U.S. Department of Transportation
Office of the Secretary of Transportation
Bureau of Transportation Statistics

Transportation Statistics Annual Report 2019:

The State of Statistics

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Notice

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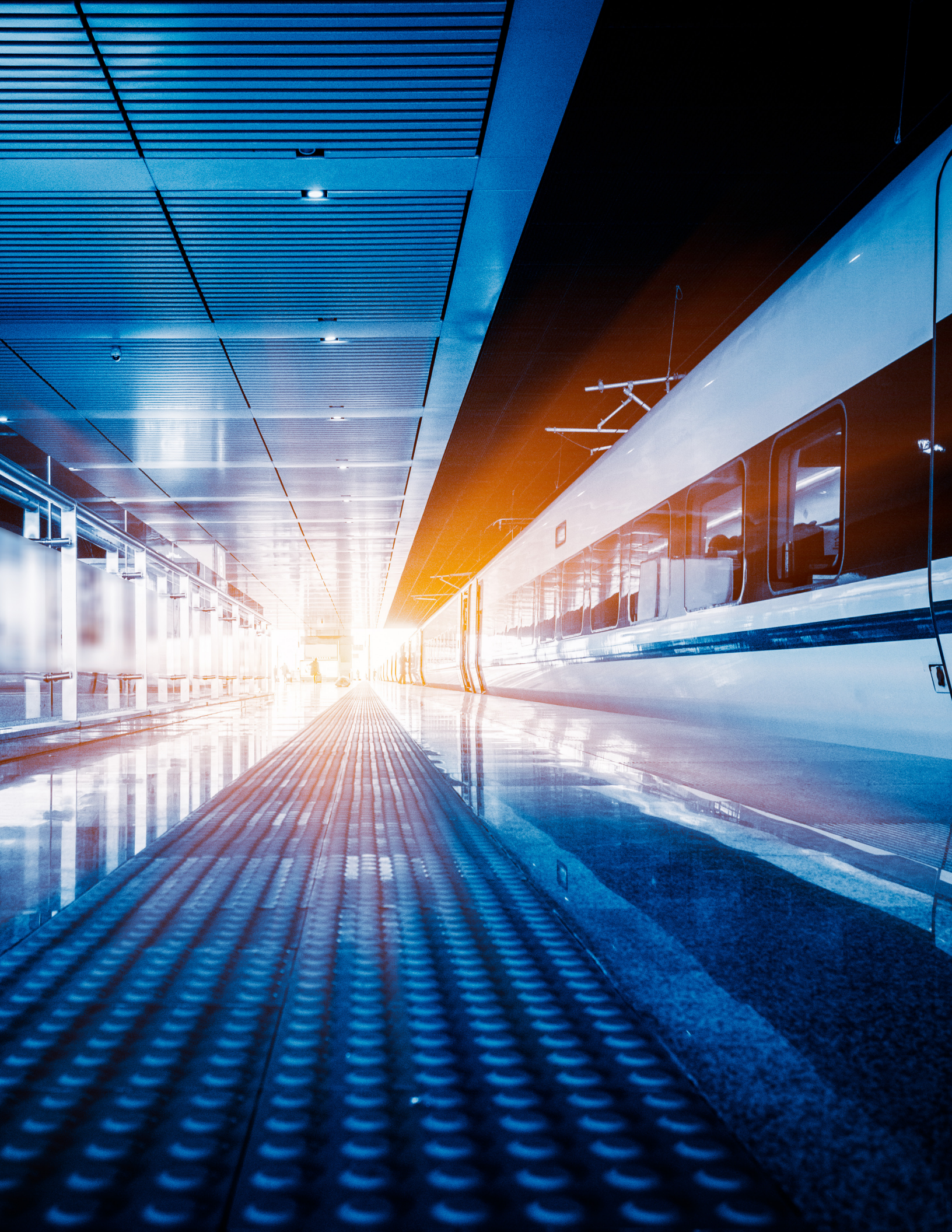
Table of Contents

Introduction

Transportation is important for how it serves and affects individuals, businesses, the economy, the environment, and the Nation. Statistics, maps, and their interpretation inform public and private decisions about transportation. To assure that statistics provide effective support for decision-making, Congress requires the Bureau of Transportation Statistics (BTS), in the U.S. Department of Transportation (DOT), to publish the *Transportation Statistics Annual Report* and assess the quality of transportation statistics and identify efforts to improve statistical information. BTS published the first *Transportation Statistics Annual Report* in 1994.

This 25th anniversary edition of the *Transportation Statistics Annual Report* highlights: recent legislation that underscores the importance of reliable statistics; the effects of emerging technologies on transportation; and how those effects can be measured. Following an assessment of the state of statistics on various aspects of the transportation system, this edition considers how emerging sources of information affect BTS programs and other data providers in the transportation community. The report concludes with a discussion of the strides BTS is taking to develop improved and relevant transportation statistics to better inform effective investment, operations, and policymaking.

BTS welcomes comment on the *Transportation Statistics Annual Report* and the Bureau's other products. Comments, questions, and requests for printed copies should be sent to bts@dot.gov or to the Bureau of Transportation Statistics, U.S. Department of Transportation, 1200 New Jersey Avenue SE, Washington DC, 20590.



Recent Legislation and the Importance of Transportation Statistics

Federal statutes, enacted in late 2018 and the beginning of 2019, codify emerging issues with regards to statistical information and underscore its importance in public decision-making and, hence, the value of BTS programs. These new laws include the Foundations for Evidence-Based Policymaking Act and the Geospatial Data Act.

Foundations for Evidence-Based Policymaking Act

The Foundations for Evidence-Based Policymaking Act[1] reinforces long-standing responsibilities of BTS to support decisions with objective, accurate, and timely information. Implementing many of the recommendations of the Commission on Evidence-Based Policymaking,[2] the Evidence Act outlines the responsibilities of federal statistical agencies, places in law a previous Executive Order for open government data, and codifies the Confidential Information Protection and Statistical Efficiency Act and Statistical Policy Directive No. 1.

The Evidence Act requires all departments to have a statistical official "to advise on statistical policy, techniques, and procedures,"[3] a Chief Data Officer, and an Evaluation Officer. The BTS Director, who already serves as the "senior advisor to the Secretary [of Transportation] on data and statistics," is the statistical official,[4] and the position of Chief Data Officer in DOT already exists in the Office of the Chief Information Officer. The Evaluation Officer, a new position in DOT, is charged with assessing the coverage, quality, methods, consistency, effectiveness, independence, and balance of evaluations, policy research, and ongoing evaluation activities of the Department. Some of the duties of these three officials overlap, and the emphasis on evaluation activities goes beyond DOT's traditional focus of performance measurement on basic indicators, measures of actionable conditions, and program output measures that are illustrated in Table 1. Since measures of actionable conditions may improve for reasons having nothing to do with the action taken, true outcomes must be measured through evaluations that determine whether the action taken caused the change in conditions. Statistics developed through evaluations are the outcome measures in Table 1.[5] Under the Evidence Act, the Statistical Officer may

[1] Pub. L. 115-435 (Jan. 14, 2019).

[2] Commission on Evidence-based Policymaking, *The Promise of Evidence-based Policymaking*. September 2017.

[3] 5 USC 314 (2019).

[4] 49 USC 6302(b)(3)(1).

[5] Data collection and analysis strategies for supporting evaluation studies are described in William R. Shadish, Thomas D. Cook, and Donald T. Campbell, *Experimental and Quasi-experimental Designs for Generalized Causal Inference*, 2nd Ed. Florence, KY: Cengage Learning, 2002. For an application to transportation, see R.R. Schmitt, "Design Considerations for Experiments in Major Regulatory Change," *Transportation Research Record*, 721: 29-34 (1979).

TABLE 1 Examples of Performance Measures for Transportation Safety

Questions to be answered	Type of measure
What is the state of transportation safety? Is it the same, getting better, or worse?	**Basic indicators**, such as fatalities per quantity of travel on the transportation system.
What aspects of transportation safety can be improved with specific actions?	**Indicators specific to actionable conditions**, such as fatalities involving distracted driving.
What actions have been taken to improve the actionable condition?	**Output measures**, such as level of federal investment in distracted driving countermeasures, number of states that implement distracted driving laws, and number of local school districts that include distracted driving in driver education courses.
Have the actions made a difference in reducing fatalities involving distracted driving?	**Outcome measures**, such as evidence that fatalities involving distracted driving were reduced as a consequence of investments, new laws, or education.

provide technical expertise and some or all of the data for use by the Evaluation Officer in developing true outcome measures.

Results from evaluation activities and other research are only useful if the findings, methods, and supporting data are made available for examination and use. Title 2 of the Evidence Act, also known as the Open Government Data Act, assures the availability of government data to anyone unless encumbered by confidentiality and security restrictions. Title 2 reinforces this availability with a mandate for the National Transportation Library (NTL), established in BTS in 1997, to:

- acquire, preserve, and manage transportation information for use by DOT, other federal agencies, and the general public;
- provide reference and research assistance;
- serve as a central depository for DOT's research results and technical publications;
- provide a central clearinghouse for transportation data and information of the Federal Government; and
- serve as coordinator and policy lead for transportation information access.[6]

The NTL leads DOT's implementation of open government data under DOT's *Plan to Increase Public Access to the Results of Federally Funded Scientific Research Results*.[7]

[6] 49 USC 6302.

[7] U.S. Department of Transportation, *Plan to Increase Public Access to the Results of Federally Funded Scientific Research Results*, Dec. 16, 2015.

Geospatial Data Act of 2018

BTS is one of the more active federal statistical agencies in the area of geospatial information. The first *Transportation Statistics Annual Report,* in 1994, dedicated a section to the promises of geographic information systems (GIS). While GIS technology has evolved over the last 25 years, some of the promised advances in geographic data remain elusive. For example, the Federal Government and the private sector maintain multiple representations of the Nation's highway system that do not always agree on locations of physical features that can be observed on the ground or measured from above.

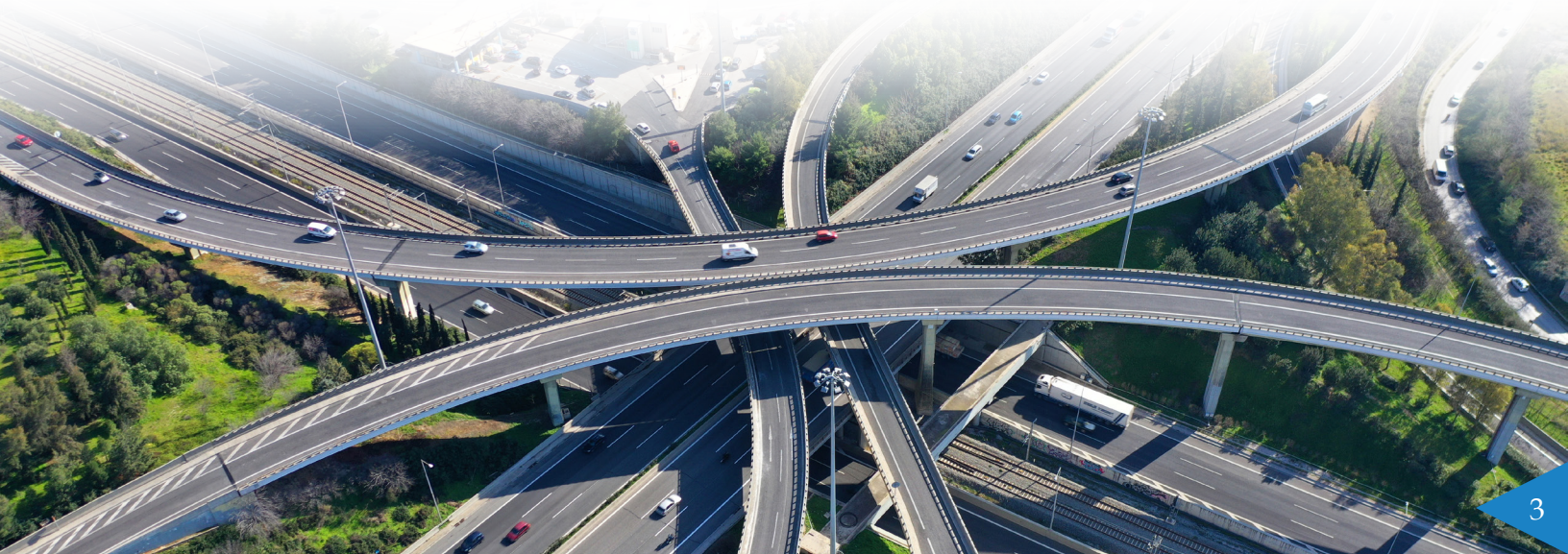
The Geospatial Data Act of 2018[8] attempts to reduce the inefficiencies and inconsistencies of public geographic data through mandated coordination and oversight. The Act codifies in law Executive Orders that created the Federal Geographic Data Committee and the National Spatial Data Infrastructure— "the technology, policies, criteria, standards, and employees necessary to promote geospatial data sharing throughout the Federal Government, State, tribal, and local governments, and the private sector (including nonprofit organizations and institutions of higher education)."[9] Under earlier legislation, BTS is required to "build and disseminate the transportation layer of the National Spatial Data Infrastructure, including by coordinating the development of transportation geospatial data standards, compiling intermodal geospatial data, and collecting geospatial data that is not collected by other entities."[10] Consistent with the Geospatial Data Act and the Information Quality Act, the National Transportation Atlas Database, produced by BTS, provides a consistent, accurate, and up-to-date representation of the transportation system and its consequences.[11]

[8] Federal Aviation Administration Reauthorization Act, Pub. L. 115-254, Secs. 751–759, 115th Cong. (Oct. 5, 2018).

[9] Ibid.

[10] 49 USC 6302(b)(3)(B)(vii).

[11] 49 USC 6309 (2019).



The Transforming World of Transportation: Changing What We Measure

The world that BTS was created to measure has evolved substantially. Technology is changing the nature and measurement of transportation in ways unprecedented since computers were first applied to forecast urban travel demand six decades ago. While some technologies are enhanced variations of traditional forms of transportation, such as ride-hailing based on apps rather than traditional taxicab services, other technologies, such as package delivery by aerial drones, are entirely new forms of transportation. To support forward-looking decisions, transportation statistics must reflect the operational, safety, economic, and societal aspects of autonomous transportation and other new technologies that provide transportation services. Furthermore, those technologies are leading to new business models for delivering mobility and generate new sources of data that could provide needed transportation statistics.

Changes in transportation technology include autonomous operation and widespread adoption of motor vehicle electrification. New motor vehicles are increasingly equipped with an array of driver assistance technologies that are intended to enhance safety— making the prospect of self-driving cars and trucks appear temptingly close. A crewless vessel has already delivered oysters across the English Channel, autonomous air taxis are under development, and major vehicle manufacturers are expanding plans to replace many of their offerings of petroleum-powered automobiles and trucks with electric versions. Prototypes of battery powered aircraft have been developed for short-haul, low-altitude passenger movement; local delivery of goods by battery powered aerial and surface drones is in active testing; and battery powered scooters are already common in many cities.

These changes in transportation technology and in providing transportation services raise new questions that warrant development of new statistics or reinterpretation of traditional statistics. Many of these questions are embedded in the 2019 critical issues list by the Transportation Research Board.[12] How much will ride-hailing services, personal and shared bicycles, and electric scooters supplant growth in single-occupant auto trips? How will transit ridership be affected? Will shared services or automated vehicles with low operating costs significantly improve mobility for households that cannot afford personal vehicles? How should the effects of automated vehicles on parking demand be measured? Will autonomous vehicles affect the number of vehicles and vehicle use, which in turn affects revenue provided for highway construction and maintenance

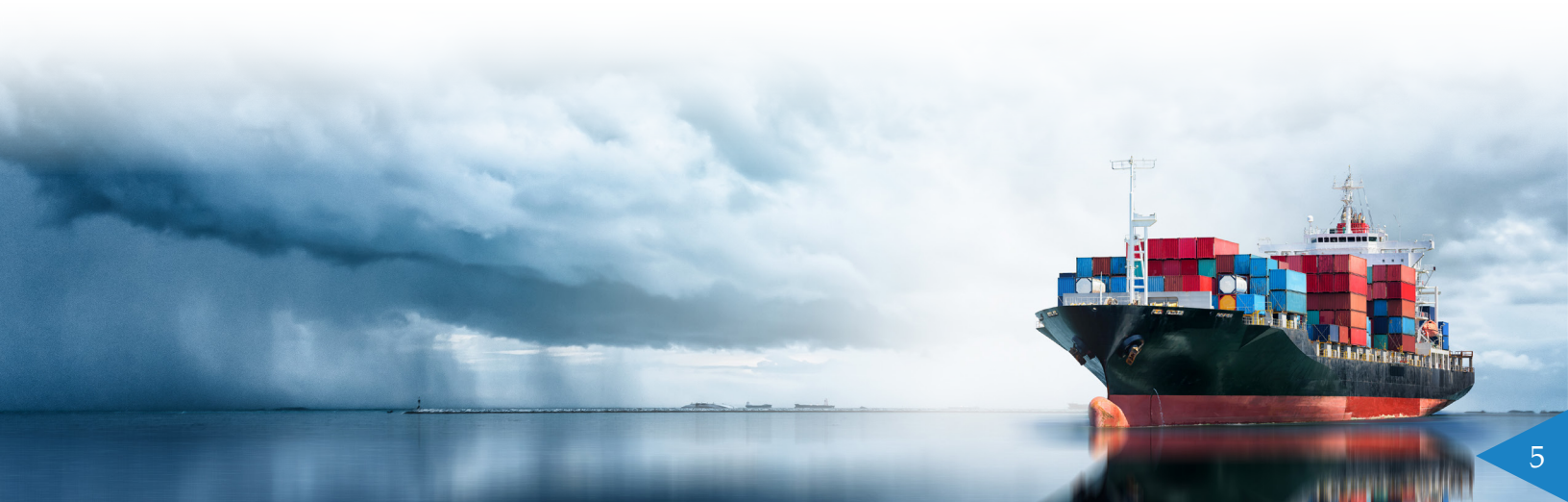
[12] https://www.nap.edu/resource/25314/criticalissues/

from vehicle registrations and fuel taxes? How will autonomous vehicles affect the number and types of jobs for vehicle drivers, mechanics, and technicians? Will driver assistance technologies change the types of safety risks that are monitored? By allowing the occupant to do things other than driving, will autonomous vehicles reduce the importance of travel time?

How will widespread electrification of transportation modes affect gas tax revenues that support infrastructure investment? How should the full environmental consequences of mining, producing, and consuming or disposing of transportation fuels and vehicle and battery components be measured? How should adequate coverage of battery recharging infrastructure and refueling stations for alternative fuels be determined?

Changes in technology beyond transportation raise additional questions warranting consideration in transportation statistics. How does the pervasive availability of wireless communication, easy internet access to information on everything from consumer goods to travel destinations, additive manufacturing with three-dimensional (3D) printing, the growth of part-time employment, and other aspects of the emerging digital economy affect travel demand and logistics? How will widespread adoption of automation in freight transportation affect the workforce? How does the technology-enabled ability to work from home and to obtain goods via overnight delivery almost anywhere in the Nation affect how mobility and geographic accessibility should be defined and measured?

Cultural shifts and other forces beyond technology raise even more questions that warrant statistical insights. How does an aging population change patterns of passenger travel and affect transportation safety? How do changes in household income affect patterns of passenger travel? How does an aging population and changing incomes affect consumption patterns that in turn affect the demand for freight movement? How does increased public attention to healthy lifestyles affect bicycle travel and walking? How does an increased emphasis on recycling affect what is transported and materials used in transportation? How do natural disasters affect travel demand, goods movement, and transportation system performance?



Strengths and Challenges in Current Transportation Statistics

The U.S. transportation system binds together a society and an economy that spans the North American continent and connects the Nation to the rest of the world. Decision-makers and the public ask questions about the system to better understand how well transportation connections are working and how the system can be improved:

- What is the extent and capacity of the system, and how much capacity is used?
- Is the system in a state of good repair?
- How well is the system performing from the perspectives of those who provide the system and those who use the system?
- How well does the system move people and goods?
- How well does the system serve the economy and promote economic growth?
- How does transportation activity reflect the health of the economy?
- How safe is the transportation system?
- What are the consequences of transportation for energy and the environment?

While statistics exist to answer aspects of these questions, shortcomings in the statistics hamper informed decisions that affect people's lives and livelihoods.

System Extent, Capacity, and Use

The extent and capacity of the transportation system is typically characterized by the system's modal components, including the highway, railroad, waterway, pipeline, and aviation networks. Use is characterized by the number of vehicles, vessels, and craft operating on those networks. Statistics are generally available to the public on a national scale for aviation, highways, transit systems, and waterways because the Federal Government operates the aviation and inland waterway systems and provides financial assistance for highways and transit systems. Publicly-available statistics on railroads, pipelines, and ports are limited because those entities are either privately owned or privately operated on leased public facilities.

Data on the extent, capacity, and use of transportation infrastructure are maintained by DOT's modal administrations:

- The Federal Highway Administration (FHWA) receives network data and estimates of vehicle travel from state departments of transportation.
- The Federal Railroad Administration (FRA) acquires infrastructure data from instrumented FRA railcars operating over the railroad network.

- The Federal Transit Administration (FTA) obtains extensive summary information from operators of public transit systems.

- The Federal Aviation Administration (FAA) collects extensive data on the extent, capacity, and use of aviation networks and airports that it operates or includes in its National Plan for Integrated Airport Service.

- The Pipeline and Hazardous Materials Administration (PHMSA) maintains information on the pipeline network, though geographic detail is not publicly available for security reasons.

Outside of DOT, the U.S. Army Corps of Engineers collects domestic waterway data from commercial vessel operators and the facilities operated by the Corps.

BTS compiles and publishes data on the extent and characteristics of the Nation's transportation network in the National Transportation Atlas Database (NTAD).[13] BTS updates the NTAD continuously and adds new layers of information as new geospatial data are made available.

BTS also publishes nationally consistent statistics on port capacity and throughput through its Port Performance Freight Statistics Program.[14] This program is necessary because many of the statistics published by individual ports are not comparable from port to port.

Public transit system operators who receive federal funds report system-wide information to the FTA. However, these data could be improved by the addition of facility and segment-specific usage data. National data on transportation services provided by school districts for students, social service agencies for their clients, charter bus operators for groups of travelers, or taxis and other ride-hailing services are lacking, even though these services may provide a substantial portion of mobility resources in many areas. Although little nationwide information is available on bicycles, BTS and its partners are now exploring sources of data on the upsurge of electric scooters for rent in many cities. Information on the use of these services is key to understanding how well communities are served and may be influencing changes in public transit use. Effective understanding of all available services for passenger mobility is important for guiding investments in various modes and for guiding programs that aid the mobility impaired.

Understanding of passenger mobility services is further challenged by technological change. One bright spot is the adoption by many transit properties of the General Transit Feed Specification (GTFS) for publishing schedule and arrival information for customers. GTFS-based data indicate the extent and frequency of service. A growing number of transit properties also provide their GTFS information to BTS for inclusion in the

[13] www.bts.gov/geospatial/national-transportation-atlas-database

[14] www.bts.gov/ports

National Transit Map. BTS is working with intercity bus carriers to expand the use of GTFS and the coverage of the National Transit Map to include scheduled intercity bus service.

Data on intermodal connections, including GTFS-based data that reflect connections between intercity and local passenger services, are published in the NTAD. Data on intermodal connections for passenger and freight include ports and docks, airports, intercity rail and local transit terminals, and bike-share facilities. Truck terminals, motor vehicle rental facilities, and pipeline terminals are poorly represented in publicly available databases.

Transportation investment decisions at all levels of government would benefit from a more complete picture of available transportation services and an understanding of system capacity. Even though most travel is in personal vehicles, significant portions of the population depend on transportation service providers for mobility. Some locations and population groups may appear to be underserved when nontraditional transportation services are actually meeting mobility needs. Other locations and population groups may appear to have adequate transportation services, but those services do not connect to needed destinations or do not operate at a time when mobility is desired. Some facilities and services may provide the desired connection but lack the capacity to accommodate existing levels of passenger travel and freight demand. Capacity is a key aspect of system performance, discussed in the following section, and affects both transportation service providers and individuals who are using the transportation system. Capacity is difficult to measure because physical constrains can be exacerbated or improved by the ways in which the system is operated.

System Condition and Performance

FHWA and FTA report extensive statistics on condition and performance in the biennial reports on *Status of the Nation's Highways, Bridges and Transit: Conditions and Performance*.[15] The FAA provides similar information on airports in its biennial *National Plan of Integrated Airport Systems* (NPIAS) report.[16]

Measures of system condition are specific to the individual transportation modes. For example, the condition of airport runway pavement is measured by visibly descriptive categories, while highway pavement condition is represented by pavement roughness that is measured by vehicle-mounted instruments. Bridge condition is based on observable characteristics, such as cracking, spalling, and scour, summarized in sufficiency ratings that were formerly characterized as structurally deficient or functionally obsolete and now characterized as good,

[15] www.fhwa.dot.gov/policy/2015cpr/

[16] www.faa.gov/airports/planning_capacity/npias/reports/

fair, or poor.[17] Age is occasionally used as a surrogate for condition, especially for vehicle and aircraft fleets, and for locks on inland waterways, though age does not reflect how investments in repair and rehabilitation can maintain good condition.

Measures of system performance are most commonly based on travel speed and reliability. Congested conditions are assumed to exist when actual speeds drop below posted speed limits, and reliability is typically measured as the difference between actual arrival times versus scheduled or estimated arrival times when routes are uncongested. Speed data are available for motor vehicles, ships, and commercial aircraft, and average system speed is published by the major railroads. On-time performance statistics are published for commercial aviation, Amtrak, and commuter rail.

Most current and planned statistics on performance are from the perspective of those who build and operate the transportation system. To serve this point of view, transportation providers are collecting data on asset management and traffic operations with greater coverage and geographic detail than ever before. An emphasis on optimizing system performance requires real time data on traffic regardless of mode, from traffic signal synchronization on roadways to the Nation's air traffic control system.

[17] www.fhwa.dot.gov/bridge/britab.cfm

The system provider perspective is important but incomplete unless it is complemented by performance measures from the user's perspective. For example, a transportation system that spreads delay evenly over all travelers may be better tolerated than a system that concentrates the same total delay on only a portion of the travelers. Delay also matters more for some trip purposes than others. For example, delay is critical for responses to medical emergencies but may only be a minor irritant for leisurely sightseeing. For any trip purpose, commercial aviation delay is frustrating when it causes travelers to miss connecting flights. In freight transportation, delay is generally a more costly problem for shippers of perishable or high-valued goods than it is for shippers of bulk commodities, though unreliability is a costly problem for all shippers and carriers of freight. Statistics on delay rarely identify which users, types of travel, or types of businesses are affected or how frequently individuals, groups, and freight are delayed.

Moving People

The Nation's transportation system accommodates extensive local and long-distance travel to meet the demands of U.S. residents and foreign visitors. Local travel typically involves daily trips for work, school, shopping, recreation, and other services. Long-distance travel is less frequent and may respond to a different mix of purposes. Modal usage also differs between local and long-distance travel, with public transit a significant part of the

former and aviation a significant part of the latter.

National statistics on long-distance and local travel on individual modes or through specific facilities are drawn from sources such as the FTA's National Transit Database,[18] Amtrak ridership data, the monthly BTS data on airline passenger enplanements,[19] and the biennial National Census of Ferry Operators conducted by BTS.[20] In addition, monthly data on inbound border crossings collected by Customs and Border Protection are made available by BTS.[21] These mode-specific and facility-specific sources do not include data on travel by personal vehicles, intercity and charter buses, and general aviation.

Most national statistics on passenger travel by personal vehicle and on the characteristics of travelers and trips come from the National Household Travel Survey (NHTS), sponsored by FHWA and several states and metropolitan planning organizations.[22] The NHTS collects information on individual trips and the demographic and other characteristics of the traveler that influence his or her decision on when, how, and how far to travel. Although the NHTS collects all personal travel taken by all modes of transportation, it mainly captures daily local travel. The high cost of conducting this type of nationwide survey has limited the frequency of this survey to once every 5 to 8 years. Despite these limitations, NHTS remains the only national source that provides the comprehensive data needed to understand travel decisions and forecast travel demand. FHWA is exploring strategies to obtain annual data by asking fewer questions to fewer households in an annual NHTS and supplementing the NHTS with data from alternative sources.

The Census Bureau's American Community Survey (ACS) is another commonly used source of data on travel by all modes for commute-to-work.[23] The ACS collects these data from an annual survey of the population. This survey provides small-area information every year, unlike the once-per-decade information formerly provided by the decennial census. The ACS also provides commute-to-work statistics for small units of geography aggregated over several years, whereas estimates from the NHTS are valid only

[18] U.S. Department of Transportation, Federal Transit Administration, National Transit Database, available at www.transit.dot.gov/ntd as of April 2019.

[19] U.S. Department of Transportation, Bureau of Transportation Statistics, Airline Passengers Enplanements, available at www.transtats.bts.gov/ as of April 2019.

[20] U.S. Department of Transportation, Bureau of Transportation Statistics, *Highlights of the 2016 National Census of Ferry Operators* (October 2017), available at www.bts.gov/ncfo as of April 2019.

[21] U.S. Department of Homeland Security, Customs and Border Protection, Office of Field Operations, Planning, Program Analysis and Evaluation Directorate; Enterprise Reporting and Data Systems Division.

[22] U.S. Department of Transportation, Federal Highway Administration, *National Household Travel Survey* 2017, available at nhts.ornl.gov/ as of April 2019.

[23] U.S. Department of Commerce, Census Bureau, American Community Survey, available at www.census.gov as of April 2019.

at the national and state levels and for selected metropolitan areas. BTS uses data from the NHTS and ACS to estimate trip generation at the Census Tract level in its Local Area Transportation Characteristics of Households program.[24]

Data from the NHTS, the ACS, and other sources are central to understanding how transportation is affected by population shifts across demographic groups and across geography. Declining population and economic activity in rural areas, generational differences in driving behavior, and other shifts in geography and demographics may place different demands on the future transportation system that may or may not be served effectively through planned investments by the public and private sectors.

While data are available on the number of trips on commercial aircraft and intercity rail, nationally consistent measures of long-distance travel in personal vehicles, regular-route intercity buses, charter buses, and general aviation are not collected. The demographic characteristics of the long-distance traveler by mode, useful for estimating future demand, have not been measured for over two decades. As a consequence, current discussions about trends in passenger travel and the consequences of travel are dominated by measures of local travel. This limitation may result in less well-informed decisions on regional investment because long-distance travel involves different trip purposes and conditions than does local travel, and one long-distance trip can generate as many miles of travel as dozens or even hundreds of local trips. More data on long-distance travel would be useful in efforts to support transportation decisions, such as how the total of local and long-distance travel contributes to safety risks.

Moving Goods

In addition to travelers, the transportation system serves the movement of freight. Statistics on shippers and carriers who use the transportation system, on the transportation decisions made by shippers and carriers, and on goods moved are key to determining whether problems with transportation system performance warrant public action.

Due to the magnitude and complexity of freight transportation, no single data collection provides a comprehensive picture of annual freight movement from origin to destination by all modes of transportation and by all commodity types. Among the various data sources, the Commodity Flow Survey (CFS), conducted by the Census Bureau for BTS, provides the most far-reaching coverage of U.S. freight flows.[25] The CFS is the only source of nationwide data on domestic freight shipments by manufacturing, mining,

[24] U.S. Department of Transportation, Bureau of Transportation Statistics, Local Area Transportation Characteristics for Households, available at www.bts.gov/latch as of May 2019.

[25] U.S. Department of Transportation, Bureau of Transportation Statistics, 2017 Commodity Flow Survey Preliminary Data, available at www.bts.gov/ as of April 2019.

wholesale, and selected retail industries covering all modes of transportation. It also is the only source of comprehensive data on domestic hazardous material shipments. The CFS is conducted every 5 years as part of the Economic Census.

The Freight Analysis Framework (FAF) builds on the CFS to provide national estimates of total freight movement by 7 modes of transportation and 42 commodity groupings for 132 regions.[26] The CFS contributes roughly two-thirds of the tonnage and value measured in the FAF. The remaining freight is estimated based on multiple, publicly available data sources, such as the BTS Transborder Freight Data, which provides details on freight flows across U.S. land borders.[27] The FAF combines these sources into a time series of 5-year benchmarks based on the CFS, annual estimates, and 30-year forecasts.

The FAF is based on observed data wherever possible, but relies on models and inferences to fill the remaining data shortcomings in the 5-year benchmarks and to make annual updates and forecasts. Among the benchmark data shortcomings requiring significant modeling are shipments from farms, the movement of municipal solid waste, and the domestic transportation of foreign trade. While movements of goods between U.S. international gateways and foreign countries are tracked continuously, movements of international trade between gateways and domestic origins for exports and domestic destinations for imports have not been measured since the 1970s. Since 2003, the value of merchandise trade increased by 54 percent in inflation-adjusted terms and the movement of these goods within the United States is placing pressure on the domestic transportation network across all modes. These domestic flows of international trade may be large enough in some areas around major ports and gateways to contribute significantly to congestion and to affect international competitiveness of economic development in local areas.

While the FAF provides a comprehensive picture of freight movement at the national and regional levels – to and from 132 regions – few local data collection programs exist to provide local pictures of freight movement, which are essential for understanding and serving the "last mile" of freight movement. Local freight delivery is especially affected by significant changes in the freight system as online shopping becomes more prevalent and new distribution strategies and delivery technologies are deployed. New data collection approaches may be required to capture potential changes in freight flows caused by e-commerce, the use of retail outlets as mini-distribution centers, shifts in supply chains, the use of robotic systems on the ground and in the air for local delivery, and shifts in economic

[26] U.S. Department of Transportation, Bureau of Transportation Statistics, Freight Analysis Framework, available at www.bts.gov/faf as of April 2019.

[27] U.S. Department of Transportation , Bureau of Transportation Statistics, Transborder Freight Data, available at www.bts.gov/transborder as of April 2019.

activity among regions and sectors of the economy.

The FAF measures flows between regions, however shipper decisions are based on many factors beyond geography, such as cost and logistical requirements of their individual supply chains. Information on specific supply chains is generally limited to case studies. Supply chains vary enormously by industry and can be specific to individual companies. Proprietary concerns have traditionally inhibited the ability of public agencies to study and understand the decision-making of shippers and carriers that ultimately affect the geography of goods movement and the performance of freight transportation systems.

Transportation Economics

Transportation plays several vital roles in the American economy; it enables economic activity and is a major economic activity in its own right. Transportation contributes to the economy by enabling the movement of people to places of employment and consumption, and goods between producers and markets, over short and long distances. It thereby enables a large economy to function and grow. The transportation sector also is important in terms of private and government expenditures for transportation facilities, infrastructure, and systems. Households, businesses, and the government directly consume transportation goods, including vehicles, and services, such as commercial aviation. Transportation also is a major contributor to the balance of payments, through exports of aircraft for example.

Transportation's role in the economy is measured by statistics on expenditures by households and businesses for transportation services, employment in transportation industries and occupations, and the contribution of transportation industries to gross domestic product (GDP). These statistics come from the Census Bureau, the Bureau of Economic Analysis (BEA), and the Bureau of Labor Statistics, each of which treats transportation as a significant sector of the economy. Based on these statistics, BTS develops Transportation Satellite Accounts to capture the true contribution of transportation to the economy.

For-hire transportation is one of the many sectors covered in the Economic Census, conducted every 5 years. This sector is also covered in the Census Bureau's Services Annual Survey, which collects operating revenue and other industry-specific data. BEA uses these data to estimate the flow of expenditures among sectors of the economy in order to understand how changes in the costs in a specific sector affect the rest of the economy. BTS expands on this accounting in its Transportation Satellite Accounts to include the sizable contribution to the economy made by in-house transportation services within non-transportation industries, such as truck fleets operated by large retail companies and grocery chains.[28] BTS also estimates

[28] www.bts.gov/satellite-accounts

the economic contribution of personal transportation that falls outside the standard accounting of GDP.

Because transportation is not often highlighted in monthly national economic statistics, BTS developed the monthly Transportation Services Index (TSI) to provide a perspective on transportation's role in a dynamic economy.[29] This index is based on activity in all modes of for-hire passenger and freight transportation services. BTS also collects quarterly air carrier financial statistics, including net profits, net income, operating revenue, air fares, and baggage fees. These statistics provide a better understanding of the relationship between transportation and the current and future course of the economy.

BTS publishes the costs to produce transportation services and the prices paid by users to use those services. The cost to produce transportation services stems from the resources it requires—labor, equipment, fuel, and infrastructure. Although data exist for transportation services, there is little data on the cost and price to build infrastructure. The closest metrics, the National Highway Construction Cost Index, measures the average change over time in the prices paid by State transportation departments for roadway construction materials and services. Construction costs affect the amount that governments invest in new roads, highways, and bridges. BTS also publishes the value of capital stock and investment in transportation infrastructure and other assets. This includes the net value of U.S. transportation capital stock, of private and public investment in highways and streets and other new transportation structures, and household spending on durable transportation goods.

Among weaknesses in the understanding of transportation and the economy, two are most acute. First, data on the cost of shipping goods is not well understood. The lack of cost data hinders development of policies that integrate the cost of product transportation for businesses and consumers into transportation programming and policy decisions. Second, accounting of the balance between public revenues and public expenditures is typically based on traditional public investment in which collected revenues are used to pay for investments, complicated only by borrowing. Public-private partnerships may require a very different accounting scheme to understand levels of investment and financial liability in the transportation system. Without an accurate accounting, standard statistics for economic decisions, such as return on investment, are difficult to estimate. BTS is in the early stages of developing a roadmap to improve and expand the transportation financial data series.

Safety

Traditionally, fatality, injury, and crash metrics are used to assess transportation safety. As described later, these metrics

[29] www.transtats.bts.gov/OSEA/TSI/

are useful indicators of the state of the system, but additional information related to human factors, safety features of transportation infrastructure and equipment, and other measures are needed to guide actions to make travel safer.

Safety is the main focus for DOT's largest statistical programs. The National Highway Traffic Safety Administration (NHTSA) and the Federal Motor Carrier Safety Administration (FMCSA) account for almost 40 percent of the expenditures on major statistical programs in the Department.[30] PHMSA and FHWA also have large-scale safety programs in place, FAA sponsors a major safety data sharing program with the aviation industry, and the safety data programs in FRA and FTA are growing. Altogether, the Department's annual expenditures on safety data exceed $50 million spread across its operating administrations.

In addition to its long-standing safety data programs, DOT is exploring new sources of information and new analytical strategies to better understand safety risks. The Safety Data Initiative includes multiple DOT pilot efforts to integrate and analyze large databases, including real-time data sets in the private sector, such as Waze, that have not been previously tapped for risk analysis.[31] The initiative initially focuses on highway safety because highways account for the preponderance of transportation fatalities and injuries. The Solving for Safety Visualization Challenge is another element of the Safety Data Initiative in which participants develop innovative visual analytics tools to gain insights on crashes and an understanding of transportation safety.

A holistic response to safety problems must be informed by integration of data on conditions of the driver, the conditions surrounding each crash, and consequences of the crash. In the case of highways, integration of police reports, crash investigations, and health records remains elusive, hindering a robust understanding of crash risk factors and optimal responses to those risks.

In comparison to highway fatalities, the relatively low fatality rates of commercial aviation, rail, transit, waterborne, and pipeline transportation do not reduce the need for data to understand risks and maintain or improve the safety of these modes. The focus of data programs for these modes goes beyond determining causes of infrequent crashes to understanding circumstances surrounding near misses or other mishaps that could have resulted in a serious incident. To identify safety problems and develop information for mitigating those problems, BTS developed a confidential close calls reporting system that allows individuals

[30] Executive Office of the President of the United States, Office of Management and Budget, *Statistical Programs of the United States Government: Fiscal Year 2018* (Sept. 30, 2017), p. 67, available at www.whitehouse.gov/ as of April 2019.

[31] www.transportation.gov/content/safety-data-initiative

and companies to report near misses without fear of retaliation. Anonymity of respondents is assured under the Confidential Information Protection and Statistical Efficiency Act.[32] The Washington Metropolitan Area Transit Authority uses this BTS authority to collect the near miss events of its rail and bus operations, and the Bureau of Safety and Environmental Enforcement of the U.S. Department of the Interior uses this program for near misses in off-shore oil extraction.

Energy and the Environment

Measures of energy and environmental effects of transportation include energy products as a source of demand for freight transportation (e.g., the movement of coal by railroad and natural gas movement through pipelines); the cost and quantity of energy consumed by each mode of transportation; and the number of vehicles and vessels by fuel type or source of energy. Many of the measures come from the Energy Information Administration.[33] Additionally, BTS compiles statistics on transportation noise. This product provides a national picture of transportation-generated noise from both highways and airports.[34] These statistics are used to quantify transportation-related noise exposure on the human environment.

Energy efficiency in transportation is typically measured as vehicle-miles per gallon and when possible measured as passenger-miles and ton-miles per Btu (British thermal unit) to more fully represent system efficiency by including vehicle occupancy rates and load factors. Unfortunately, vehicle occupancy rates are not available on an annual basis, and reliable data on freight conveyance load factors are also lacking. Information about vehicle occupancy rates is available from infrequent surveys, such as the NHTS. Data on actual occupancy rates based on field observation are costly, rare, and not comprehensive. BTS is seeking innovative ways to gather vehicle occupancy data to help in understanding the propensity to share travel and, hence, reduce vehicle trip demand.

While individual agencies compile information to meet specific needs, integrating these data and developing analytical techniques from many disciplines are the keys to effectively using these data sources to help improve mobility-related energy efficiency and other impacts. For example, the relationships between vehicle usage patterns and energy usage intensity are crucial. BTS is collaborating with several federal partners to reinstate the Vehicle Inventory and Use Survey (VIUS) which has not been conducted since 2002. The results will provide data for traditional applications, such as vehicle size and weight studies, to track the deployment of driver assistance technology, for input to freight demand models, and to measure the economic activities performed with motor vehicles.

[32] 44 USC 3561-3564, 3571, 3572, 3575, 3576 (2019).

[33] www.eia.gov/consumption/

[34] www.bts.gov/geospatial/national-transportation-noise-map

Energy and safety concerns converge in the transportation of crude petroleum, ethanol, and other hazardous cargo. In response to the Fixing America's Surface Transportation (FAST) Act of 2015,[35] BTS worked with the Association of American Railroads to measure the use of tank cars for carrying these dangerous goods—distinguishing tank cars that meet new standards from those that have not been brought up to standard or switched to non-hazardous use. BTS continues to publish summary statistics in its annual report,[36] including statistics on planned construction and retrofits of existing tank cars to new standards.

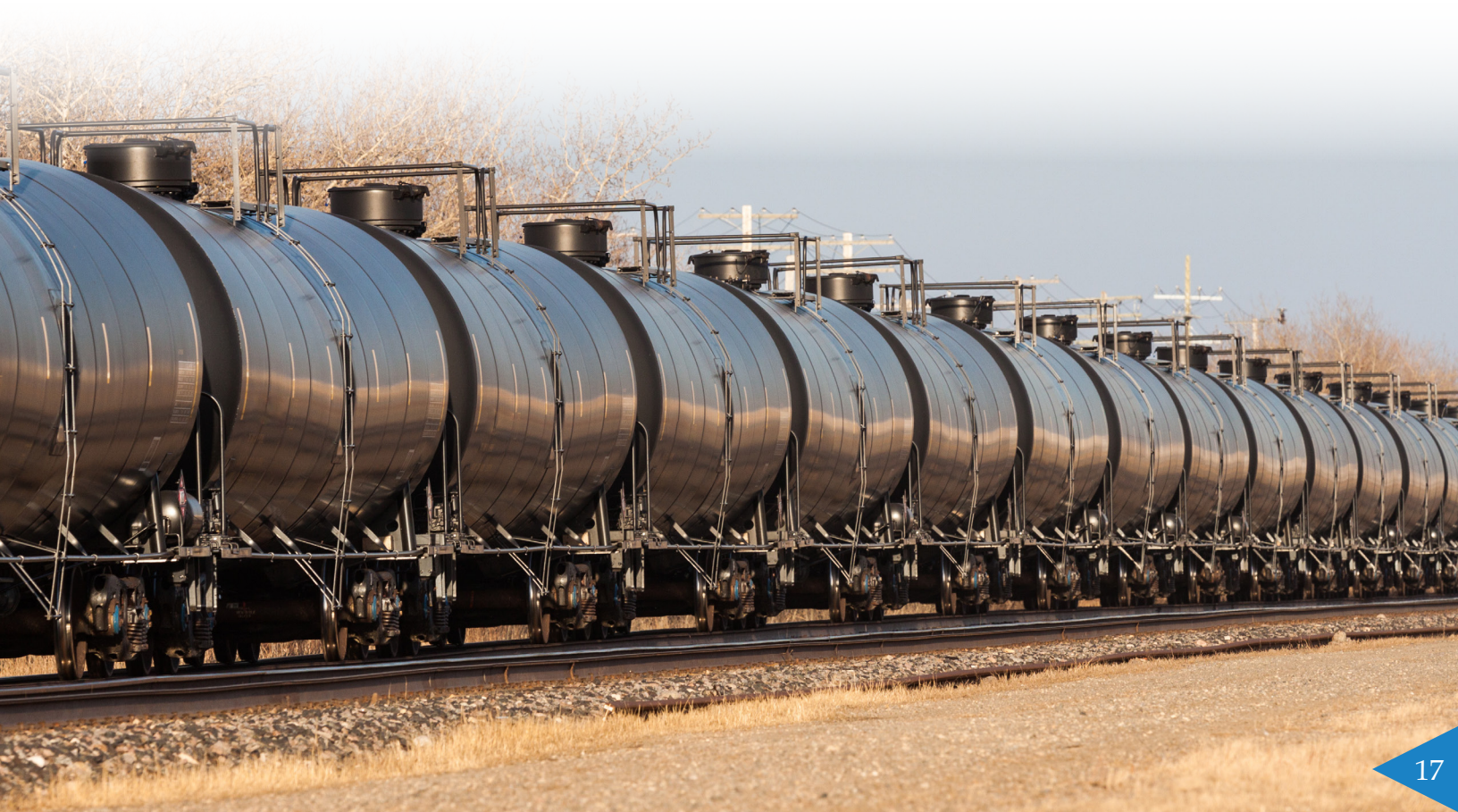
[35] Pub. L. No. 114-94, Dec. 4, 2015.

[36] U.S. Department of Transportation (DOT), Bureau of Transportation Statistics (BTS), *Fleet Composition of Rail Tank Cars That Transport Flammable Liquids*, annual editions, available at rosap.ntl.bts.gov/view/dot/35540 as of April 2019.

New Forms of Information to Measure Transportation

New technology is creating a world flooded with data from satellites, cell phones, highway traffic control systems, vessel tracking systems, and "smart devices" in homes, workplaces, and in vehicles. While data are being generated by many new sources, methods for accessing and using the flood of data intelligently and accurately—especially for public decisions—are far less developed than the traditional world of surveys and administrative records.

Some information can only be obtained by asking questions of travelers, shippers, or transportation service providers through a survey. However, declining response rates,



increased costs, respondent burden, and accommodation and privacy protections for data make surveys an alternative for data collection methods rather than the only choice.

Data sources and collection methods beyond surveys include:

- administrative records, such as vehicle registration files and police reports from highway crashes;
- sensors, such as rubber hoses stretched across highways to count traffic, engine monitors to estimate fuel economy, and positions reported by cell phones to track travel and by transponders to track ships and aircraft;
- imagery, such as traffic monitoring cameras and satellite photos;
- crowd sourcing, such as Open Street Map[37] for tracking changes in the highway network and Waze[38] for tracking highway disruptions; and
- web scraping, such as the Billion Prices Project[39] for tracking the prices of consumer goods.

While these data sources and methods show great promise, the availability of data alone does not assure that robust statistics exist to help answer the questions of decision-makers. Technology-based data typically provide narrower windows on the phenomena measured than do surveys, placing a premium on data integration and statistical representation. New technologies also raise major privacy, confidentiality, and intellectual property issues. Significant quality issues, inadequate methods for analyzing data to create effective information, and confidentiality concerns can undermine the effectiveness of these data to generate credible public statistics.

Data quality is a critical aspect because all datasets are subject to errors. Sensors break or are poorly calibrated. Administrative records suffer from misspellings, duplicate names for different individuals, and incompatible categories of information collected about those individuals. Coverage limitations can bias resulting statistics.

Statistical agencies have extensive, well-established methods for identifying and controlling for error in data from well-designed sample surveys, but methods are less developed for dealing with errors in data from sources other than surveys. Some sources of error in data from alternatives to surveys are analogous to those found in surveys. Other sources of error may require very different approaches for identification and correction. The challenge is compounded when data are blended from many sources for an estimate. For instance, do the individual sources of error cancel each other out or compound one another?

[37] www.openstreetmap.org

[38] www.waze.com

[39] www.thebillionpricesproject.com

The data challenge is exacerbated by the dynamics of transportation technologies and business models. The pace of change and the diversity of contexts make data collection and use challenging. The dramatic changes in Transportation Network Company (TNC) availability and pricing, for example, make early data not particularly useful for understanding current or future trends in different locations. Similarly, the rapid uptake of escooters overwhelms typical infrequent data collection efforts.

The concern of federal statistical agencies about data quality is not a quest for statistical purity for its own sake. New data sources, analytical methods, and data visualizations are potential sources for new insight and understanding for decision-makers, but they can just as easily misguide decision-makers with flashy graphics and spurious correlations. This is why the Information Quality Act places a major emphasis on "fitness for purpose" in the use of data for public decisions.[40]

Information quality concerns go beyond data to include new analytical methods. Frequently labeled "big data analytics," these methods were originally developed to make short-term forecasts from very large datasets. These methods have been adapted by private shippers to monitor and manage supply chains, and are now being explored by public agencies as early indicators of changing social and economic conditions and of emerging safety problems. The potential for adapting these methods to long-range forecasting and to the understanding of complex, uncontrolled transportation phenomena remains in the formative stages.

Forecasting is important for planning infrastructure investments and for identifying safety risks. Good forecasts, such as done in the FAF, can be based on correlations and extrapolated trends without a complete understanding of causation. However, causation is essential to understanding the effectiveness of public programs and to learning from experience. Data and analysis methods to determine causation are central to achieving the goals of the Foundations of Evidence-Based Policymaking Act.

[40] *Treasury and General Government Appropriations Act of 2001*, Pub. L. 106-554, Sec 515, (Dec. 4, 2000), reinforced and clarified in Office of Management and Budget Memorandum M-19-15, Apr. 24, 2019.

Recent Progress and Next Steps

BTS is responding to these challenges from its unique position at the nexus of four communities, each with its own set of partners and stakeholders:

1. As part of the transportation community:

    - BTS serves DOT as a source of statistical expertise and of objective information on transportation (especially from the perspective of system users rather than from suppliers of modal components);

    - BTS serves the entire transportation community as a portal to and an integrator of diverse information sources; and

    - BTS serves both DOT and the broader transportation community as a repository of research, data, and institutional knowledge through the National Transportation Library and BTS' activities through partners like the Transportation Research Board, the North American Transportation Statistics (NATS) Interchange, and the International Transport Forum (ITF).

2. As 1 of the 13 designated principal agencies of the federal statistical system, BTS represents DOT and the transportation community in the development of federal statistical policies and collaborates with other federal statistical agencies to meet the quality requirements and information needs of the transportation community.

3. As part of the federal geospatial data and mapping community, BTS is the principal integrator of geographic data related to transportation and works with a variety of organizations that develop and compile geospatial data to establish high-quality, comprehensive, and detailed electronic maps and visuals that can be used throughout government and industry.

4. As part of the knowledge management community, BTS's National Transportation Library (NTL) works with the Library of Congress, the National Library of Medicine, the National Agricultural Library, state DOT libraries, universities, and others to assure that transportation data, results of research relevant to transportation, and institutional memory are maintained and sharable in forms that are readily accessible to the transportation community.

BTS is only part of DOT's statistical programs and is the smallest of the 13 principal statistical agencies (table 2). In spite of its small size, Congress has charged BTS with an unusually broad range of responsibilities for a statistical agency. For example, BTS remains the only principal federal statistical agency to house a designated national library. BTS is charged by law with ensuring that its statistics serve state and local governments, metropolitan planning

organizations, transportation-related associations, the private sector, and the public as well as the Federal Government.[41] BTS is also charged with encouraging standardization of data, data collection methods, and data management and storage technologies for those entities.[42]

BTS strives to provide statistics at the greatest geographic detail it can support with confidence and is exploring the deployment of new statistical methods to provide greater geographic detail. However, it is recognized that needs may be best met by the organizations closest to those topics, and local data needs are generally best met by organizations closer the locality.

[41] 49 USC § 6302(b)(3)(B)(i).

[42] 49 USC § 6302(b)(3)(B)(iv).

TABLE 2 Budgets of the 13 Principal Statistical Agencies and Other Statistical Programs in Their Home Departments ($ millions)

Department	Agency	FY2018
Agriculture	Economic Research Service	76.7
	National Agricultural Statistics Service	185.7
	Other Statistical Programs	289.9
Commerce	Bureau of Economic Analysis	97
	Census Bureau	1681.4
	Other Statistical Programs	240.9
Education	National Center for Education Statistics	330.1
	Other Statistical Programs	82.2
Energy	Energy Information Administration	118
	Other Statistical Programs	13
Health and Human Services	National Center for Health Statistics	155
	Other Statistical Programs	323.3
Justice	Bureau of Justice Statistics	49.9
	Other Statistical Programs	36.2
Labor	Bureau of Labor Statistics	607.8
	Other Statistical Programs	98.8
Transportation	Bureau of Transportation Statistics	26
	Other Statistical Programs	92.8
	Federal Aviation Administration	9.4
	Federal Highway Administration	16.3
	Federal Motor Carrier Safety Administration	3.4
	Federal Railroad Administration	7.1
	Federal Transit Administration	5.8
	National Highway Traffic Safety Administration	42.1
	Pipeline and Hazardous Materials Safety Administration	8.7
Treasury	Statistics of Income (IRS)	33.6
National Science Foundation	National Center for Science and Engineering Statistics	56.9
	Other Statistical Programs	95.9
Social Security Administration	Office of Research, Evaluation, and Statistics	32.5
	Other Statistical Programs	120.6

SOURCE: Office of Management and Budget, Executive Office of the President, Statistical Programs of the United States Government 2018, available at www.whitehouse.gov/wp-content/uploads/2018/05/statistical-programs-2018.pdf as of November 2019.

BTS has contributed to improved statistical information over the last year. Examples of this include:

- Release of over 100 statistical products (published annually), including 82 data releases; 1 report to the President and Congress; 3 reports to Congress; 3 reports for clients of the confidential close calls program; statistical summaries for 50 states and DC; digital profiles for 49 of the Nation's largest maritime ports; continuous updates to National Transportation Statistics and the National Transportation Atlas Database; annual updates to the Freight Analysis Framework, the popular *Pocket Guide to Transportation*—now in mobile and web app form; and several interactive, topic specific web-based applications.

- Major data collections including the Commodity Flow Survey, Transborder Freight Statistics Program, Border Crossing/Entry Data Program, commercial airline information programs, and the Port Performance Freight Statistics Program.

- Innovative use of Global Positioning System (GPS) data to monitor maritime and trucking performance.

- Development of new analytics and visualizations as part of the Secretary of Transportation's Safety Data Initiative.

- The Repository and Open Science Access Portal, an online repository of documents and data of interest to the transportation community, including all research data and reports funded by DOT.

- Pioneering the use of new technologies to improve data dissemination, from early adoption of the internet to today's use of interactive data visualizations and a mobile application.

- Assistance to DOT operating administrations in meeting statistical quality standards to obtain Office of Management and Budget approval for over 100 information collection requests annually.

Looking ahead, the transportation community must manage the demands of evidence-based decision-making and the development and interpretation of new data sources with the maintenance and improvement of traditional statistics on which decision-makers and planners are dependent. BTS has direct control over a small portion of the data sources highlighted in this volume, but it has a leadership role in many external data sources as the principal federal statistical agency for transportation. BTS is also developing a larger role in improving the quality and availability of all major DOT statistical data through its proposed Transportation Statistics Integration and Publication (TSIP) initiative. TSIP is intended to provide a web-based platform that enables analysts, researchers, and others to discover, access, and combine data from throughout DOT.

BTS recognizes that it must evolve its statistical products, data collection methods, and expertise to provide effective services to the transportation community in a rapidly changing world. As a forward-looking, effective statistical agency, BTS works continually to:

- provide fresh, relevant information to a wide range of users in the formats that best meet their needs;
- be flexible and nimble to address emerging issues;
- focus on new technology for collection and delivery of information; and
- adhere to Statistical Policy Directives of the Office of Management and Budget and provisions of the FAST Act and the Evidence Act to assure that statistics are objective, accurate, timely, and credible.

Toward these ends, BTS will:

- replace some of its recurring publications such as *Freight Facts and Figures,* with continuously updated digital material to improve timeliness of the statistics and provide the statistics in more readily discoverable and usable contemporary forms;
- establish a Commercial Flight Database, combining real-time information from the Federal Aviation Administration and monthly data from the BTS Office of Airline Information to provide timely, detailed information on commercial flights without adding to respondent burden;
- develop near real-time, multimodal statistics on disruptions to the transportation network;
- improve the range and timeliness of statistics on public and private investments in transportation, government revenues and expenditures related to transportation, and the extent of public-private partnerships in transportation finance;
- complete publication of data from the 2017 Commodity Flow Survey and use that data to update and improve benchmarks for comprehensive freight flow statistics;
- improve data collection methods to reduce respondent burden and accelerate data processing in the next Commodity Flow Survey as part of the 2022 Economic Census;
- restore the Vehicle Inventory and Use Survey as part of the 2022 Economic Census;
- develop additional statistics for the Port Performance Freight Statistics Program from administrative and sensor-based data;
- automate manual processes for updating databases in BTS to improve timeliness of BTS products, reduce costs, and reduce the potential for transcription errors;

- implement new ways to view and disseminate information through the BTS website; and

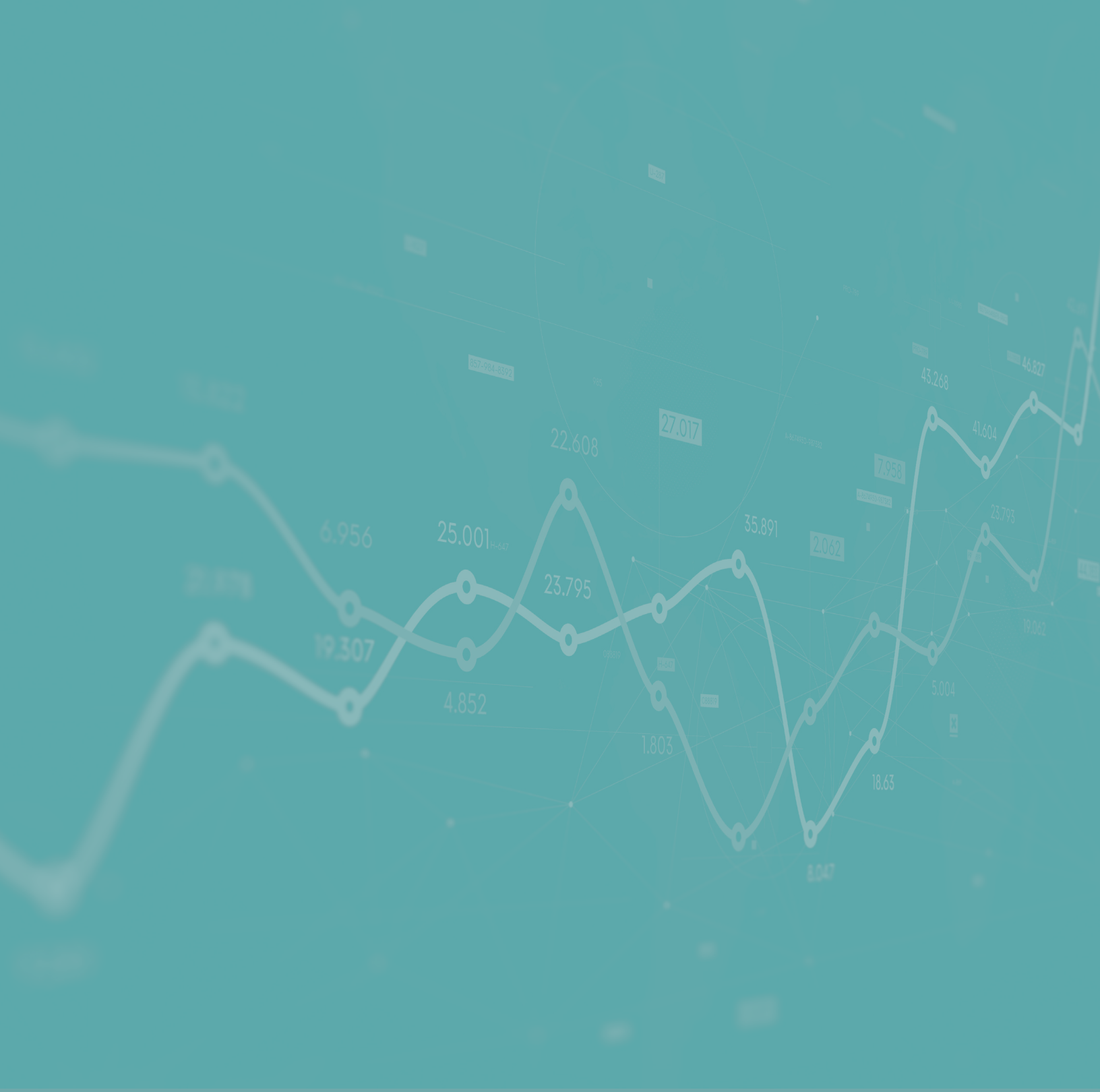
- continue to operate and improve the NTL, which curates and makes transportation information, statistics, databases, and research findings from throughout DOT transparent and accessible to the public.

All BTS products and the collections of the NTL are available at www.bts.gov.

BTS recognizes the need to take a more active role with its partners to assist with performance measurement and evidence-based policymaking. BTS stands ready to provide statistical expertise to performance measurement and evaluation activities and to assist in access to data that can be used in program evaluations. BTS will continue to explore ways to turn data collected for performance measurement and program evaluation into useful statistics for decision-makers and the public.

BTS has achieved significant progress in improving the state of transportation statistics over the last quarter century. BTS will continue to strive in the years ahead to create increasingly robust, timely, and credible products in each of the topic areas identified in legislative mandates and DOT goals. Furthermore, BTS will continue to produce statistics that are relevant and useful throughout the Nation, and fulfill Abraham Lincoln's vision that: "Statistics will save us from doing what we do, in wrong places."[43]

[43] Lincoln, A., "Internal Improvements," Speech of Mr. A. Lincoln of Illinois in the House of Representatives (Washington, DC: June 28, 1848), *Congressional Globe*, 30th Cong., 1st Sess., pp. 709–711.



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