uses a variety of data sources for its freight planning purposes. WisDOT uses Transearch and FAF as multimodal databases. For trucks, they also use ArcGIS, and Traffic Operations and Safety Lab (TOPS) data from UW-Madison, which uses NPMRDS data on travel speed and travel time to examine freight mobility in terms of reliability, speed, and recurring highway bottleneck locations. They also rely on internal crash counts for total truck crashes. For rail, they use STB Waybill and data from the American Association of Railroads (AAR) to examine total carloads and tonnage. WisDOT also uses USACE data for ports and FAA data on enplanement totals for air. For pipeline data, WisDOT also relies on FAF data which shows estimates of total freight tonnage by pipeline. WisDOT has noted, however, that the data itself is only useful for providing an overview of pipeline freight, but not for understanding county-to-county pipeline freight flows (WisDOT, 2018). Lastly, they use U.S. Census data, data from the ACS, InfoUSA data for demographic and economic data, and data from the U.S. Bureaus of Economic Analysis (BEA) and Labor Statistics.

WisDOT also engages in some in-house data collection efforts. For instance, for the development of its Wisconsin Rail Plan 2030, WisDOT administered an online survey to stakeholders and the general public for input on rail issues and needs to collect further information on the state of the railroad industry in the state (WisDOT, 2010). The survey contained 11 multiple choice questions related to inner-city passenger, freight, and commuter rail as well as an open-ended question where respondents can provide any input they deem necessary. The survey garnered 5,300 responses in total in which responses came from every county in Wisconsin. This survey is not an ongoing initiative, rather, it was an effort developed specifically for the Wisconsin Rail Plan 2030.

While WisDOT uses data sources to examine freight and its impact on the economy, it has also noted that these data sources are often incomplete and outdated. In its 2018 freight plan, WisDOT relied on freight and economic data from 2009 to 2013, specifically 2009 data on state GDP, 2013 Transearch data, and 2012 IMPLAN data[38] on Wisconsin's top employment by industry.

Data collected in-house are used for a variety of analyses, such as a measure of traffic movement or congestion levels using a level of service (LOS) performance threshold. WisDOT also developed its own Statewide Travel Demand Model (TDM) – "this model provides forecasts for trucks on Wisconsin roadways. The database estimates the tonnage productions based on the employment within the traffic analysis zone level in Wisconsin, and at a larger aggregate zone level outside of the state using estimated trip attraction rates from Transearch" (WisDOT, 2018). Similarly, WisDOT has developed its Mobility, Accountability, Preservation, Safety, and Service (MAPSS) performance improvement program that evaluates WisDOT's transportation system's effectiveness on a variety of both freight and passenger transportation measures, such as highway maintenance and the presence of adequate bicycle paths on rural roadways.

WISCONSIN FREIGHT ADVISORY COMMITTEE (FAC)

WisDOT established its state Freight Advisory Committee to "help inform the department on issues that impact freight mobility and to provide a voice for the freight sector on the development of freight-related policies, processes, and projects" (WisDOT, 2022). The FAC serves a strictly advisory role and

[38]IMPLAN data include information from the Transportation and Warehousing sector, Information sector, and Utilities and Energy sector.

members provide guidance and help identify potential issues with the freight plan. Because of the strictly advisory nature, there is no formal involvement from FAC members in project selection.

FAC's membership is by appointment of the Secretary (WisDOT, 2017). Individuals can submit a request for Committee membership through the Administrator of the Division of Transportation Investment Management (DTIM) or by nomination of current members. The Secretary reserves the right to add or remove members to maintain or enhance the functioning of the FAC. Each member serves for a period of two years.

The FAC consists of a representative cross-section of public and private sector freight stakeholders. This includes representatives from a variety of industries (agriculture, logistics, warehousing, manufacturing, construction, and energy); representatives from transportation modes (trucking, oversized/overweight, class I and short line railroads, ports/harbors, and air cargo); academia; and representatives from local governments (counties, towns, cities and villages, and MPOs), tribes, and state and federal agencies (WisDOT, 2022). As of January 2022, there were 43 FAC members of which eight were ex-officio members, three were to be determined, and one was to be recruited.

The non-chartered FAC meets about twice a year. The programming includes general updates from FAC members' respective sectors and organizations as well as presentations about emerging and ongoing freight issues, such as COVID-19's impact on the freight industry.

In 2017, WisDOT created an Intermodal Subcommittee co-chaired by WisDOT and Wisconsin Manufacturers & Commerce (WisDOT, 2019). The subcommittee's goal is to identify current and future opportunities and challenges to connect Wisconsin industries to world markets. Members include the University of Wisconsin; Wisconsin's Departments of agriculture, transportation, and economic development; representatives of private companies, transportation modes, and municipalities in Wisconsin; as well as Canadian railways.

FREIGHT COLLABORATIONS

WisDOT is a member of many collaborative freight agencies such as MAASTO, MAFC, GLRTOC, Lake Michigan Interstate Gateway Alliance (LMIGA),[39] Upper Mississippi River Basin Association (UMRBA),[40] and American Great Lakes Ports Association (AGLPA).[41]

[39] The Lake Michigan Interstate Gateway Alliance is a voluntary organization with active member participation from WisDOT, IDOT, MDOT, the Indiana DOT, the Illinois Tollway, the Indiana Toll Road Concession Company LLC, and the Skyway Concession Company LLC.
[40] The Upper Mississippi River Basin Association is a regional interstate organization formed by the governors of Illinois, Iowa, Minnesota, Missouri, and Wisconsin to coordinate river-related programs and policies
[41] The American Great Lakes Ports Association represents the interests of 12 commercial ports and port users on the U.S. side of the Great Lakes.

6.2.1.2 Illinois

The Illinois State Freight Plan, which was most recently published in 2017, will be updated by the end of 2022. This effort is led by one staff member in the Bureau of Planning who manages a team of consultants contracted to develop the plan update. Cambridge Systematics is the primary consultant but several other subconsultants have also been assigned various tasks under the contract, which has a duration of two years. The 2022 State Freight Plan will include nine freight plans at the district level as well as 102 county profiles. In total, the development of the 2022 freight plan will cost approximately $2.8- $2.9 million (excluding data costs).

In addition, the Bureau of Planning recently developed an aviation plan and waterway plan, and is also working on a rail plan update, an aviation plan, and a pipeline study.

DATA COLLECTION PRACTICES

The Illinois Department of Transportation (IDOT) relies on a variety of multimodal and single modal data sources for its freight analyses and freight planning. Freight data sources utilized by IDOT for the 2017 Illinois State Freight Plan included FAF for truck, STB Waybill for rail freight, Transearch for water, and the T-100 air database for air freight. For the 2022 freight plan update, IDOT is primarily using Transearch data, however, they are also gathering FAF and STB Waybill data as supplemental sources. IDOT currently has a contract with renewal options that will allow the acquisition of Transearch data for up to four total years, which should help them prepare for the next freight plan update. Lastly, IDOT utilizes the NPMRDS data for determining truck bottleneck locations.

In addition to external data sources, IDOT collects some data in-house, such as truck count data. IDOT asserted that a key focus is on promoting more stakeholder outreach in the future, as a way to verify data being gathered and gain a better understanding of what the data are showing, in order to plan more effectively.

The IDOT representative noted that it would be desirable to validate the data by comparing it to another data source. However, this can be difficult as even if more than one data source is available, they often use different approaches of data collection methods. According to the representative, it may seem intuitive to use data sources that are developed specifically for one freight mode to get the most comprehensive information, but these data sources can be incomplete and may not complement each other which can create inaccuracies when combining them together for a total freight analysis. Therefore, it is hoped that using one data source for all modes, such as Transearch, will improve the accuracy as any anomalies will have already been reviewed and corrected, if necessary.

ILLINOIS STATE FREIGHT ADVISORY COUNCIL (ISFAC)

The Illinois State Freight Advisory Council was established in 2013. ISFAC has no official charter but was established to provide a standing forum for the coordination of freight multimodal planning in the State of Illinois. The IDOT representative noted that the primary purpose of the makeup of the ISFAC is to involve as many freight organizations and companies as possible in the development of the state freight plan and other freight initiatives.

ISFAC members provide guidance and opinions on freight trends and challenges and discuss freight issues that may need to be incorporated into the state freight plan. In addition, ISFAC members provide input on project selection. For instance, IDOT conducted a call for projects in 2017 for internal, district or external projects for the freight formula funding they received from the federal government under the FAST Act. By involving ISFAC, IDOT garnered knowledge of the projects most relevant to the industries and agencies represented by its FAC.

ISFAC brings a mix of freight experts from all modes. Representatives include railroad, port, and airport operators; and trucking firms; freight shippers and receivers; economic development organizations; public sector representatives; academic and professional organizations; and representatives from manufacturing, agriculture, and energy sectors. As of May 2022, ISFAC has 34 members and meets quarterly, though this membership number is not fixed and can fluctuate.

FREIGHT COLLABORATIONS

Primarily, Illinois is a part of the MAFC and through this channel, interacts with and collaborates with the other nine states that are also members of MAASTO. In addition to its membership in MAFC, Illinois participates in various workshops and peer exchanges that often involve states outside of the MAFC area.

6.2.1.3 Michigan

The Michigan Department of Transportation (MDOT) published its first statewide freight plan in 2017. In addition, single-modal plans are also published but updated less frequently than the statewide freight plan. Historically, Michigan's statewide freight plan and its single modal plans have been separate documents. However, the state was the first one to incorporate all three plans: the long-range plan, state freight plan, and rail plan into one main plan. Its aviation plan is not managed by the freight office, but rather by the state's aeronautics division.

MDOT has two full-time freight planners and used a consultant team to complete their freight plan in 2020. Michigan estimates that about ten other staff in the freight office were called upon with various tasks and requests to complete the plan.

DATA COLLECTION PRACTICES

MDOT relies on several data sources for freight analysis and planning. Overall, Transearch has become the primary multimodal freight data source, while FAF is used to supplement Transearch data and for data validation purposes. Transearch is also used to assess which commodities represent the largest freight shipments moving within inbound, outbound, and through the state. This database is purchased every three years, although the state gets data updates every year. In addition to Transearch, MDOT uses the STB Waybill data for rail freight, the U.S. Army Corps of Engineers for ports, and T-100 for air cargo. MDOT uses INRIX data for truck performance measures and applied software tools like TREDIS to assist in the completion of the freight plan.

MDOT produces a travel demand model that includes a freight model. For this effort, MDOT uses Transearch as the primary source of data as well as ATRI truck GPS data and its own employment database, which provides employment figures, industry categories, and the physical location of businesses throughout the state. Truck movements are assigned with the passenger vehicles on Michigan's network and forecasted for the next 30 years.

Michigan has identified several gaps in the available freight data sources used for trucks, rail, waterways, and air modes and is undertaking efforts to address them.

First, truck data are never entirely complete. Transearch has captured most of the long-haul, heavy truck movements, but some commodities are under-represented, and smaller utility trucks are not included. FAF has similar shortcomings and uses only three zones for Michigan's origins and destinations.

Second, for rail freight, there are limitations with short line movements in the STB Waybill. To address this gap, MDOT collects data through communication with short line rail operators. While some short lines offer portions of their data, some are reluctant to due to privacy issues.

Third, the USACE port database is incomplete because some ports are not required to report to the U.S. Army Corps of Engineers. To address this gap, MDOT representatives directly contact port representatives.

Fourth, for air cargo, MDOT expressed that the data are both unreliable and incomplete. MDOT obtains monthly data from the 18 scheduled-service airports in the state, but as with most air cargo data there are no commodity distinctions. [42] The department then uses T-100 data to supplement their database with information from airports without scheduled service. Discrepancies between reported totals for airports can be confusing, and not all belly cargo may be accounted for.

Lastly, international shipments make up a large portion of Michigan freight, and getting accurate data is difficult from any source. True origins and destinations are difficult to depict, as some are noted by their import/export custom zone, some by their border crossing location, and some by their true physical start and end points.

MICHIGAN'S COMMISSION FOR LOGISTIC AND SUPPLY CHAIN COLLABORATION (LSC)

The Commission for Logistics and Supply Chain Collaboration is the freight advisory committee in Michigan. The LSC was created by Public Act 76 and signed into law in 2013. The LSC operates as a commission rather than as a committee. According to the MDOT representative, this is because FACs

[42] Data compiled into an online database: Measures of Michigan Air Carrier Demand available at https://mdotjboss.state.mi.us/AIRSTATS/AIRSTATSHome.htm

can be difficult to maintain, and an established commission would make the group more formal than a committee. LSC members provide guidance and input on the development of the statewide freight plan and long-range plan in addition to offering knowledge on freight trends or challenges. LSC members are not involved in formal project selection for investments.

The Michigan LSC is chartered and all of its ten members are appointed by the governor. The members represent private businesses from various industries (supply chain/logistics, automotive, healthcare, and manufacturing) and transportation modes, state agencies (Department of Transportation, Department of Agriculture and Rural Development, and Economic Development), and academia. The LSC meets four times a year. These meetings are commonly hosted in Lansing but have also met at freight- significant locations around the state with tours hosted by a private company. Different freight modes have been represented in these tours, and this unique and interactive component of the meetings allows the company to showcase their services to MDOT and other LSC members. MDOT gains greater knowledge, understanding, and appreciation for each freight mode and its stakeholders.

FREIGHT COLLABORATIONS

MDOT is a member of many collaborative freight agencies that also consist of other states and Canada. This assists not only in data collection but also in helping MDOT to better understand the impacts of freight activity in other states and cross-border freight movement on its own transportation system. MDOT is a member of the GLRTOC, MAASTO, MAFC, Northwoods Rail Transit Commission,[43] Eastern Border Transportation Coalition,[44] Transportation Border Working Group, and Public Border Operators Association.[45] Michigan was a leader in initiating the Truck Parking Information Management System (TPIMS) in the MAASTO region.

Most of Michigan's data sharing is with the other states in the MAFC. Much of this is discussion about the state of freight in the region, and some database materials are shared for common projects. Michigan has a long history of data sharing with Ontario, due to several past origin and destination studies completed on both sides of the border. This informal data sharing has been helpful for travel demand modeling efforts and procuring more data for its analyses.

6.2.1.4 Ohio

Ohio DOT published its first freight plan in 2013, which was last updated in 2019. The DOT is currently in the process of updating its statewide plan, which involves four to five main staff members and the Canadian Pacific Consulting Services as the primary consultant and WSP as a subconsultant. This effort will cost the DOT approximately $2 million for an accelerated 18-month timeframe.

[43]Northwoods Rail Transit Commission membership includes 13 Wisconsin and nine Michigan counties
[44] Eastern Border Transportation Coalition membership includes Michigan, New York, Vermont, and Maine; and the Canadian provinces of Ontario, Quebec, New Brunswick, Nova Scotia, Newfoundland, and Labrador.
[45] Public Border Operators Association membership includes Michigan, New York, and the province of Ontario.

DATA COLLECTION PRACTICES

The Ohio DOT primarily utilizes FAF for freight planning, but uses several other single modal data sources to supplement FAF. The DOT uses Streetlight data for trucks, which relies on technology (such as GPS and tracking devices) and provides more real-time data. They also use STB Waybill and data from the American Association of Railroads for rail. In the past, they also utilized Transearch for multimodal freight information and PIERS for waterways and ports. The DOT discontinued the purchase of PIERS given its cost and their limited use of the data source.[46] Lastly, the DOT uses Dunn & Bradstreet for business and economic data. This data source provides information on employment totals, revenue, and other analytics on each business.

The DOT also collects some data in-house for truck freight. For instance, they have their own traffic counts. The 12 district offices constantly collect and update average daily truck traffic by vehicle type. Each district has a schedule to count traffic totals for major roads within a three-year period. These data are all uploaded to the central office's transportation management system and the DOT maintains it. Similarly, the DOT has a statewide travel forecasting model that supports traffic analysis and the benefit-cost analysis and informs the statewide freight plan. This model includes the state and a 50-mile buffer zone. While the model is primarily focused on the highway mode, the DOT is working to build other modes into the model.

The DOT noted several limitations with the data sources they are currently utilizing. First, the Streetlight dataset is expensive and does not have commodity information. This database costs the DOT over $1 million annually.[47] In addition, Streetlight does not have commodity type information. To address this gap, the DOT purchases IHS Global Insights data.

Second, the STB Waybill dataset is based on a small sample of operators. According to the DOT representative, these data are based on a sample that represents one percent of the totality of railroad operators, and then it is stripped down to a point where it is barely usable. In addition, this data source is not free, and the DOT has to purchase it.

Third, air cargo data remains a gap. Information such as how much cargo, type of commodities, and destinations are difficult to get. To address some of these gaps, the DOT collects data directly from airports through targeted interviews with managers, planners, and engineers. Data gathered includes cargo counts and estimates. Although there are 109 general aviation airports in the state, the DOT conducts interviews with the six largest airports given their impact on overall air cargo freight movement. However, despite the additional effort to gather data, data gaps remain for air freight. Overall, freight that travels by air may have a higher economic value per tonnage volume, thus having a significant impact on the economic system and therefore deserving consideration in the freight transportation system.

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[46] According to the DOT representative, this data source was mostly used by their economic team.
[47] The DOT shares that data with their 17 MPOs and six regional transportation planning organizations (RTPOs).

Outreach strategies, such as targeted interviews, have been important for the DOT to understand the needs and challenges of the private sector. The representative highlighted several practices that have been working for them to engage private sector companies. First, approach the interview through the proper channels, such as the company's government relations staff. Second, explain to the private company the purposes of the interview, the reasons why their participation is important, and the benefits for them. Third, identify the correct stakeholders to discuss freight issues. In the DOT's experience, logistics and supply chain staff are crucial, and they are also thrilled to talk with the government about their needs. Fourth, satisfy interview stipulations set by the private company, especially to ensure that information is kept confidential.[48] This includes not recording the interview or writing anything down during the interview. All these practices have led to a rich discussion between the DOT and private companies about the specific needs and challenges experienced by them and how the DOT could address those needs and challenges.

The DOT representative noted that while data gaps exist, the primary issue is that data are underutilized.

TRANSPORT OHIO FREIGHT ADVISORY COMMITTEE

Ohio's FAC is relatively new and was more formally established in 2019 whereas historically, the FAC was more of an ad hoc effort. Though it has been formally established in recent years, it remains unchartered. The Ohio's FAC is tasked with two main functions. First, it guides the DOT through the development of the state freight plan which helps the DOT to have a better understanding of what investments would be most helpful to the freight industry. Second, the FAC serves as a resource for the DOT for additional freight information and data sharing. For example, the FAC can help the DOT better understand the trends and challenges in each mode of freight transportation as well as help economic development agencies understand what transportation infrastructure is needed to encourage new companies to settle in Ohio. While FAC members are not formally involved in project selection, they provide guidance to help the DOT determine which projects will be most helpful in developing more efficient freight movement.

The FAC is mixed and has representation from all sectors of the state and transportation modes. Ohio's DOT has attempted to represent all modes in their FAC by selecting members that represent modal associations, such as trucking, rail, and air associations, port authorities as well as business associations. Representatives from public utilities, academia, economic development agencies, and environmental agencies are also included. However, the DOT has expressed an interest in including more representation from third-party logistics providers and a representative from space organizations, such

[48] The DOT representative noted that in some interviews a consultant was in attendance to assist with the interview and note taking. This allowed for both information capture and confidentiality as the consultancy would not be subject to FOIA for the collected data, unlike the DOT.

as NASA that are in Ohio. The FAC typically meets about three times a year, though the number of meetings may increase during the height of the update of the freight plan.

Overall, the FAC is serving as a resource for the DOT for additional freight information and information sharing. The DOT, for instance, collaborates with the Rail association to try to determine the number of trains moving through the state, the type of commodities transported, or the hazardous material routes.

FREIGHT COLLABORATIONS

Ohio DOT is a member of many common freight Collaboration groups: MAFC, AASHTO, Council of Great Lakes Governors, as well as an intrastate organization called the Ohio Association of Regional Council Freight Working Group. There is some data sharing that occurs within these groups. In particular, the DOT has interviewed states in the past to gather general information about their freight planning practices. For instance, Ohio has coordinated weigh station installation on highways with Indiana to avoid installing weigh stations within only a few miles of each other. However, no continued, formal freight data sharing relationship occurs.

6.2.2 Neighboring States

6.2.2.1 Iowa

Iowa's statewide freight plan is developed completely in-house with two DOT planners. Its most recent published freight plan was released in 2017 and an updated version will be published by the end of 2022. In addition, Iowa publishes an aviation plan with the assistance of consultants every five years, and its rail plan is updated every four years. However, they are training their in-house staff to work with FAF data and further improve staff capabilities to utilize various data sources.

DATA COLLECTION PRACTICES

Iowa DOT uses a variety of data sources for freight planning and analysis. FAF dataset is the primary source of multimodal freight information, but the DOT utilizes some single-mode data sources to validate FAF data. For instance, the DOT uses truck counts and their permitting database on oversize/overweight trucks that contains information about the type of commodities that are being moved, truck heights and weights. Similarly, they use USACE for waterways. The department has also purchased Transearch, but this source is primarily used by consultants to produce the analysis that the DOT requires.

Iowa DOT maintains a statewide travel demand model called Iowa Travel Analysis Model (iTRAM)[49] and a freight network optimization model. iTRAM contains a freight flow model that uses FAF data

[49] The first travel demand model was developed in 2012 and is currently being updated.

disaggregated at the county level to account for freight facility information. The freight network optimization model,[50] developed by Quetica, uses the data from the travel demand model and goes further and has more international shipment information such as BOL and some other datasets to assess commodity movements. The DOT uses these models to inform infrastructure investment decisions.

Iowa also engages in some in-house data collection. For instance, for its freight plan, they have been administering an annual railroad survey since the 1980s to collect railroad data. Railroad companies operating in the state are required by law to fill out the survey with information such as their earnings, the type of commodities they are hauling by NAICS code, investments made by the companies, and their total mileage. In addition to using the survey findings for its freight plan, Iowa DOT produces an annual trend report about the railroads with annual roadmaps that show where goods are moving. According to the representative, the DOT is discussing replicating the state-administered rail survey for trucks. This task is easier to complete for the railroads because there are only 18 of them and the DOT knows the contacts at those railroad companies. For trucks, however, there are many more companies to sample and the best contacts at those organizations are unclear. In addition, Iowa DOT identified bottlenecks in their rail network through a freight mobility survey. This survey was sent to the state's Class I, II, and III railroads, MPOs, regional planning affiliations, and DOT district transportation planners to gather their inputs and identify capacity constraints in 2015 (Iowa DOT, 2021). The same process was used for the 2021 State Rail Plan and 2022 State Freight Plan updates.

The DOT noted that there are some gaps in freight data by route. First, given the data disaggregation and the assumptions they need to make the information is not completely accurate. Second, specific commodity information by route is the biggest gap. According to the DOT representative, having more specific information about the types of commodities companies move, the routes they use, and the facilities they are going to would be helpful for planning purposes and prioritizing investment projects. Lastly, the DOT representative noted that proprietary sources can often be difficult to use and are not always more comprehensive or detailed than free, public freight data sources.

Iowa DOT has also conducted several freight-related studies. For instance, they recently completed a truck parking study that developed an inventory of truck parking spaces, assessed truck movements, and provided recommendations about where truck parking spaces could be constructed or removed (Iowa DOT, 2020; Iowa DOT, 2022). In addition, the DOT is participating in a multistate truck parking initiative with seven other MAASTO states[51] to develop a real-time truck parking information management system (TPIMS). The TPIMS will collect and provide data that will inform truck drivers of available parking spaces at predetermined locations along certain corridors. Iowa DOT broadcasts the information through apps, such as Iowa 511, which eliminates the need for installing and maintaining variable message signs (InTrans, 2012). Lastly, the DOT is also compiling the freight generating facilities in the state. In the late 1990s and early 2000s, the DOT administered a big survey to capture the location of

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[50] This tool is also used by Iowa's state economic development agency to identify development opportunities and target companies to the state.
[51] Other participating states are Indiana, Kansas, Kentucky, Michigan, Minnesota, Ohio, and Wisconsin.

freight generating facilities such as distribution centers. Now the efforts are focused on maintaining and updating that database. For this, they mostly rely on internet searches, knowledge of employees from different parts of the state, and other state agencies that may have that information (for instance, they use grain elevators from the Department of Agriculture).

IOWA'S FREIGHT ADVISORY COUNCIL (FAC)

Iowa's FAC was established in 2012 with the primary goal of guiding the Iowa DOT to foster a multimodal freight transportation system to enhance the competitiveness of Iowa's business and industry. Iowa's FAC serves several key functions including validating the contents of the state freight plan, helping to prioritize projects, providing input on performance measures, advising on ongoing freight trends and challenges and potential solutions, and general information sharing between DOT and industry.

Iowa's FAC is largely a regularly scheduled gathering of relevant private and public sector individuals who have a stake in freight projects and planning. Currently, the FAC has 17 private sector representatives from each of the freight modes as well as key industries in the state, such as the agricultural and energy industries (Iowa DOT, 2022). In addition, there are fifteen ex officio members that represent the public sector, with one representative per state agency, as well as some representatives from federal agencies and MPOs.

Generally, FAC members provide informal guidance on projects and the statewide freight plan. However, individual FAC members and their respective agencies can be called upon for additional assistance in qualifying for funds. For example, a railroad FAC member assisted Iowa DOT in a federal grant application by providing additional data. Iowa's FAC meets quarterly throughout the year, with three meetings held at a central Iowa location, and one meeting held at another location of the state (Iowa DOT, 2022).

FREIGHT COLLABORATIONS

Iowa DOT is a member of the MAFC, however, most of its collaboration and data sharing occurs between state agencies for the purposes of economic development, workforce development, or freight planning.

6.2.3 Coastal States

6.2.3.1 California

The California Department of Transportation (Caltrans) develops the California Freight Mobility Plan (CFMP) that governs state investments with respect to freight movement. In the last update of its freight plan, consultants led the effort to develop the plan, however, Caltrans is focusing on developing in-house capacity to develop their next statewide freight plan. In addition to its main statewide freight plan, Caltrans also develops an air, rail, and pipeline plan due to their modal importance in the state.

DATA COLLECTION PRACTICES

Caltrans uses several data sources for freight planning. This includes FAF as a multimodal data source, ATRI, various FHWA and BTS data sources, and ESRI's HERE data for truck counts, as well as InfoUSA and the American Community Survey (ACS) for business and economic data. In addition, Caltrans gets its waterborne freight data from the U.S. Department of Transportation Maritime Administration (MARAD), while rail data comes from STB Waybill and Association of American Railroads. For air, Caltrans uses data from the Federal Aviation Association (FAA) and tonnage totals from its own conducted air studies (such as the 2013 Air Cargo Groundside Needs Study completed by Caltrans and the Caltrans Airport Forecasting study conducted in 2014 completed by Cambridge Systematics). [52]

Caltrans has developed a travel demand and freight flow model into one model to support freight planning. This model is called the California Statewide Freight Forecasting and Travel Demand Model (CSF2TDM). For this model, they used a combination of the most common public freight data sources. Due to the limited budget, they did not use any proprietary data sources. The freight flow model significantly helped Caltrans better assess freight movement, however, the model itself initially lacked O-D data and accurate truck count. To address this gap, Caltrans installed 96 detector sites statewide that capture truck counts as well as vehicle classifications. Caltrans has also utilized ATRI and Streetlight to fill in trucking data gaps. Despite these efforts, some data gaps remain.

First, there is a need for more accurate and reliable trucking data. On the one hand, Caltrans detector sites are not always operational and data from these detectors are not always being captured accurately. As of March 2022, there are only 29 sites active throughout southern California. On the other hand, when attempting to model total truck freight some calibrations and data validations must be performed as current data sources are not representative. ATRI and Streetlight data sources are based on a few truck fleets. Although Caltrans has collected data both internally and through external sourcing, overall, it still relies on old data for truck volumes.

Second, interviewees identified gaps in the freight data sources currently used for ports. Caltrans has not been able to get sufficient freight data regarding the type of freight flowing in and out of the ports. This is further exacerbated by the fact that many ports in California are privately owned, and private companies are often unwilling or unable to share data with Caltrans. This information is important as California is home to two of the busiest ports in the world that have enormous economic impacts as well as significant impacts on the transportation system.

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[52] The Air Cargo Groundside Needs Study examined the impact on freight facilities caused by future cargo growth. The study concluded that the growth of air cargo necessitates a well-functioning highway system that can ensure trucks are able to access airports in a timely and efficient manner (California Department of Transportation Dept. of Aeronautics, 2020). The Airport Forecasting Study examined the economic impacts of each of California's airports and found that airports can encourage economic growth in areas that are strong economically and that transportation infrastructure that supports airports is critical to the success of the airports and thus the economic health of the region (Cambridge Systematics, 2014).

Caltrans interviewees have also noted that commodity information is lacking in available rail data sources. Given that railroad networks are an important part of freight transportation flows, this lack of commodity information is a significant gap in freight data.

Lastly, Caltrans expressed frustration with the lack of geographic granularity available in the FAF dataset. Currently, FAF data categorizes California into 7 zones, which Caltrans deems insufficient given its large size and geographical variability. Therefore, the state disaggregates the FAF zones into 125 zones and further into 5,500 traffic analysis zones. However, according to the state representatives, the data are not very accurate.

For socioeconomic and demographic data, Caltrans relies primarily on MPOs as they have more granular data on these variables available.

Caltrans has engaged in significant efforts to collect better freight data in the past. In 2016, for example, Caltrans undertook a $7 million project to build out its own Vehicle Inventory and Use Survey (VIUS), which was modeled after the federal VIUS was discontinued in 2003.[53] The CA-VIUS aimed to collect information from private companies regarding their trucking use and habits through a 15-minute optional survey. The project was largely successful and resulted in 15,000 completed surveys for in-state as well as out-of-state trucks. Caltrans representatives stressed that the survey was kept short to keep survey takers engaged and incentives were offered for participation to increase response rate. Primarily, the information provided in the survey was more location-based, however, survey takers could answer optional questions about commodities that are carried via their trucks. Results from the survey were incorporated in the CSF2TDM to help Caltrans evaluate plans and projects that are most beneficial to the environment, economy, and transportation network.[54] The Caltrans VIUS effort has not been replicated since 2016 due to its enormous cost and effort. However, the state expressed interest in an ongoing joint, national data collection effort for the VIUS.

Lastly, Caltrans is currently participating in the NextGen National Household Travel Survey, which will include a freight component to the findings. Although Caltrans will have access to the data as it is contributing to the project, Caltrans has noted that the data are aggregated at Metropolitan Statistical Area (MSA) level and are limited in their use at State and regional levels.

CALIFORNIA FREIGHT ADVISORY COMMITTEE (CFAC)

California has a chartered FAC that is required by state law via Assembly Bill (AB) 14 (Caltrans, 2022). CFAC members are stakeholders from public and private sectors and from varying freight modes. This includes representatives of ports, shippers, carriers, freight-related associations, the freight industry workforce, and local governments (Caltrans, 2022). While Caltrans aims to ensure that all modes of freight transportation and other important freight stakeholders are represented on the CFAC,

[53] The team included Cambridge Systematics, Redhill Group, Franklin Hill Group, Calstart, ATRI, Fehr and Peers, and Inchecks (Cambridge Systematics, 2019).
[54] A non-disclosure agreement must be in place in order to access the data.

membership is not necessarily exclusive. Organizations can join if they desire to and do not have to be specifically invited or appointed by the state.

As of March 2022, there are 81 members on the CFAC, and there is a need for greater rural representation to better serve the needs of the entire state, as noted by a Caltrans representative. CFAC currently meets four times a year and provides guidance on the development of the freight plan. While CFAC members were not involved in any project selection for the last statewide freight plan, Caltrans hopes to involve the CFAC in the project selection process in their upcoming statewide freight plan as well as in greater data sharing.

FREIGHT COLLABORATIONS

Caltrans has worked with the state of Arizona in the development of its freight plan, though no formal data sharing occurs. In addition, Caltrans staff are members of some collaborative freight agencies, such as the Western States Freight Coalition, and several subgroup collaborations such as the Interstate 15 Mobility Alliance, the I-80 Smart Corridor Project, the I-5 West Coastal Green Highway, and the I-10 Corridor Coalition. These agencies collaborate and complete various studies and projects as a group through data sharing on freight movements, improving safety on roads, and improving multimodal transportation. In addition, these groups often emphasize public-private partnerships, stakeholder outreach, and sharing best practices from their states or regions (Western States Freight Coalition, 2019; I-15 Mobility Alliance, 2022; Alameda County, 2022; I-10 Corridor Coalition, 2022).

6.2.3.2 Florida

The Florida freight plan is called Freight Mobility and Trade Plan (FMTP). The last statewide freight plan was published in 2020 and was largely a consultant-driven effort. In addition, FDOT publishes an air and rail plan as well as a maritime support system plan, in which more detail is provided for those freight modes than in the overall state freight plan. Lastly, the state also undertakes several other initiatives on a more frequent basis that contribute to its understanding of freight movement within its borders.

DATA COLLECTION PRACTICES

The Florida Department of Transportation (FDOT) has conducted several studies to determine the advantages and limitations of different freight data sources.

In 2016, FDOT conducted an analysis to compare FAF and Transearch data in the study of freight movements. According to the study, FAF contains more information for the U.S. in its entirety and is best suited for inter-state or multistate analysis, while the Transearch data were developed for and customized specifically for the state. While more commodities are covered in FAF, Transearch has more details on the commodities that are included (4-digit level versus the 2-digit level in FAF). FAF also includes more modes but has less detail on sub-modes, while Transearch distinguishes among sub-modes. The study also notes that both databases have similar limitations. First, they rely on data samples, which may exclude information for certain industries, geographic areas, or commodities.

Second, they use modeling processes in which uncertainty is inherent. Third, assumptions and judgment are intrinsic to the estimation process, which introduces additional uncertainty. Lastly, the study highlights two best practices. First, to treat data as estimates rather than as factual information. Second, to check the flow estimates against other sources (e.g., truck counts at Weigh In Motion -WIM- stations) (RS&H, Inc, 2016).

FDOT also conducted a Freight and Commodity Analysis study in 2021 to establish a consistent, data-driven and repeatable set of procedures to objectively understand the commodity flow patterns at the statewide and county levels (FDOT, 2021). Using the Transearch database,[55] FDOT analyzed freight activity in the state including modal movements that originate and terminate in the state for different commodities. The primary components of this study include import/export information by county and by primary commodity types (2-digit STCC); and forecasts for a 30-year time horizon using the base year 2018.

While FDOT largely utilizes FAF data for its freight modeling and analysis, it complements information using other databases as well as with its own data collection efforts. FDOT also utilizes Transearch data, however, this purchase is typically in the form of analyses conducted by consultants that use Transearch data, rather than purchasing the data source itself.

For single-modal sources, FDOT uses a variety of data sources. For truck freight, FDOT utilizes FAF and Transearch data and supplements with ATRI and weigh-in-motion data. For rail freight, FDOT uses the STB Waybill database and conducts extensive interviews with rail operators about the challenges they face and perceived opportunities. Air cargo is analyzed via FAF data, but state representatives express the need for more detailed freight data for this mode. Lastly, FDOT used the PIERS database in the past for ports but now it supplements information with data collected via the Florida Ports Council that publishes annual reports on total tonnage, Twenty-foot Equivalent Unit (TEUs), and value.

FDOT maintains its freight data efforts through the state's Multimodal Data System Program (MDSP). Within the MDSP, there are a few main data collection programs and ongoing studies that are a part of the effort to solve some of Florida's main freight challenges: the Truck Empty Backhaul study, the Statewide Truck GPS Data Analysis, and the Freight and Commodity Analysis study. Each study represents Florida's independent effort to both understand and improve freight flow movement within the state.

[55] The study also highlights limitations of Transearch data as well as key differences between FAF and Transearch. According to the study, Transearch is the most comprehensive U.S. and cross-border freight database available, and the commodity flow data are developed at the county level. Contrary, FAF commodity flow data are not available at county level geography which makes it difficult to evaluate freight movements at geographies smaller than the state or FAF regions/zones. In addition, FAF is not updated very frequently.

The Truck Empty Backhaul study has been undertaken by Florida in the last several years to improve the efficiency of the freight industry overall in the state (FDOT, 2018). Empty backhaul[56] not only increases supply chain costs and reduces productivity and profitability, but also has environmental costs. The study quantifies truck empty backhaul by using WIM data[57] and identifies potential solutions that could decrease the frequency of empty backhaul in the state. Recommendations include obtaining industry data to better understand the private sector perspective of empty backhaul, considering a partnership with the Florida Department of Agriculture and Consumer Services and the Florida Department of Revenue to identify specific cargo inside truck trailers to better understand commodity movement, and considering a Florida Freight Commodity Survey to understand commodity flows at a micro-level.

Similarly, in 2019, the state undertook the Truck GPS Data Analysis initiative to assess the availability of truck parking, one of the most significant challenges in the trucking industry (FDOT, 2019). While not directly related to freight, the lack of adequate truck parking can create dangerous conditions for truck drivers needing rest along their routes and potentially creates inefficiencies in the movement of freight commodities. The study developed a methodology for the evaluation of truck parking supply utilizing truck GPS data from ATRI and other data sources, such as truck counts from FDOT, property tax records from DOR, and parking supply by location from multiple data sources.

FLORIDA FREIGHT ADVISORY COMMITTEE (FLFAC)

The Florida Freight Advisory Committee is chartered and stakeholders interested in becoming members have to submit an application. Once new members are selected by the Governing Board of the FLFAC, an invitation to join the board is sent by the Florida Governor to make the membership official. FDOT utilizes a cross-sectional approach to assemble its FAC members. FLFAC membership is a three-year cycle, and by committee bylaws, every year and a half, half of the committee members are replaced to welcome new members while retaining half of the members to encourage continuity (FDOT, 2017). FDOT also noted that membership and engagement on FLFAC from the private sector are simplified by the solid relationships that local district coordinators have with those potential members from the private sector. Thus, the district coordinators play an important role in constructing the makeup of the FLFAC.

FLFAC is charged with several tasks. It advises the State on freight-related priorities, issues, projects, and funding needs; serves as a forum for discussion of State decisions affecting freight transportation; communicates and coordinates regional priorities with other organizations; promotes the sharing of information between the private and public sectors on freight issues; and participates in the development of the State's Freight Plan. While FAC members are not involved in any formal project selection process for project selection, FDOT presents proposed projects to the FAC for guidance.

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[56] Empty backhaul occurs when a truck returns only partially loaded or empty after entering the state and delivering consumer goods.

[57] It includes information such as date, time, travel direction, travel lane, truck gross weight, vehicle class, vehicle length, axle spacing and axle weights for each truck that passes through Florida’s WIM stations.

As of March 2022, there are 25 members in the FLFAC. FLFAC members represent major industries as well as other state agencies (such as the department of economic development), local governments, MPOs, academia, and representatives from each transportation mode. Typically, the FLFAC meets twice a year, but there could be additional meetings, especially when preparing the state freight plan.

FREIGHT COLLABORATIONS

Generally, FDOT collaborates with cross-border states on freight plans and trends, however, not much collaboration occurs when federal funding is at stake due to the competitive nature of the fund securing process.

FDOT has also emphasized public-private partnerships through the development of long-term relationships between the agency and the private sector that prioritizes outreach to partners and frequent communication. In this way, FDOT has learned that data sharing is more likely to occur because the private sector understands the motivations for FDOT to collect data and trusts what FDOT will do with the information. In particular, the private sector is willing to share data to inform infrastructure improvements that benefit them.

6.2.3.3 Maryland

Maryland published its first statewide freight plan in 2009, but published its most recent plan, titled the Strategic Goods Movement Plan, in 2017 and will be publishing a new statewide freight plan to be completed in 2022 in accordance with the Infrastructure Investment and Jobs Act (IIJA) requirements. Primarily, its freight planning efforts as well as its other freight data initiatives are supported by "embedded consultants," who are individuals hired by Maryland's DOT as contractors, some of whom are employees of Texas Transportation Institute (TTI), in addition to its smaller staff of full-time state employees.

In addition to the statewide freight plan, MDOT develops separate plans for each mode of transportation. The 2022 statewide freight plan update effort costs about $300,000 with an additional $200,000 paying for consultant assistance.

DATA COLLECTION PRACTICES

Maryland's DOT relied on a variety of data sources for past freight planning and projects. The DOT currently utilizes FAF, T-100, INRIX, and ATRI databases. Though it has used Transearch in the past, the agency does not consistently purchase it due to its cost. The agency typically purchases a year of data and models it for the following years. For example, it first purchased Transearch data in 2003 and modeled it out to 2009. The agency purchased the data again in 2013 and has continued to model it each year, utilizing a growth factor. Currently, Maryland DOT relies on FAF, INRIX XD and INRIX Trip data, as well as the NPMRDS for freight analytics.

In addition to the freight data sources currently used, Maryland also uses information from the Maryland Statewide Transportation Model (MSTM) and a tool recently developed called the Maryland Roadway Performance Tool (MRPT).[58] The MSTM is a tool for forecasting and scenario analysis, while the MRPT helps determine where the needs are. The MSTM model also resulted in the development of the freight flow model that helps analyze the impacts of freight on the state's transportation system.[59]

The MRPT is a new, important tool designed to have better visibility over potential and existing bottlenecks. Maryland's DOT, however, has identified several limitations in their MRPT. It provides INRIX data conflated to the Maryland highway network, which allows the Maryland DOT to assess freight movement in relation to anything else aligned with the highway network, such as pavement, safety, or economic and environmental information. The tool is currently focused on highway data because multimodal data are not readily available. Additionally, the tool includes a commodity value estimate. Commodity data are also not readily available, but this tool helps practitioners understand the commodity value for roadway segments and will incorporate additional commodity intel, such as Transearch information, in the future. As the Maryland DOT builds out this new tool, more data are scheduled to be included, such as environmental and safety data.

Connected supply chain data have also been identified as a data need in freight planning. In particular, Maryland's DOT has expressed interest in leveraging the use of blockchain technology to understand intermodal connections and how bottlenecks impact the transportation system and the efficiency of its supply chain. To progress on this initiative, the DOT has asserted that collaboration with the private sector for supply chain data is crucial but is also a challenge that would need to be addressed in order to conduct this type of analysis.

Maryland is currently working in several areas to improve freight movement. First, Maryland's DOT is undertaking studies to improve the availability of truck parking. Historically, the DOT has done manual counts of truck parking spaces, however, this effort has become more advanced with the recent usage of probe data to assess truck parking to create truck parking performance tools.[60] Second, the DOT continues to work on analyzing freight fluidity, which is measuring trip performance to determine how

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[58] The MRPT was developed primarily as a response to the FHWA's identification of key bottlenecks throughout the U.S. The FHWA's tool did not have accurate information for Maryland. The MRPT tool was built using similar ranking criteria to the model developed by the FHWA that assessed bottlenecks as delays per mile by segment and state. The tool allows for more frequent analysis of bottlenecks and thus the state can also update when a bottleneck no longer exists or when a new one appears. According to the state representative, while ATRI also provides a list of bottlenecks, these are locations that ATRI identifies and are not updated as new roadways or bottlenecks emerge.

[59] The freight flow model was developed as a result of a grant and partnership agreement with the FHWA to be a part of the Strategic Highway Research Program 2 (SHRP2) Initiative, which was replaced with the FAST Act. The SHRP2 initiative sought to help states fund transportation research initiatives to "improve safety, enhance productivity, boost efficiency, and increase reliability" on the nation's highway network (Michel & Hutton, 2018).

[60] The Truck Parking Study used INRIX Trip data. Analytics include assessing counts and parking duration, utilization and capacity, origins and destinations and performance statistics for state lots (Katsikides, Schrank, Kong, & Gick, 2021).

efficiently goods are moving in a region. It involves answering questions like: What are the goods? How do they get from point A to point B? What is the route?

The Maryland DOT is cultivating data sharing by investing in connected and automated vehicle and transportation system management operations (TSMO) data platform solutions. This effort will help facilitate emerging technology. One goal is to obtain more freight data that can assist in better freight planning at the state level. Maryland has also expressed that better freight data can improve the selection and prioritization of road projects as is planned by using more data with the MRPT.

MARYLAND'S STATE FREIGHT ADVISORY COMMITTEE (SFAC)

The goal of Maryland's SFAC is to advise the State on freight-related issues and to encourage information sharing between the Maryland DOT and key transportation stakeholders. The SFAC is chartered. To construct the makeup of its SFAC, MDOT aimed to "cast a wide net" to determine stakeholders to be included while emphasizing engagement and participation from SFAC members.

The SFAC is tasked with several primary objectives. These include supporting the state freight plan update; providing feedback on freight project prioritization; advising the state on freight-related priorities, policies, projects, and funding needs; serving as a forum for discussion of transportation decisions affecting freight mobility; communicating and coordinating regional priorities with other organizations; promoting information sharing between the private and public sectors on freight issues; providing recommendations for urban and rural freight corridors; and providing guidance on freight-related performance measures and performance data.

As of March 2022, there are 30 members from a wide variety of public organizations, private companies, regional partners, military, and academia. Representatives from public organizations include federal agencies, state agencies (such as the department of commerce, energy, labor, and planning), local governments, and MPOs. Regional partners include representatives from the DOTs in Pennsylvania, Virginia, Delaware, and West Virginia. In addition, there are representatives from the industry from different transportation modes and associations (Maryland DOT, 2022).

Maryland SFAC typically meets two to three times a year with additional meetings scheduled as needed. These meetings are important channels through which SFAC members can educate and engage Maryland's DOT staff on key freight industries and trends. Although there are no mandates for information sharing, some SFAC members have shared data that help with forecasting and planning purposes. Lastly, SFAC members are not formally involved in project selection but they provide guidance on proposed freight investments noted in the freight plan.

FREIGHT COLLABORATIONS

Maryland DOT's primary involvement in collaborative freight agencies or partnerships is through the development of the Metropolitan Planning Organizations (MPO) freight plans, statewide freight planning, Delmarva freight plan, Eastern Transportation Coalition (ETC) plans and projects, and other cross-jurisdictional efforts. In participating in cross-jurisdictional or regional plans, there is an opportunity to share some data, input, and information. However, when it comes to using large datasets like INRIX or Transearch, these data are often limited to a particular geographic boundary and may not be shareable with other jurisdictions. For example, Maryland may not be able to simply give its purchased data to another state in many cases due to proprietary data sharing agreements. Regional or multi-jurisdictional agencies can purchase data together to cover a larger geography and if every entity has the same data purchased, then these data may be combined. Lack of consistent data purchase and availability can make regional planning difficult.

Maryland is also a member of the Eastern Transportation Coalition (ETC).[61] Members of this coalition have collaborated on several data procurement efforts as part of its Vehicle Probe Project (VPP).[62] This project led to the creation of a multistate traffic data marketplace (ETC-TDM) that is available to the Coalition and all state members and has provided traffic data with a monetary value of over $50 million. In 2022 the coalition completed its third procurement request for information to replace the existing contract and add traffic data specifications, which will improve access to new and emerging datasets. The coalition awarded five vendors[63] to provide a variety of freight-related data including travel time, speed and volume data (as well as reliability), O-D information for long-haul and regional fleets, parking data (including availability and utilization), and commodity movement. Members of this Coalition also have access to FAF disaggregated data (using Cambridge Systematics formula), which includes information from the state as well as neighboring states.

6.2.3.4 Delaware

The Delaware Department of Transportation (DelDOT) publishes its Statewide Freight Plan every five years in compliance with FHWA requirements. Its first statewide freight plan was published in 2015. Since then, it was updated in 2017 and an updated plan will be published in 2022. In addition to its statewide freight plan, Delaware publishes a state rail plan, which is required by the Federal Rail Administration.

DelDOT utilizes a combination of in-house staff and consultants for freight planning purposes. Three of its ten planners are dedicated to the production and publication of the statewide freight plan. In addition, DelDOT partners with the Institute of Public Administration at the University of Delaware for assistance with its statewide freight plan and FAC. This partnership costs approximately $200,000 annually. The Institute coordinates the logistics of organizing the monthly freight meetings as well as manages the freight planning agenda to further the freight plan project.

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[61] Other members include Alabama, Connecticut, Delaware, District Columbia, Florida, Georgia, Kentucky, Maine, Massachusetts, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, and Virginia (ETC, 2022).

[62] The primary goal of this project was to provide the Coalition members with the ability to acquire reliable travel time & speed data for their roadways without the need for sensors and other hardware (ETC, 2022).

[63] Vendors awarded include Future Mobility, Geotab, INRIX, Quetica, and Streetlight.

DATA COLLECTION PRACTICES

DelDOT utilizes a variety of multimodal and single modal freight data sources. The state DOT uses FAF as its primary multimodal data source, although it has also used Transearch. For trucks, DelDOT uses Transearch and FAF to gather information on truck counts and commodities, National Highway Traffic Safety Administration (NHTSA) for truck crash counts, and the CUBE Voyager software package for VMT for trucks. In addition, DelDOT uses American Trucking Association (ATA) data on total truck tonnage and U.S. Census FT-900 data on international shipments. For rail, STB Waybill dataset is used, and waterborne data are gathered from the USACE waterborne commerce statistics dataset and the Navigation Data Center maintained by the Delmarva Water Transport Committee. Lastly, for pipeline data, DelDOT uses the National Pipeline Mapping System dataset, an online GIS dataset created and maintained by the U.S. DOT.[64]

DelDOT also uses a travel demand model and its freight flow model component for freight analysis. The DOT uses the travel demand model for evaluation and selection of projects for investments on highways. This model only has truck data and utilizes the CUBE's Voyager software.[65] Similarly, DelDOT uses the freight flow model for scenario analysis. For instance, if the state loses a rail operator, the model helps analyze the modes that will move commodities. The freight flow model utilizes Transearch data (multimodal data) and the CUBE Cargo product,[66] which allow them to develop maps showing O-D information for freight modes and commodities. The freight flow model has not been updated given its high costs. According to the DOT representative, the current costs of maintaining the model are higher than their use of it warrants.

For DelDOT, the limited geographic granularity in the data is a limitation for freight planning. Particularly, FAF data categorize Delaware as one geographical area, which is problematic as different parts of the state contribute differently to its transportation system. For example, its southern counties contain the majority of its agricultural industry activities, while its northernmost county is the most densely populated and is in close proximity to other major metropolitan areas such as Philadelphia, New York, and Washington D.C., where both the VMT and freight flows increase. To address this issue, DelDOT has purchased and utilized Transearch data in the past. However, while the geographic granularity of these data was at the county level within the state and within 50 miles of the state, beyond 50 miles it was at the state level. In addition, these data would cost them around $100,000

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[64] The National Pipeline Mapping System is a data source that has some public information available, however, an application is needed to access most of the data and applications can only be submitted by government officials or pipeline operators.

[65] CUBE Voyager, developed by Bentley, is a software that allows for both predictive transportation modeling and transportation simulation.

[66] The CUBE Cargo product "models freight movement throughout a city or region to understand the impacts of commodity flows" and contains information on "multiple commodity groups and logistical nodes where transport mode or vehicle may change" (Bentley Systems, Inc, 2022). The approximate cost of this product is $6,000 per year (Virtuosity, 2022).

annually. Given that the state has only three counties, the data were not cost-effective for the state to continue purchasing.

DELAWARE STATE FREIGHT ADVISORY COMMITTEE (SFAC)

The Delaware State Freight Advisory Committee is not chartered. Membership and makeup of the SFAC is fluid as there is no formal standing group. This was intentional as DelDOT prioritized the engagement from as many stakeholders as possible, versus having a smaller, more focused group of selected stakeholders. In total, about 100 people consistently attend the freight meetings. While the SFAC membership has skewed to more public representation in the past, DelDOT is actively attempting to recruit more private sector members. Typically, attendees of the freight summits include mostly private sector companies related to the freight industry, such as railroad operators and companies in private industries. However, meeting information for the freight summits, such as the zoom link, is posted to DelDOT's freight website allowing anyone to attend.

The SFAC meets twice a year via a Winter and Summer freight summit with presentations on current and emerging freight issues on a wide variety of topics. Past freight summits have included presentations on the impacts of technology on freight logistics, the growing beer brewery industry in Delaware, and when applicable, updates on the statewide freight plan. Delaware SFAC serves as a source of information for DelDOT to understand its key industries as well as the reasons those industries are in Delaware and continue to operate in the state, and the challenges they face that DelDOT should be aware of. The Delaware SFAC is not involved in any formal project selection. In addition, the DelDOT SFAC has noted in its published 2017 statewide freight plan that it intends to involve the SFAC in a greater capacity for inputs on potential grant opportunities for projects.

FREIGHT COLLABORATIONS

DelDOT's primary involvement in collaborative freight agencies or partnerships is through the development of the Delmarva freight plan, which is developed in collaboration between Delaware, Maryland, and Virginia. The Delmarva freight plan was initially developed as a response to the interest in understanding the impacts of the interconnectedness of the region's economies and transportation systems. To develop the freight plan, each state shares some data with one another; however, full data sharing is not permitted due to restrictions in sharing of proprietary data sources.

DelDOT has also worked with its MPOs and the Wilmington Area Planning Council (WILMAPCO) in the Delaware First/Final Mile Freight Network Development project (CPCS, 2021). This project identified additional first/final mile routes using several data sources including the location of freight-related businesses, truck GPS tracking records, and stakeholder feedback on specific needs collected through an online mapping tool.[67] Some of the issues identified through the study include institutional problems

[67] An initial network was identified using data from Reference USA, land use and zoning data from the state, Google Earth satellite images, INRIX truck GPS tracking data, and ESRI Network analyst road network files.

related to the difficulty of coordinating freight investments between multiple levels of government; land use problems related to freight routes passing through residential areas; mobility problems related to seasonal and heavy truck traffic; safety problems related to the co-location of truck routes alongside bicycle and pedestrian facilities; and condition problems related to the poor condition of the transportation infrastructure.

6.3 BEST PRACTICES IN GENERATING AND COLLECTING FREIGHT DATA

This section presents common and best practices in generating and collecting freight data based on the case studies. The research team identified two state common and three best practices based on the case study findings. Common practices include identifying freight data needs and identifying limitations of current freight dataset. Best practices include utilizing available data sources to address freight data needs, identifying appropriate data collection methods, and collaborating with other states to share freight information.

6.3.1 Common Practices

6.3.1.1 Identify freight data needs

States discussed the need for updated information and data to close the gaps of existing data sources. In addition, they noted the need to identify freight mobility issues, the need for commodity information across transportation modes, the need for information on intermodal connectivity, and the need to incorporate environmental factors into freight considerations. In some cases, states are undertaking efforts to address these needs.

Some states noted the need for complete and up-to-date data to address current and potential challenges faced by the freight industry. Representatives from Michigan, Ohio, California, and Maryland highlighted the need to involve private stakeholders to address these issues, particularly for rail, ports, and air networks.

Some states discussed their need to identify freight mobility issues. For instance, Wisconsin, Illinois, and Maryland mentioned the need to determine truck bottlenecks in the transportation network including not only the existing ones, but also the potential bottlenecks, as well as the need for regularly updating this information. Some states like Iowa, Florida, and Maryland also discussed the need to improve the availability of truck parking spaces, which has been one of the most significant challenges for the trucking industry in those states. Lastly, Florida discussed the need to quantify truck empty backhaul.[68]These states are undertaking efforts to address these needs, which are discussed in the following best practices.

Several states pointed out the need for commodity information across all transportation modes. In Maryland, for instance, current commodity data are not readily available, and the DOT intends to incorporate additional commodity information in its roadway performance tool in the future. In California there is a need to know which commodities are moved by rail and which commodities flow in and out of ports. Similarly, an Ohio DOT representative noted that for air cargo data, information such as cargo amounts, type of commodities, and final destinations are difficult to get. Finally, an Iowa DOT representative discussed the need for more specific information about the types of commodities companies move, the routes they use, and the facilities they are going to for planning purposes and prioritizing investment projects.

Some states also noted the need for more information on intermodal connectivity for planning purposes and prioritizing investment projects. In California, for instance, there is a need to understand where the containers from the ships are going to (e.g., first to warehouses and then to distribution centers) and through which transportation modes. According to the DOT representative, such information could come from GPS, but that information is not shared with DOTs. In Maryland, the DOT representative also mentioned that there is a need for connected supply chain data and expressed interest in leveraging the use of blockchain technology for this.

Lastly, some states discussed the need to incorporate environmental factors into freight considerations. This need was noted in two dimensions. One as the impact of environmental issues on the freight network and the other as the impact of freight transportation on the environment. Maryland, for instance, noted the need to include vulnerability factors (such as flooding risk) into its MRPT to account for environmental vulnerability. Florida stated that addressing empty backhaul reduces costs and environmental impacts for the commercial motor vehicle industry.

6.3.1.2 Identify limitations of current freight datasets

Almost all case study states have identified data gaps in the existing data sources they are using for their freight planning and analysis. These include the high cost of proprietary data sources, lack of accurate and reliable data sources, lack of geographic granularity, and difficulty of using proprietary data sources (see Table 6.2).

Some states have identified a lack of accurate and reliable data as a gap in the existing freight data sources. For instance, Ohio and Iowa pointed out that some data sources may not be completely accurate or reliable due to their small sample sizes and modeling methods. Two states (California and Michigan) discussed a lack of reliable and accurate data for trucks. While in California, this issue arises due to the detector sites not always being operational or capturing data accurately, Michigan noted that

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[68] Motivated in part by Florida Statute 334.044(33) (a) that established that the Freight Mobility and Trade Plan shall identify "investments that capitalize on the empty backhaul trucking" (Worrell, N.D.).

truck data are incomplete. One other state also raised concerns about the difficulty of validating freight data. For instance, according to an IDOT representative, it would be desirable to validate the data by comparing it to another data source. However, this can be difficult as even if more than one data source is available, they often use different approaches of data collection methods. Lastly, the MDOT representative noted that getting accurate data for international shipments is difficult from any source.

Similarly, several states have identified the high cost of proprietary freight data as a limitation of the existing data sources. All states that use Transearch highlighted its high cost as a limitation. For instance, Maryland purchases Transearch data for the development of their freight plans and models it for several following years. In addition, some states have discontinued the use of some proprietary data sources due to their cost-ineffectiveness. For instance, Ohio and Delaware discontinued the use of PIERS and Transearch, respectively. Lastly, while Ohio continues to use Streetlight, according to the DOT, this data source is expensive and costs them over $1 million annually.

Some states also noted that the existing data sources are incomplete or outdated. WisDOT and Caltrans have noted that some of the existing data sources are incomplete and outdated. In California, the DOT relies on very old truck data. Similarly, the STB Waybill for rail data, for instance, does not capture short line data, while the USACE port database is incomplete because some ports are not required to report to the U.S. Army Corps of Engineers.

Some states also identified lack of geographic granularity as a gap. Both California and Delaware, expressed frustration with the lack of geographic granularity in the FAF dataset. According to these state DOT representatives, the FAF dataset categorizes their respective states into very few geographic zones, which makes the dataset insufficient and inaccurate for their freight planning purposes.

Lastly, one state brought up the difficulty of using proprietary data sources. According to an Iowa DOT representative, proprietary sources can often be difficult to use and are not always more comprehensive or detailed than free, public freight data sources.

Table 6.2 Current freight data gaps

Freight Data Gap	State	Description
Lack of accurate and reliable data	Ohio	The STB Waybill dataset is based on a small sample of operators that represents one percent of the totality of railroad operators, and then it is stripped down to a point where it is barely usable.
	Iowa	Given the data disaggregation and the assumptions they need to make, the information is not completely accurate.
	California	Caltrans detector sites are not always operational and data from these detectors are not always being captured accurately.

	Michigan	Truck data are never entirely complete. Getting accurate data for international shipments is difficult from any source.
	Illinois	Validating data by comparing it to another data source can be difficult as even if more than one data source is available, they often use different approaches of data collection methods.
High cost of proprietary data	Maryland	Purchases a year of Transearch data and models it for the following years.
	Ohio	Discontinued the purchase of PIERS given its cost and their limited use of the data source. Streetlight dataset is expensive (costs over $1 million annually).
	Delaware	The freight flow model has not been updated given the high cost of Transearch data.
Incomplete and outdated data	Wisconsin	These data sources are often incomplete and outdated.
	California	Relies on old data for truck volumes.
	Michigan	STB Waybill data do not capture short line data. USACE port database is incomplete because some ports are not required to report to the U.S. Army Corps of Engineers.
Lack of geographic granularity	California	FAF data categorizes California into 7 zones. Caltrans disaggregates it into 125 zones and 5,500 TAZ. However, the disaggregated data are not very accurate.
	Delaware	FAF data categorizes Delaware as one geographical area, which is problematic as different parts of the state contribute differently to its transportation system.
Difficulty to use proprietary data	Iowa	Proprietary sources can often be difficult to use and are not always more comprehensive or detailed than free, public freight data sources

6.3.2 Best Data Practices

6.3.2.1 Utilize available data sources to address freight data needs

Some state DOTs have used existing datasets to address their freight data needs. According to a representative from Ohio DOT, while data gaps exist, the primary issue is that data are underutilized. Overall, the use of existing data sources requires understanding their limitations and depends on budget constraints as agencies must purchase some datasets, and provide the staff capacity to analyze the data.

Some states, for instance, have purchased Transearch to address some of their data needs for statewide freight analysis, but purchases are made in different capacities. Maryland purchases the data every few years and models the data for the following years until the next purchase. Iowa has purchased the dataset to be used primarily by consultants to produce the analysis that the DOT requires. Similarly, Florida uses Transearch, but in the form of analyses conducted by consultants that use the data, rather than purchasing the source itself.

Similarly, to identify some freight mobility issues, some state DOTs have used existing data. Table 6.3 presents the datasets that each state has used to identify bottlenecks, truck parking issues, freight generating facilities, and to quantify truck empty backhaul.

Table 6.3 Data used to address freight mobility issues

Freight Issues/Needs	State	Data Used
Truck Bottlenecks	Wisconsin	Traffic Operations and Safety Lab (TOPS) data from UW-Madison, which uses NPMRDS data on travel speed and travel time
	Illinois	NPMRDS data
	Maryland	Maryland Roadway Performance Tool
Truck Parking	Iowa	DOT's data collected at each of the existing rest areas. Also has some data collected by HDR in 2012 as part of the Iowa Rest Area Study. Data include counts, parking duration, utilization, and capacity.
	Florida	Truck data from ATRI, truck counts from FDOT, property tax records from DOR, and parking supply by location from multiple data sources
	Maryland	INRIX trip data to assess counts and parking duration, utilization and capacity, origins and destinations and performance statistics for state lots
Truck Empty Backhaul	Florida	WIM data to quantify truck empty backhaul. WIM data include date, time, travel direction, travel lane, truck gross weight, vehicle class, vehicle length, axle spacing and axle weights for each truck passing through 30+ WIM stations across the state
Freight Generating Facilities	Iowa	Survey administered in late 90s/early 2000s Currently focusing on maintaining and updating the database by doing internet searches, gathering knowledge of employees, and using data available through other state agencies (such as from the Dept. of Agriculture)

6.3.2.2 Identify appropriate data collection methods

Several states have undertaken in-house data collection efforts to address data needs. Typically, the methods used to collect data depend on staff capacity, budget constraints, and cost-benefit analysis assessment. Data collection methods commonly utilized by states include qualitative and quantitative approaches including targeted interviews and surveys. These efforts are often carried out by in-house staff for specific data needs of the DOTs, which have led to long-term relationships with industry and related agencies.

States have collected additional information to address freight data gaps. While more states have used a qualitative approach for data collection, some have opted for a quantitative approach. As part of the qualitative approach for in-house data collection, some states have conducted targeted interviews and surveys. Table 6.4 presents some of the qualitative efforts carried by state DOTs to collect freight information. States have typically conducted targeted interviews with a small group of stakeholders in a specific transportation mode. As the targeted groups are small, typically state DOT staff have built relationships with the stakeholders.

Similarly, states have conducted surveys to learn more about issues and constraints faced by stakeholders in a specific transportation mode. Generally, surveys reach a larger audience including states or local agencies and the general public, and are a one-time effort. Wisconsin, for instance, is the only state that has included the general public as a target audience for its rail survey. To reach the target population, the DOT distributed a press release announcing the launch of the online questionnaire to the general public. Similarly, Iowa has conducted both an ongoing and a one-time survey to capture freight information, particularly for rail. The ongoing survey is easier to complete due to the small number of railroad companies in the state, the existing relationship with the companies, and the requirement by law. According to the representative, the DOT has discussed replicating a similar survey for trucks, however, they recognize that the effort may not be easy as there are many more trucking companies to sample, and they do not have contacts at those organizations.

Table 6.4 Qualitative efforts to collect freight information

State	Data Collection Instrument	Type of Data Collected
Interviews		
Michigan	Communications with short line rail operators	
	Communications with port representatives	
Ohio	Targeted interviews with managers, planners, and engineers in the six largest airports	Cargo counts and estimates
	Targeted interviews with representatives of private companies	Needs and challenges of private companies Understanding of supply chain
Florida	Extensive interviews with rail operators	Challenges faced and opportunities perceived
Surveys		
Wisconsin	One-time online survey to rail stakeholders and the general public (with 5,300 responses)	Input on rail issues and needs to collect further information.
Iowa	Freight mobility survey distributed among state's Class I, II, and III railroads, MPOs, regional planning affiliations, and DOT district transportation planners	Inputs and identify capacity constraints in the rail network
Iowa	Annual survey for 18 railroad companies required by law	Earnings, the type of commodities (by NAICS code), investments made, and total mileage

Two states have undertaken a quantitative approach for data collection. The data collection approaches vary in terms of continuity of the effort (one-time vs regular effort), the sample size, type of information collected, and administration method. Table 6.5 presents some of the quantitative efforts carried by state DOTs to collect freight information. Michigan, for instance, compiles monthly cargo reports from 18 smaller scheduled airports. The information is stored in the DOT's Intermodal Management System and has been collected monthly since 1950. Contrarily, California implemented a one-time statewide vehicle inventory and use survey. Although the effort was successful, it was not replicated due to its high costs and effort. The survey was successful due to several factors. First, survey instruments were available in several formats including web-based surveys, GPS/OBD, and a limited number of paper surveys. Second, the survey was kept short to keep survey respondents engaged. Third, this was an optional survey and incentives were provided to increase response rate.

Table 6.5 Quantitative efforts to collect freight information

State	Type of Effort	Type of Data Collected	Data Access
Current Efforts			
Michigan	Monthly cargo reports from 18 smaller scheduled service airports	Passengers, air cargo, and air mail (pounds). Available by enplaning (embarking on aircraft); deplaning (disembarking); and total.	Online database available to the public
California (1)	One-time statewide vehicle inventory and use survey (with 15,000 responses)	Vehicle characteristics (fleet size, class, weight, age, axle number), fuel type, VMT, loading pattern, payload	Available on the website, requires NDA.
Potential Efforts			
Florida	Freight Commodity Survey	*Commodity flows at the micro level	
Maryland	Leverage the use of blockchain technology	*Intermodal connections *Bottlenecks	

Table 6.5 also presents some potential efforts that states have identified to capture the information they need. In Florida, for instance, the Truck Empty Backhaul study recommended that the state DOT considers collaborating with the Department of Agriculture and conducting a Freight Commodity Survey to understand commodity flows at a micro-level. Similarly, Maryland expressed interest in leveraging the use of blockchain technology to understand intermodal connections and the impacts of bottlenecks on the transportation system and the efficiency of the supply chain. For this effort, the DOT representative highlights the need to collaborate with the private sector.

BEST PRACTICES TO ENGAGE PRIVATE COMPANIES

Several state DOT representatives highlighted the need for collaborating with the private sector to understand supply chain and commodity flows. Interviewees identified two channels used by state DOTs to engage with private companies and obtain the data and information that is relevant for freight planning.

First, directly approaching the private company and requesting an interview. Ohio has used this approach to understand the needs and challenges of the private sector, and even access to supply chain data. According to the representative, there are four factors that made this engagement possible: Approaching the company through the proper channels (e.g. company's government relations staff); explaining the purposes of the interview, the importance of their participation, and the benefits for them; identifying the correct stakeholders (e.g. logistics and supply chain staff); and satisfying interview stipulations set by the private company, especially to ensure that information is kept confidential (including not recording or writing anything down during the interview).

Second, approaching private companies through the Freight Advisory Committees. There are two practices that have been beneficial for state DOTs to engage private companies in their FAC. One is to take advantage of the solid relations that local district coordinators have with members from the private sector. This has been an important factor in constructing the makeup of the FAC in Florida. The second one is to host FAC meetings at different locations across the state (such as in Michigan and Iowa). In Michigan, for instance, some of the largest companies around the state host the FAC meeting, which allows the company to showcase their services to other FAC members and provides greater knowledge and visibility for state DOT staff to understand each freight mode.

Although there are no requirements for data sharing, some FAC members in some states have shared some of their information to address specific needs. In Iowa, for instance, a railroad operator has assisted the state DOT in a federal grant application by providing some data. Similarly, in Ohio, the rail association collaborates with the DOT to determine the number of trains moving through the state, the type of commodities transported, and the hazardous material routes. Lastly, in Maryland, some FAC members have shared some data that have helped the state DOT with forecasting and planning purposes. Although data sharing has not happened in California, they hope to involve their FAC members in data sharing in the future.

Overall state FACs are used by state DOTs as an opportunity to learn more about freight-related issues and challenges. Across the states, FAC members provide guidance on the development of the state freight plan, which DOTs use as an opportunity to validate their data, learn more about the trends of the industries, and understand the issues that are relevant for stakeholders. In addition, although the FAC is not formally involved in the selection of projects, in some states they provide inputs on the selected projects. State DOTs use this information to learn which projects are the most relevant to stakeholders.

Lastly, due to the importance of FACs, it is crucial to bring the right stakeholders to the table. Based on case study findings, this includes having representation from federal and state agencies, localities in urban and rural areas, tribal nations, key industries to the state's economy, transportation modes, academia, and neighboring states (in the U.S. or Canada).

6.3.2.3 Collaborate with other states to share freight information

State DOTs have engaged in collaborations with neighboring states in the U.S., and those on the border with provinces in Canada. While these collaborations mostly facilitate the coordination of large projects across the states, in some cases they have also facilitated data sharing.

Generally, most of the data sharing with neighboring states occurs through membership in collaborative freight agencies. For instance, Caltrans staff are members of some collaborative freight agencies that involve Arizona, Utah, Nevada, Washington, and Oregon. As part of their involvement with these states, Caltrans has contributed to sharing data on freight movements, improving safety on roads, and improving multimodal transportation. Similarly, Maryland and Delaware are involved in data sharing for the development of the Delmarva freight plan through their membership with the Delmarva Freight Working Group. Ohio is also involved in some data sharing through its membership with MAFC, AASHTO, and Council of Great Lakes Governors though there is no continued formal data sharing. Lastly, the state of Illinois also participates in various workshops and peer exchanges that often involve states outside of the MAFC area. Several DOT representatives mentioned that full data sharing is not permitted due to restrictions in sharing proprietary data sources.

Similarly, Michigan and Wisconsin -as bordering states- have collaborated with peer agencies in Canada. Michigan has collaborated with the province of Ontario on O-D studies that helped the state with its travel demand modeling and procured more data for its analysis.

Finally, some states in collaborative freight agencies have expressed a desire for more formal collaborative efforts. For instance, MAFC member states are exploring the possibility of purchasing Transearch data as a group.

CHAPTER 7: BEST PRACTICE RECOMMENDATIONS

This chapter provides two sets of best practices recommendations. The first set of recommendations is about generating and collecting freight data and the second set of recommendations is about determining data sources helpful for planning, programming, and design of future infrastructure on the freight network. The recommendations in this report are based on literature review and findings of the case studies.

7.1 BEST PRACTICE RECOMMENDATIONS IN GENERATING AND COLLECTING FREIGHT DATA

This section presents best practices in generating and collecting freight data based on the study findings. The research team identifies the following best practices.

- **Use existing data sources to address freight data needs**

Freight planners in Minnesota should consider using existing data sources to address their freight data needs. According to the study findings, in some instances, lack of data is not the issue, rather the primary issue is that data are underutilized. Using existing freight data sources benefits freight planning in that it allows for the efficient use of resources including staff time and data collection costs.

The various existing freight data sources (either public or proprietary) serve different data needs. The datasets vary in type of information, level of detail (such as in the level of geographic granularity, level of commodity information), time dimension (such as real-time data, monthly data, annual data), and ease of access and cost (directly as downloadable files or indirectly as data available for purchase, and restrictions of use). In section 2.2, we discuss some of the advantages and limitations of the most commonly used freight data sources.

- **Strategize the purchase of proprietary freight data**

When public data sources are not sufficient, freight planners should strategize the purchase of proprietary freight data. Strategizing the purchase of proprietary freight data allows for the efficient use of resources and saves costs.

Data purchase strategies will depend on budget constraints and available staff capacity. Some strategies used by other states include (i) the purchase of one year of proprietary data and modeling it a few years until the next purchase, (ii) purchase of the data for contractors to use and produce the analysis required, or (iii) purchase the analysis rather than the data itself.

- **Formalize interagency agreements to purchase proprietary freight data**

Freight planners at state DOTs should formalize agreements with other state DOTs to jointly purchase freight data sources from private vendors and to share freight information that is not available through existing freight data sources. Through formal agreements, state DOTs could collaborate in data procurement efforts or pursue group purchases of private data sources. For instance, Maryland — as a member of the Eastern Transportation Coalition (ETC) — has collaborated on several data procurement efforts that have improved access to new and emerging datasets. In addition, these efforts have allowed states to access freight data from different vendors for their states as well as other member states, eliminating data sharing restrictions from private vendors. Similarly, state members of the Mid-America Freight Coalition are currently discussing the group purchase of Transearch data. This cost-sharing strategy would help reduce data costs for states.

- **Collect additional freight data to supplement existing data sources**

Freight planners in Minnesota should consider collecting additional data when more specific information is required, and the existing data sources do not meet the freight data needs.

Collection methods will depend on the type of data that needs to be collected, staff capacity, and budget constraints. Freight planners may use qualitative methods such as targeted interviews with a smaller group of stakeholders or quantitative methods such as surveys for data that need to be collected from many stakeholders. These could be continuous efforts to have longitudinal data or one-time efforts to address specific freight-related issues. Table 7.1 provides some examples of the type of instruments for data collection and the information collected.

Table 7.1 Examples of data collection methods

Methods	Instruments	Examples of information collected
Qualitative	-Targeted interviews -Surveys	-Capture shot line rail information -Needs and challenges of the private sector
Quantitative	-Surveys -Use of technologies (e.g., GPS, blockchain)	-Passengers, air cargo, and air mail (pounds) -Vehicle characteristics, VMT, fuel type. -Commodities moved

Collecting specific information that otherwise is not available through existing data sources will address the data gaps and thus improve freight planning. In addition, depending on the data collection methods used, these can help freight planners at state DOTs to build long-term relationships with relevant stakeholders.

- **Approach firms in the private sector to understand their businesses and the freight-related challenges they face**

Freight planners should directly approach the private sector to address data gaps. Some strategies for approaching the private sector for data collection used by other states include conducting extensive outreach, directly requesting interviews to collect specific data, and leveraging the Freight Advisory Committee (FAC). For instance, Florida DOT carries out extensive outreach efforts and frequent communications with the private sector that have helped it build long-term relationships and thus gain the trust of the private sector. These efforts have resulted in private companies sharing data needed for planning purposes. Similarly, approaching the private sector directly through proper channels (e.g., government relations staff); explaining the use of the company's data and the benefits to the company, as well as assuring them of data confidentiality; and identifying the right stakeholders at the company have helped Ohio DOT earn private sector trust and gain insights into the needs and challenges of the private sector.

Lastly, states have leveraged their FAC to engage and approach the private sector. For this, two practices have been beneficial for state DOTs. One is to take advantage of the solid relations that local district coordinators have with members of the private sector. This has been an important factor in keeping the FAC engaged in Florida. The second one is to host FAC meetings at different locations across the state (such as in Michigan and Iowa). This approach allows the private sector to showcase its services to other FAC members and provides greater knowledge and visibility for state DOT staff to understand each freight mode.

- **Approach FAC members for specific data needs**

Freight planners in Minnesota should leverage the FAC to address freight data gaps. For this, it is important to ensure all relevant stakeholders are represented in the makeup of its FAC. These include public sector representatives including federal agencies (e.g., FHWA, USACE), state agencies (e.g., economic development, commerce, and agriculture), local and regional agencies (e.g., cities, counties, MPOs), private sector/state key industries (e.g., manufacturers, supply chain/logistics, healthcare), transportation modes, Tribal Nations, and academia. In addition, it is important to include public and private representatives from the neighboring states as their economic activity may influence the local freight. Having all relevant stakeholders, particularly, the private sector, can help not only with the statewide freight planning but also address freight data needs.

FAC members are involved in several activities that enable the sharing of information needed for freight planning. These include identifying freight-related issues and challenges, providing inputs for project selection, serving as a direct source for freight information and data sharing, validating freight data, and providing information to understand industry trends among others. Although there are no requirements for data sharing, FAC members have shared some of their information to address specific needs in some states.

- **Validate freight information**

Freight planners should validate their freight data estimates to ensure that the data used for freight planning reflects the freight transportation in the state for informed decision-making. Freight data could be validated against other data sources or by leveraging the expertise of TAC members or other state or local agencies such as departments of agriculture and MPOs. For instance, single-mode data sources can be used to validate data in multimodal sources and vice versa.

7.2 RECOMMENDATIONS IN DETERMINING WHICH DATA ARE THE MOST HELPFUL FOR PLANNING, PROGRAMMING, AND DESIGN OF FUTURE INFRASTRUCTURE ON THE FREIGHT NETWORK

According to the findings of this study, the existing freight data sources serve varying data needs. In this section, we summarize some of the advantages and disadvantages of the most widely used freight data sources.

In general, an advantage of many public sources is that they are available to the public at no cost and users can access the data immediately. However, some public sources cannot be accessed immediately due to licensing requirements, restrictions of use, and costs (such as STB Waybill and U.S. Port Data). In contrast, proprietary data sources often require payment and a request form that can slow the process of accessing the data.

7.2.1 Multimodal Data Sources:

FAF and Transearch are the most commonly used multimodal data sources. According to data users, FAF is a good data source for inter-state or multistate freight trends, but its limitation is that the data are highly aggregated. States can use these data for intrastate freight analysis by making some assumptions and data disaggregation, although this affects the accuracy of the data. Similarly, Transearch is a good data source for freight analysis at the county level. However, it lacks pipeline freight, some commodities may not be well represented, and information on international shipments is inaccurate (a significant disadvantage for border states).

These two data sources vary in the level of detail they provide, and it is likely that even if an agency purchases Transearch data, FAF may still be used to fill data gaps. While more commodities are covered in FAF, Transearch has more details on the commodities that are included. In addition, FAF includes more transportation modes but has less detail on sub-modes, while Transearch distinguishes among sub-modes. FAF does not contain information on secondary trips, which are provided in Transearch. Overall, both data sources rely on data samples, which may exclude information for certain industries, geographic areas, or commodities. Table 7.2 presents the advantages and disadvantages of each data source.

Table 7.2 Advantages and limitations of the most widely used multimodal freight data sources

Datasets	Advantages	Limitations
Freight Analysis Framework	-Covers all major transportation modes -Contains nationwide information -Contains commodity information -Contains information on O-D flows -Provides data on weight and value of goods transported -Includes forecasts -Includes trade information -Historical data available	-Information not available for counties or cities -Does not contain information on sub-modes (LTL vs Truckload) -Does not provide information on secondary trips -Routes and modes are based on modeling -Data are not very reliable for non-highway modes -Does not provide information on the number of trucks
Transearch	-Contains almost all major transportation modes -Contains information up to the county level -Contains commodity information -More complete information on domestic O-D flows as it includes secondary trips (trips from distribution centers to warehouses/ distribution centers) -Provides information on weight and value of goods transported -Includes forecasts -Includes trade information -Contains information on the number of truck trips	-Does not contain pipeline data -Some commodities are better represented than others -Does not always categorize trip chains correctly -Information-on international shipments is often inaccurate -Only includes North American flows -Provides only a snapshot of data for the purchased data time frame -Payment needed to access data (expensive) -Data sharing is restricted due to licensing

7.2.2 Truck Data Sources:

Trucks have historically and continue to be the largest carrier of freight by any mode. Despite this, there are not many comprehensive truck data sources. Most of the data sources available are based on a small sample of truck fleets[69] in the U.S., which creates a need for modeling and assumptions to estimate total truck volume. Furthermore, these data sources do not contain commodity information such as type of commodity, weight, and value.

In addition to the multimodal data sources, there are several truck-specific data sources. Many of these data sources are based on GPS data. While these data sources provide real-time data, these sources often contain no commodity detail. These data sources also vary in the persistency of truck IDs. ATRI

[69] The sample of trucks included in these data bases are larger than the ones used in multimodal data sources.

contains persistent truck IDs so that trucks can be precisely tracked to examine their O-D flow, while Streetlight assigns a new truck ID whenever a truck does not move for over five meters in five minutes.

Another popular truck data source used is the NPMRDS dataset. This data source contains information on both passenger and commercial trucks. However, the data contains neither commodity information nor data for trucks that venture off the national highway system. Table 7.3 presents the advantages and disadvantages of each data source.

Table 7.3 Advantages and limitations of the most widely used truck freight data sources

Datasets	Advantages	Limitations
StreetLight	-Real-time information on truck movements	-Does not have commodity information -Does not have persistent truck IDs -Based on a sample of truck fleets -Payment needed to access data
American Transportation Research Institute (ATRI)	-Real-time data -Has persistent truck IDs	-Does not contain commodity information -Based on a small sample of truck fleets -Payment needed to access data
NPMRDS	-Contains information on passengers and trucks -Historical data available	-Does not contain commodity information -Not real-time data -Data may be incomplete depending on road type, location, day of week, time of day, segment length, and traffic volume (particularly for low-traffic and rural roads) -Covers only the national highway system (NHS) (1).

Note: *(1) Data on other networks are available for purchase through private vendors.*

7.2.3 Rail Data Sources:

Despite rail being the second-largest carrier of freight, there is limited data on rail freight flows. This is mostly because railroad operators are privately owned. The two most common data sources for rail that are used for freight planning are STB Waybill and American Association of Railroad (AAR) data. Largely, these data sources do not contain information on shortline railroad operators or smaller railroad businesses.

STB Waybill is perhaps the most commonly used data source for rail. This data source provides detailed commodity information for all major railroad operators and contains geographic information at the business economic area. However, the commodity information is limited, and smaller railroad operators are not represented in the data.

The AAR dataset is another popular data source that covers a greater number of commodities, but only for Class I railroads. In addition, the geographic granularity of AAR data is limited simply to the U.S. East, U.S. West, and nationwide, making it difficult for states to determine their specific rail freight movements. Table 7.4 presents the advantages and disadvantages of each data source.

Table 7.4 Advantages and limitations of the most widely used rail freight data sources

Datasets	Advantages	Limitations
STB Waybill Sample	-Contains data for all major railroad operators (Class I and Class II railroad operators) -Contains geographic detail at the BEA level -Contains detailed information on the goods moved (weight, value, number of carloads), as well as routing of the waybill	-Limited commodity information for some commodity groups -Does not provide data on shortline railroad operators or smaller railroad enterprises
American Association of Railroads	-Contains commodity information -Provides information on the largest railroad operators (Class I)	-Does not contain information for railroad operators that are not Class I -Data are limited to some geographic regions: East, West, and U.S.

7.2.4 Ports and Waterways Data Sources:

Ports and waterways are a significant sector of the freight transportation system. In addition to multimodal data sources, two data sources are used most often for ports and waterways: the proprietary PIERS dataset and the Waterborne Commerce Statistics Center (WCSC) data developed by the USACE.

A popular proprietary data source is PIERS. This dataset provides detailed commodity information (such as type of commodity and description of goods), shipper, and O-D information as it is based on BOL data. In addition, it includes all U.S. ports due to the agreements with public and private ports.

The WCSC data source contains a plethora of useful information, such as data for some commodities; geographic granularity for region, state, port or waterway; and historical data. In addition, the data contains information on export and import tonnage, which is an important distinction for understanding the flow of freight throughout the U.S. Despite this, the WCSC does not contain an exhaustive list of commodities. Lastly, the WCSC dataset is incomplete as some ports are not required to report to the USACE because they are privately owned. Table 7.5 presents the advantages and disadvantages of each data source.

Table 7.5 Advantages and limitations of the most widely used ports and waterways freight data sources

Datasets	Advantages	Limitations
Port Import/Export Reporting Services (PIERS)	-Detailed commodity and O-D information as the result of using BOL -Comprehensive data source that covers 100% of U.S. ports (both private and public) -Data available for 13 countries outside the U.S. -Includes import and export BOL -Historical data available	-Payment needed to access the data -Data sharing is restricted due to licensing
Waterborne Commerce Statistics Center (WCSC)	-Information available for region, state, or waterway -Historical data available	-Limited commodity coverage -Does not include information from private ports

7.2.5 Air Data Sources:

Perhaps one of the most significant gaps in freight data is air freight. While some information on air freight exists in multimodal data sources, there are few single modal air freight data sources, and these sources lack type of commodity information.

Commonly used air freight data sources are the BTS T-100 and FAA enplanement data. These contain information on total passengers and cargo for airports operating within the U.S. BTS T-100 also contains information for U.S. territories as well as some airports in Canada. However, neither data sources contain information on commodity flows or information on the value of the freight flown. This is critical as much of air freight tends to be high-value, low-weight. In addition, with the advent of just-in-time delivery of goods that is increasingly relying on air travel, this missing commodity information represents a significant gap to understanding total freight flows. Table 7.6 presents the advantages and disadvantages of each data source.

Table 7.6 Advantages and limitations of the most widely used air freight data sources

Datasets	Advantages	Limitations
BTS T-100 Data	-Contains information on cargo shipments and passenger -Historical data available	-Does not have commodity information
FAA Enplanement Data	-Contains information on cargo shipments and passenger enplanements -Contains information on total weight landed and Year-Over-Year change from the previous year -Historical data available	-Contains information only for large airports -Does not contain commodity information other than yearly total of tonnage

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APPENDIX A: ADDITIONAL INFORMATION FOR SELECT PUBLIC DATA SOURCES

This appendix presents additional information on the public data sources.

MULTIMODAL DATABASES

Freight Analysis Framework

The Freight Analysis Framework (FAF) is produced through a partnership between the Bureau of Transportation Statistics (BTS) and the Federal Highway Administration (FHWA). The database integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation. FAF incorporates data from agriculture, extraction, utility, construction, service, and other sectors. The database compiles information from other data sources including Commodity Flow Survey (CFS), Census Foreign Trade Statistics, Economic Census data, USDA's Census of Agriculture, Port Import/Export Reporting Service (PIERS), Vehicle Inventory and Use Survey (VIUS), National Highway Planning Network (NHPN), Highway Performance Monitoring System (HPMS), and U.S. Energy Information Administration (EIA).

Website for data:

- FAF5 Data Tabulation Tool
- FAF Data link

Reference guide: RG version 4

Use cases: Economic analysis and freight planning, and the webinar "Leveraging other datasets with the FAF: A case study on California's statewide freight model".

Commodity Flow Survey

The Commodity Flow Survey (CFS) is conducted every five years by the U.S. Census Bureau in partnership with the U.S. Department of Transportation's Bureau of Transportation Statistics. The CFS is a shipper survey of approximately 100,000 establishments from the industries of mining, manufacturing, wholesale trade, auxiliaries (i.e., warehouses and distribution centers), and select retail and service trade industries that ship commodities. Data requested by the CFS includes the type of commodities shipped, their origin and destination, their value and weight, and mode(s) of transport. The CFS provides a comprehensive multimodal picture of national freight flows and represents the only publicly available source of data for the highway mode. Results from the CFS are used to analyze trends in the movement of goods, mapping spatial patterns of commodity and vehicle flows, forecasting demands for the movement of goods, and for guiding management and investment decisions on transportation infrastructure.

There are two versions of the dataset, a Public Use File (PUF) and a restricted file (Title 13 - T13 dataset) (BTS, 2021b). The T13-dataset contains more detailed information. For instance, while the PUF file contains geographic information up to the CFS area, the T13 file has street address, city, state, and zip code data. Similarly, there is more granularity in the commodity information. While the PUF data has 2-digit SCTG, the T13 data has 5- digit SCTG. The BTS recommends using the PUF file for high-level analyses, regulatory analyses, and rapidly validating an idea for further research using the T13 version, and using the T13 for academic research and detailed modeling and analysis work.

The modes represented in the database are described at a high-level in Table 2. However, a full description of the modes is as follows: (1) All modes, (2) Single modes, (3) Truck (for-hire and private), (4) Rail, (5) Water (shallow draft, deep draft, Great Lakes), (6) Air (including truck and air), (7) Multiple modes, (8) Parcel, USPS, and courier, (9) Truck and rail, (10) Truck and water, (11) Rail and water, (12) Other multiple modes, and (13) Other and unknown modes.

Website for data: 2017 data

Reference guide: 2017 RG

Use cases: Freight planning and economic analysis, and Freight Analysis Framework database development.

TRUCK

National Performance Management Research Data Set (NPMRD)

NPMRDS provides vehicle probe-based travel time data for passenger autos and trucks. The data are made up of HERE and ATRI databases. The real-time probe data are collected anonymously from a variety of sources including mobile devices, connected autos, portable navigation devices, commercial fleet and sensors. NPMRDS includes historical average travel times in 5-minute increments on a daily basis covering the National Highway System (NHS). The data are provided in two parts. The first part is a Traffic Message Channel (TMC) static file that contains TMC information that does not change frequently. The second part includes travel times and identifies roadways geo-referenced to TMC location codes. The two datasets need to be joined in GIS-based software to provide the full picture (FDOT, 2016).

NPMRD contains public use data, however, more data are accessible through the NPMRD portal that requires a data-sharing agreement to access.

Website for data: Public use file

Reference guide: RG – Website contains multiple links to webinars, contact information, and other supportive resources.

Use Cases: Terminal and border access planning, sustainable transportation investment, and congestion planning.

RAIL

Carload Waybill Sample

It is a stratified sample of carload waybills for all U.S. rail traffic submitted by those rail carriers terminating 4,500 or more revenue carloads annually. The waybills are sampled under two different plans. The "MRI" plan for data delivered on cartridges stratifies sampled waybills into five different levels of sampling frequency depending on the number of carloads on the waybill. Waybills representing a larger number of carloads are sampled more frequently. The second technique called the "Ex Parte 385" plan allows manual sampling of waybills, typically for smaller railroads, and is stratified into three different levels of sampling frequency. The entire sample of waybills is then expanded using appropriate multipliers for each sampling level to represent total U.S. rail movements in that year (STB, 2019).

A confidential version of the Carload Waybill Sample is available for railroads, federal agencies, states, transportation practitioners, consulting firms, and law firms in specific proceedings, and other users. In order to access the confidential data, an appeal is required.

Website for data: summary sample

Reference guide: 2019 RG

Use cases: Rate cases, development of costing systems, productivity studies, exemption decisions, and analyses supporting regulations.

Railroad Annual Reports

The Surface Transportation Board collects a series of economic data for regulatory purposes and to monitor the financial health of the freight railroad industry. Reports issued with data collected for Class I railroads are: Annual R-1 Reports, Revenues & Earnings, Carloads & Volumes, Employment & Wage, and Fuel surcharges.

Website for data: data

Reference guide: Data description in each tab

Use cases: Analysis of commodity travel by railroad company.

AIR

BTS T-100

This database presents data reported by U.S. carriers operating between airports located within the boundaries of the United States and its territories. These data are often referred to as either "market" or on-flight origin and destination records. The data fields contain information on passengers, freight, and/or mail enplaned at the origin airport and deplaned at the destination airport (BTS, 2021c).

Website for data: Monthly data

Reference guide: RG

Use cases: Air freight/passenger analysis, and comparison of most common air freight, mail, and passenger movement by origin/destination.

PORT & WATERWAY

U.S. Port Data

The database provides information on value, method of transportation (air and vessel), and the shipping weight of cargo at each port with each of the 240 trading partners and around 400 U.S ports coast-to-coast. It provides detailed statistics on goods and estimates of services shipped from the U.S. to foreign countries. The United States Code, Title 13, requires data to be collected for the continuation of this program and participation is mandatory. Data on export to all countries, except Canada, are compiled from the Electronic Export Information (EEI) and import data comes from the U.S. Customs' Automated Commercial System, U.S. Customs and Border Protection, and Canadian sources (U.S. Census Bureau, n.d.).

Website for data: public data & data for purchase

Reference guide: Guides/Glossaries

Use cases: Value and shipping weight of vessel cargo exported and imported through the Port of New York, the top 10 countries importing through the port of New Orleans, value of total imports from Japan through the port of Los Angeles, air value of exports by type of commodity through the Miami International Airport, and the top 100 commodities exported or imported through any port.

Port Performance Freight Statistics Programs

The Port Performance Freight Statistics Program provides nationally consistent performance measures on capacity and throughput for the Nation's largest tonnage, container, and dry bulk ports (BTS, 2021).

The dataset combines information from a variety of sources including U.S. Coast Guard Nationwide Automatic Identification System data; USACE data, port and terminal websites, American Association of Port Authorities (AAPA), Port Industry Statistics, NAFTA Region Container Traffic data, and National Oceanic and Atmospheric Administration (NOAA) data.

Website for data: Dashboard & port profile

Reference guide: guide & glossary

Use cases: Total tonnage by port, and most common commodity by major port.

Waterborne Commerce Statistics Center (Ports and Waterways)

WCSC compiles monthly reports submitted by principal U.S. ports in all states and captures information on vessels, tonnage, commodity, origin, and destination from vessel operating companies. These data and information are intended to assist USACE's navigation mission by providing statistics used to analyze the feasibility of new projects, and to set priorities for new investments and for the operation, rehabilitation, and maintenance of existing projects.

Website for data: multiple data files

Reference guide: Commodity codes

Use cases: Analyze movements of freight among U.S. ports and waterways, and compare totals by traffic and commodities in ports, harbors, and waterways.

APPENDIX B: ADDITIONAL INFORMATION FOR SELECT PROPRIETARY DATA SOURCES

This appendix presents additional information on the proprietary data sources.

MULTIMODAL

Transearch

Transearch is a comprehensive database that combines over a hundred industry, commodity, and proprietary data sources to produce its database and forecasting tools. Truck, barge, and air freight flows are presented at the county level. However, due to non-disclosure agreements with some major railways, rail data are only available at the Business Economic Area (BEA) level. The database combines information from various sources including agricultural products and livestock (sourced from the U.S. Department of Agriculture), coal and automobiles (sourced from other IHS in-house databases), selected chemicals (sourced from IHS Markit Chemical group), minerals (sourced from the U.S. Geological Survey), and household tax revenue (for demand modeling) for economic modeling. In addition, import and export volumes are taken from U.S. Federal port census data (RS&H, Inc, 2016)

Use cases: Find transportation statistics by country, state, business economic area (BEA) and county, track modal competition or commodity groups, benchmark individual performance relative to the market, estimate market potential and identify transportation demand by commodity, location and mode.

TRUCK

American Transportation Research Institute

American Transportation Research Institute (ATRI) provides real-time GPS-based spatial and temporal information for a large sample of trucks (approximately 800,000) with onboard, wireless communication systems in the U.S. Data include geospatial (coordinates) and temporal (time/date stamp) information for the corresponding trucks. Other information such as spot speed and heading are also provided in the data. The data do not provide information on commodity type, TL/LTL, number of axles, travel purpose or other details of individual trucks. Currently, more than 100 million GPS data points are collected per day by ATRI. ATRI manages the "U.S. DOT's Freight Mobility Program, and has provided freight mobility and performance measures technical assistance to 31 state DOTs and 11 of the 15 largest MPOs in the U.S." (ATRI, 2021).

Use cases: Freight performance measures, congestion management, sustainable transportation investment, freight transportation and land use planning, and urban tour-based freight modeling.

American Trucking Association

American Trucking Association (ATA) is an 86-year old federation with state trucking association affiliates in all 50 states. ATA's work represents every sector of the industry, from LTL to truckload, agriculture and livestock to auto haulers, and from large motor carriers to small mom-and-pop operations.

ATA offers membership packages for carriers, companies, and shippers. Membership in ATA offers benefits, including reduced cost of data products.

Links for specific reports:

- Refrigerated Truck Freight Market Analysis
- U.S. Freight Transportation Forecast
- American Trucking Trends
- Trucking Activity Report
- Monthly Truck Tonnage Report

Use cases: Forecast demand for trucks carrying freight, forecast for future freight movement and economic trends, and current outlook on freight movement and economic trends.

AIR

International Air Transport Association

The International Air Transport Association (IATA) is the trade association for the world's airlines, representing some 290 airlines or 83% of total air traffic. IATA data provides information on passenger and air cargo flows, including forward-looking data, based on actual tickets and airway bills. Data packages also include several years of historical data.

Use cases: Analyze freight tons by air with country origin/destination, forecast air travel and analyze current air traffic demand, and access up-to-date air cargo data.

International Civil Association Organization

The International Civil Association Organization (ICAO) is directed by 193 national governments as part of a collaborative effort established by the Chicago Convention in 1944. Its overall goal is to research new air transport policy and standardization innovations as suggested by the ICAO Council.

ICAO's Data+ tool contains detailed financial, traffic, personnel, and fleet information about commercial aircraft carriers. ICAO's website notes several benefits to its data:

- Contains some data collections not publicly available in any other source, such as traffic by flight stage
- ICAO data cover a period of over 30 years
- ICAO Data+ contains both a web-based platform and downloadable reports
- ICAO is the only international civil aviation organization that covers all aspects of the air industry
- ICAO is validated on a government level by ICAO government states, making it an accurate source of international information
- ICAO is an impartial organization, thus its air traffic statistics and forecasts are well-respected and without national bias

Use cases: Compare airport performance, analyze forecasted trends in the airport market (freight, traffic, passenger), and analyze air traffic by manufacturer (Boeing, Airbus, etc.).

PORTS

Port Import/Export Reporting Services

Port Import/Export Reporting Services (PIERS) database contains detailed import and export data at the bill-of-lading level, a type of data collection that is extremely granular. Other data sources include data from the United Nations, U. S. Census, Dun & Bradstreet, and direct international country sources. Going back to 2003, the PIERS database processes close to 60,000 BOLs and includes import/export transactions for 13 international markets and more than 80 countries. The PIERS database offers three subscription levels with increasing details and the number of data points and cost.

The following is the full list of variables and additional detail contained in the database:

- Bill of lading number
- Vessel name, IMO code, voyage number
- Ocean carrier/shipping line
- NVOCC
- Consignee name/address (only for U.S. imported shipments, not for U.S. exported shipments)
- Shipper name/address (included for both imports/exports, unless the company has applied for confidentiality from U.S. States Customs)
- Notify name/address (only for U.S. imported shipments, not for U.S. exported shipments)
- Location and country of lading
- Departure date (included for U.S. exports, arrival date indicated for U.S. imports)
- Location and country of destination
- Port of discharge/transshipment port

- Description of goods (full description and PIERS-generated summary)
- Weight
- Container number(s)
- Six-digit HS code
- Master and house bill of lading numbers
- Estimated value
- Vessel flag/country of registry
- Containerized/non-containerized
- Refrigerated, potentially hazardous, roll-on/roll-off cargo

Use cases: Value.

Use Cases: Analyze market opportunities by tracking shifts in supply and demand, and understand commodity movement through many countries, ports, waterways, etc.

APPENDIX C: NON-TRANSPORTATION, NON-FREIGHT SPECIFIC DATA SOURCES

Several non-transportation and non-freight specific data sources are used in freight planning and analysis. These data points can provide further insight into freight movement by providing economic and social indicators that indicate economic movement. For instance, transportation practitioners may use employment, demographic, and census data within a region to estimate the number of facilities that would use freight carriers and utilize this information to aggregate a total number for freight vehicles. Similarly, data on the number of transactions and business locations may be used as a proxy for the exact commodity data. Table C-1 presents some data sources that are used for this purpose.

Table C-1: Economic and demographic data sources for use in freight modeling and analysis

Data Source	**Type of Data for Freight Analysis Use**
Public data sources	
U.S. Census Bureau	-County Business Patterns Data -Quarterly Census of Employment and Wages -Longitudinal Employer-Household Dynamics
U.S. Bureau of Economic Analysis	-County employment data
Proprietary data sources	
Woods and Poole; Moody's Economy	-Historical economic and demographic data -Forecasts
Business Analyst; Reference USA; InfoUSA	-Demographic data -Business data

APPENDIX D: SURVEY QUESTIONNAIRE

Identify Best Types of Freight Flow Data for Roadways, Railways, Airways, and Waterways Studies

The purpose of this survey is to collect information about state freight data practices as well as the benefits and challenges of using different data sources. This survey is part of a research conducted by the Institute for Urban and Regional Infrastructure Finance (IURIF) at the Humphrey School of Public Affairs, University of Minnesota. The information you provide is critical for planning, programming, and design of future infrastructure on the truck freight, railroad, ports and waterways, and airport networks within Minnesota and surrounding states.

This survey will take about 15-20 minutes to complete. You can save your responses and complete the survey later using the same link. We greatly appreciate you taking the time to respond to this survey.

If you agree to take this survey, please click next.

General Information

1. State you are representing: ______________________ (Response required)
2. Department you are representing: _____________________

Freight Data Sources

3. To what extent does the state use the following freight flow data sources within its State Freight Plan and/or State Rail Plan?

Data Source	To a large extent	To some extent	To a small extent	Not at all	Not sure
Commodity Flow Survey (CFS)					
Freight Analysis Framework (FAF)					
North American TransBorder Dataset					
Airport Activity Statistics					
Transearch					
U.S. Waybill data					
American Transportation Research Institute (ATRI) Database					
Less Than Truckload (LTL) Commodity and Market Flow Database					
Freight Commodity Statistics					
Air Carrier Activity Information System					

International Air Transport Association (IATA) database					
International Civil Aviation Organization (ICAO) database					
Port Import/Export Reporting Service (PIERS) database					
InfoUSA					
USACE Waterborne Commerce Statistics					
REMI Forecast					

4. What other freight flow data sources does the state use? Please specify the extent to which these data sources are used. [insert text box]
5. Please describe the extent to which your State Freight Advisory Committee reviews freight data as part of your transportation plans. [insert text box]
6. How does the state address gaps in freight flow data if there are any? (Through imputation of missing data, data disaggregation etc.) [insert text box]
7. Does the state collect any freight flow data? (Select one option) (response required)
    a. Yes, the state collects data in-house [skip logic-Q8]
    b. Yes, the state collects data through contractors [skip logic-Q9]
    c. Yes, through a combination of in-house efforts and contractors [skip logic Q8 and Q9]
    d. Yes, the state collects data through another method (please specify) ______________________ [skip logic-Q10] (response required if selected)
    e. No [skip logic-Q16]
8. [skip logic 7a] Please describe the staff capacity and tools that the state has to collect the data (number of full-time employees, specific skills, software programs etc.). [insert text box]
9. [skip logic 7b] Please describe the terms of the contract the state uses to collect the data at a high level (consultants used, specific responsibilities, required skills, required software programs, contract period, costs, etc.). [insert text box]

The following questions are about the freight flow data the state collects.

10. What kind of details does the freight data the state collects contain? (Select all that apply)
    a. Type of commodity [skip logic - Q11]
    b. Spatial details [skip logic-Q12]
    c. Freight value and weight
    d. Freight mode [skip logic-Q13]
    e. Travel time
    f. Other (please specify): _____________ (response required if selected)

11. [skip logic 10a] Please describe how commodities are classified (e.g., NAICS), the level of grouping employed (e.g., 3-digit classification), and the number of commodities included in the data collected by the state. [insert text box]
12. [skip logic 10b] In the freight data collected by the state, what is the level of spatial aggregation? (Select all that apply). [insert text box]
    a. Origin and Destination
    b. Intermediate points
    c. Other (please specify): ____________________ (response required if selected)
13. [skip logic 10d] In the freight data collected by the state, which of the following modes are included? (Select all that apply)
    a. Roadways (trucks)
    b. Railways
    c. Airways
    d. Waterways
    e. Other (please specify): ____________________ (response required if selected)
14. What methods are used to collect this data? [insert text box]
15. What year did the state start collecting this data and how often is it collected? [insert text box]

The following questions are about the freight flow data the state collects as well as data coming from existing databases available through other sources.

16. What are the advantages of the freight data sources the state currently uses? (Select all that apply)
    a. Contains spatial details
    b. Contains type of commodity information
    c. Contains travel time details
    d. Contains freight quantity details
    e. Inexpensive or free of charge
    f. Easily accessible
    g. Reliable
    h. Clear data collection methods
    i. Other (please specify): ________________ (response required if selected)
17. What are the disadvantages/limitations of the freight data sources the state currently uses? (Select all that apply)
    a. Lacking spatial details
    b. Difficulty determining freight quantity
    c. Lacking type of commodity information
    d. Lacking travel time details
    e. Expensive
    f. Unreliable
    g. Lacking multimodal information
    h. Unclear data collection methods
    i. Other (please specify): ________________ (response required if selected)

18. Are the freight databases the state uses sufficient to generate the information it needs? (if not, please elaborate) [insert text box]

Freight Flow Models

19. Has the state developed a freight flow model? (Select one option) (response required)
    a. Yes [skip logic-Q20]
    b. No [skip Q27]
20. [skip logic - Q19a] Which of the following data sources are used to develop the freight flow model? (Select all that apply)
    a. Commodity Flow Survey (CFS)
    b. Freight Analysis Framework (FAF)
    c. North American TransBorder Dataset
    d. Airport Activity Statistics
    e. Transearch
    f. U.S. Waybill data
    g. American Transportation Research Institute (ATRI) Database
    h. Less Than Truckload (LTL) Commodity and Market Flow Database
    i. Freight Commodity Statistics
    j. Air Carrier Activity Information System
    k. International Air Transport Association (IATA) database
    l. International Civil Aviation Organization (ICAO) database
    m. Port Import/Export Reporting Service (PIERS) database
    n. InfoUSA
    o. USACE Waterborne Commerce Statistics
    p. REMI Forecast
    q. Other (please specify): _________________ (response required if selected)

21. What kind of details does your freight flow model contain? (Select all that apply)
    a. Type of commodity
    b. Spatial details (please specify): _________________ (response required if selected)
    c. Freight value and weight
    d. Freight mode (please specify): _________________ (response required if selected)
    e. Travel time
    f. Other (please specify): _________________ (response required if selected)
22. What methods were used to develop your freight flow model?
    a. O-D factoring method - Makes use of two additional components of mode split and traffic assignment with the Origin–Destination (O–D) factoring
    b. Truck model - Generates aggregate truck trips and assigns them to the road network
    c. Four-step commodity model - Includes trip generation, trip distribution, mode split, and traffic assignment at a zone level for discrete but unconnected trips between a single origin and a single destination

d. Tour-based or activity-based freight demand model - Treats travel as a demand derived from the desire for activities
e. Economic activity model - Economic land use models that incorporate feedback mechanisms with freight transport costs
f. Other (please specify): ___________________ (response required if selected)

23. What types of outputs are available from these models and to what extent are they used in practice?

Outputs	To a large extent	To some extent	To a small extent	Not at all	Not sure
Zone-to-zone and link-level flows					
Travel times					
Total freight Vehicle-Hours Traveled (VHT)					
Total freight Vehicle-Miles Traveled (VMT)					
Emissions levels					
Others (please specify): _____________ (response required if selected)					

24. Who uses your freight flow model and/or its outputs? (Select all that apply)
    a. State Department of Transportation
    b. Local transportation agencies in the state
    c. Other state departments within the state (please specify): __________________ (response required if selected)
    d. Metropolitan planning organizations
    e. Private companies
    f. Agencies from other states
    g. Other (please specify): ________________ (response required if selected)
25. How often do you revisit and adjust your model? (Select one option)
    a. Quarterly
    b. Semesterly (every six months)
    c. Annually
    d. Never
    e. Other (please specify): ________________ (response required if selected)

26. Would you be willing to participate in a more in-depth interview about your state's freight data practices as a follow-up to this survey? (Select one option)

a. Yes (please provide email for contacting you): ________________ (response required - email address format)
b. No

27. [skip logic Q19b] Is there anything additional you would like to share with us about your state freight flow data practices? [insert text box]

APPENDIX E: EXTENT OF USE OF DATABASES BY STATE

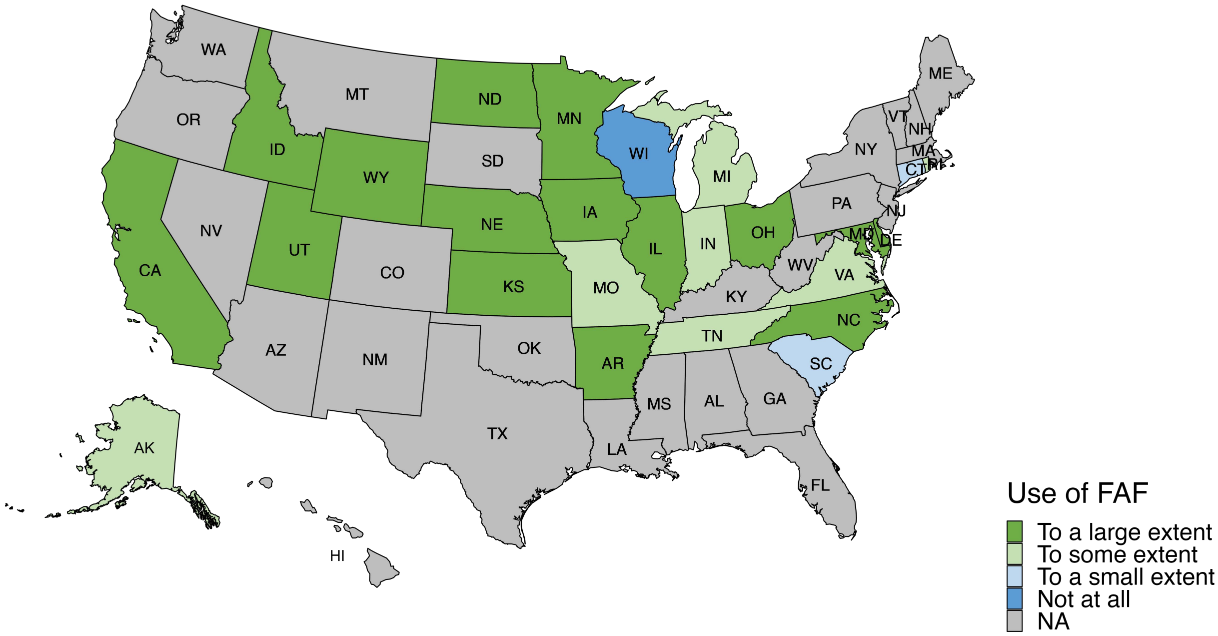

Figure E.1 Extent of use of the FAF database by state

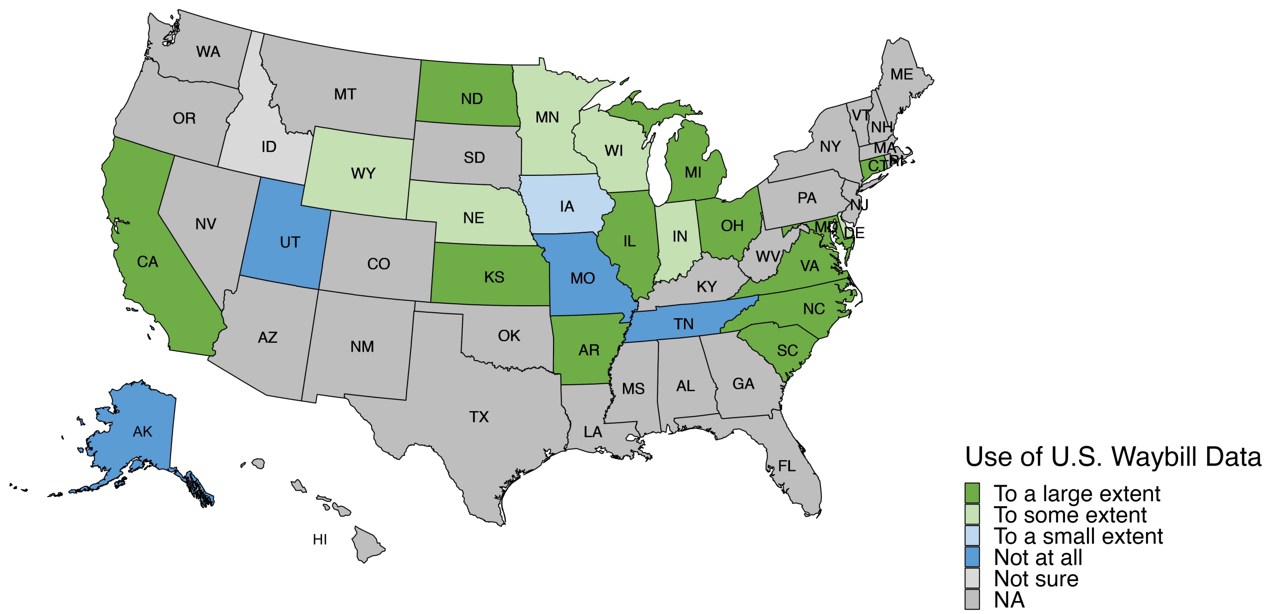

Figure E.2 Extent of use of the U.S Waybill database by state

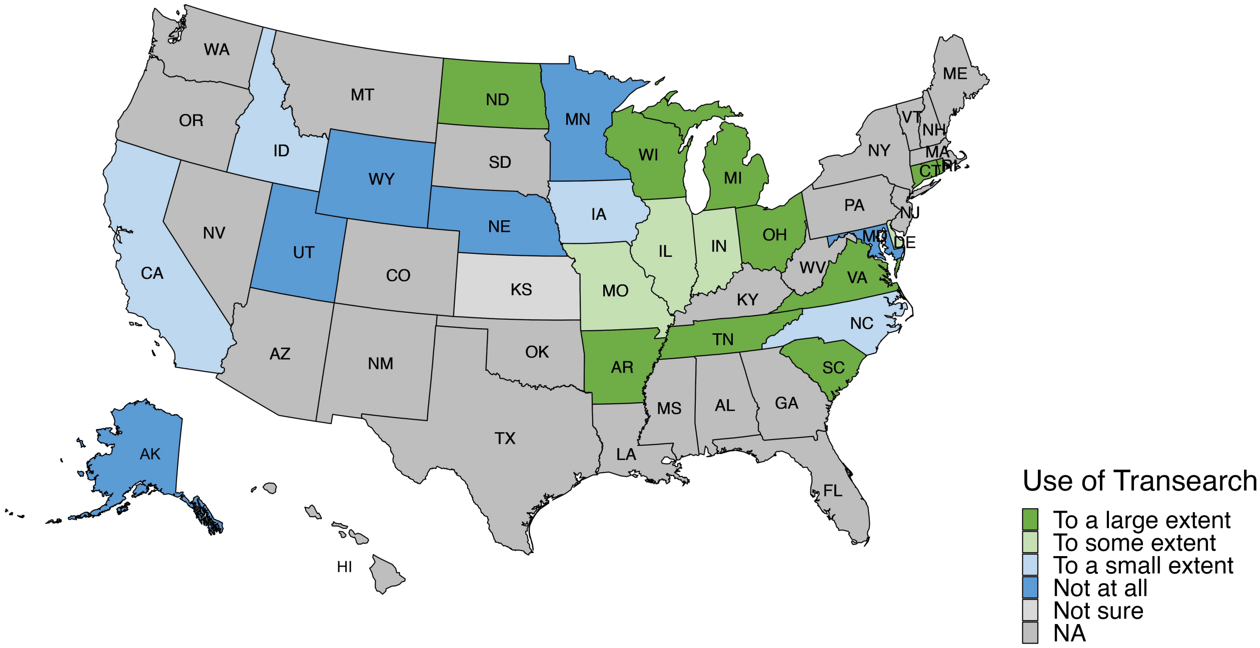

Figure E.3 Extent of use of the Transearch database by state

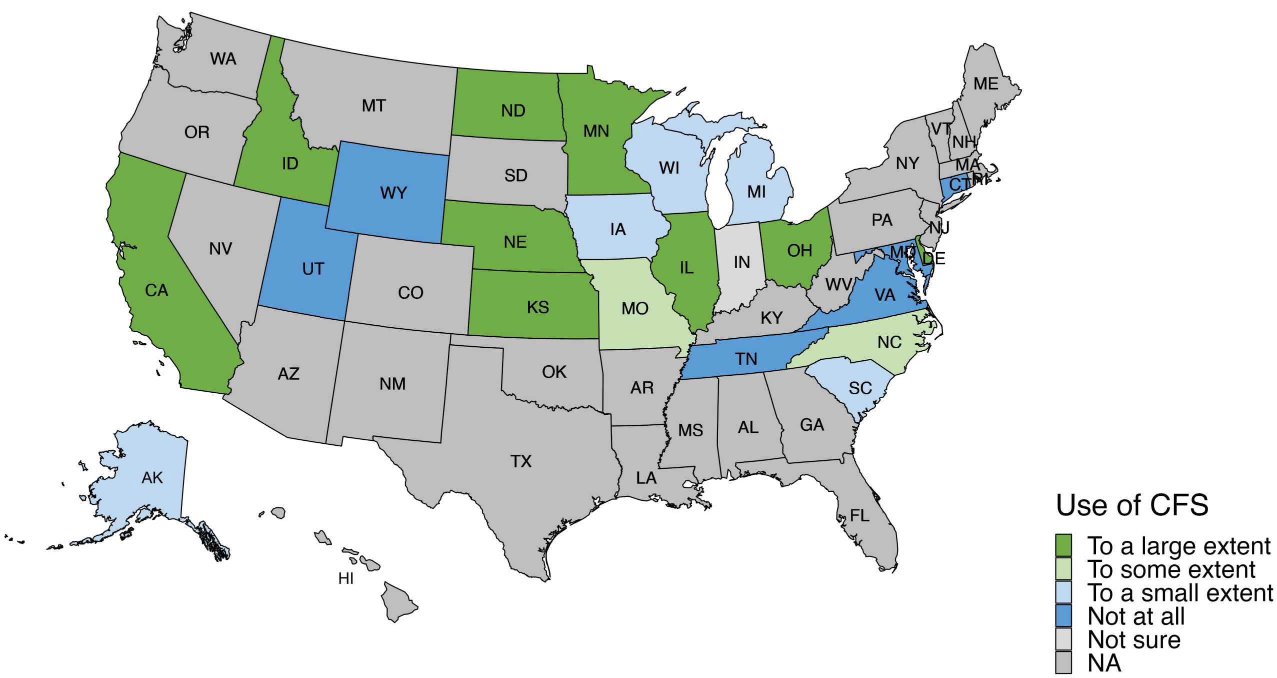

Figure E.4 Extent of use of the CFS database by state