



Planning Minnesota's
Transportation Future

LOGISTICS TREND ANALYSIS

CONTENTS

Logistics Trend Analysis1

 Contents.....2

 Summary3

 Freight in Minnesota3

 Environmental Impacts of Freight Movement4

 Logistics Organization.....7

 Logistics Technology Trends, 20228

 The Changing Face Of American Shopping11

Trends in Freight Modes12

 Trucking12

 On-Demand & Automated Trucking13

 Freight Rail.....14

 Automated Freight Rail.....16

 Intermodal facilities16

 Aviation.....17

 Waterways and Ports.....17

 Pipelines18

Related Trends19

Revision History.....19

SUMMARY

Logistics is the coordination of freight. It includes the movement of materials, equipment, consumer goods, and supplies. The freight network consists of trucks, trains, airplanes, pipelines, ships, and barges moving goods between intermodal hubs, distribution centers, and delivery locations. Worldwide, nearly one-third of all energy used for transportation is used by trucks, ships, and trains moving freight.¹ In the U.S., trucks carry more than half of all domestic freight. Trucks also account for most of the energy used in logistics.²

The logistics landscape is changing fast. Changes in supply chain management, the growth in e-commerce, technological advances, and new product delivery options create the possibility for new business models. These changes are shifting the flow of goods and rising customer expectations. For example, same-day home delivery has become more prevalent during and after the COVID-19 pandemic as, according to the U.S. Bureau of Transportation Statistics, the Freight Transportation Services Index (TSI), which is based on the amount of freight carried by the for-hire transportation industry, rose 5.6% from June 2020 to June 2021.³ This and other changes will significantly impact how logistics adapt and evolve in the future and the demands the logistics sector places on transportation infrastructure.

Supply chain managers want to make moving freight more time and energy efficient. Companies now compete for home delivery market share, and concerns over greenhouse gas emissions are growing. This leads to more centralized and streamlined logistics networks along primary trucking routes. Additionally, electric and automated trucks can provide efficiency and save money. The make-up of freight vehicles is also changing. Companies like Amazon, Uber, Walmart, and FedEx shape and respond to the surge in-home delivery.

Rail, air, pipeline, and waterway freight movement are also changing. Rail is transporting less coal as power generation from coal declines. However, rail is finding new goods to transport across the state. New pipelines are moving forward while being met with protests and lawsuits. Pipelines will continue to be important in moving liquid oil and gas as the U.S. continues to grow as a net exporter of fuel liquids. Air freight will grow as high-tech manufacturing increases and more high-value goods move across the country. This anticipated growth is attracting new investments in freight air terminals. Finally, the Mississippi waterway system, made up of many locks and dams, plays an important role in moving agricultural goods and large industrial equipment. However, the over 80-year-old system needs funding to make upgrades and repairs.

FREIGHT IN MINNESOTA

Minnesota is home to a diverse economy, with financial services, manufacturing, and professional and business services making up the three largest sectors of the state's economy. Each possesses unique and changing transportation needs for shipping and receiving goods. The process by which goods arrive at their destination is referred to as a 'supply chain.' Goods in Minnesota flow through a network of road, rail, water, and air infrastructure to reach their destination (see Figure 1). In Minnesota, the overall freight volume has grown, mirroring the overall growth of the state's gross domestic product (GDP) and the impact of COVID-19. Heavy-duty

¹ Levinson, David. Rep. The Transportation Future Project: Planning for Technology Change. Minneapolis, Minnesota: MnDOT, 2016.

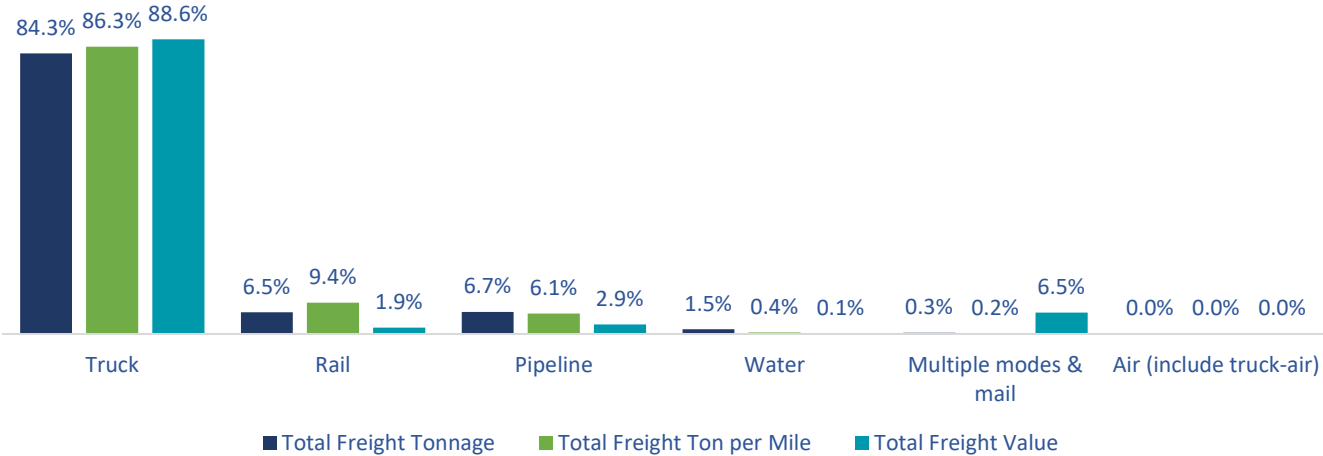
² "2017 North American Freight Numbers," 2017 North American Freight Numbers | Bureau of Transportation Statistics, accessed May 21, 2021, <https://www.bts.gov/newsroom/2017-north-american-freight-numbers>.

³ June 2021 Freight Transportation Services Index (TSI). [June 2021 Freight Transportation Services Index \(TSI\) | Bureau of Transportation Statistics \(bts.gov\)](https://www.bts.gov/newsroom/june-2021-freight-transportation-services-index-tsi)

truck freight tonnage has grown the most. From 1997 to 2020, total freight shipments grew by 71%, while freight shipments by heavy-duty trucks grew by 60%.⁴ Trucks are now one of the most used modes of freight movement as they account for up to 86.3% of freight moved on a per-mile basis, compared to 2018, which was just 38%. They moved the most freight, totaling more than 300,000 tons (84.3%) in 2020. Furthermore, trucks move the highest total value of goods of about \$137.9 billion, as shown in Figure 1.⁵

Multimodal shipments make up only 0.3% of total tonnage but 0.2% of freight ton per mile, and it includes any freight carried by multiple modes by the United States Postal Service or other delivery couriers. In contrast, rail accounts for just 6.5% of total freight tonnage but 9.4% of freight ton per mile. Total freight tonnage by pipeline is about 6.7%, but 6.1% of freight ton per mile. Air cargo moves smaller but higher-value goods, including electronics, medical devices, and precision instruments.⁶

Figure 1: Percentage of freight tonnage, tons per mile, and total value shipped by mode in Minnesota in 2020⁷



Environmental Impacts of Freight Movement

In 2020, the transportation sector accounted for 1,632 million metric tons of carbon dioxide (CO₂) equivalent emissions, 27% of the total greenhouse gas emissions produced in the U.S.⁸ This is a significant decrease of 13% in comparison to 2019. Freight movement accounts for 33% of the total transportation-related greenhouse gas emissions in 2020, a 2% increase compared to 2019.⁹ Freight trucks accounted for the largest share of greenhouse gas emissions, followed by pipelines, freight rail, and commercial aircraft (see Figure 2). In comparison to 2019, there has been a significant decrease in the greenhouse gas emitted. This is largely due to

⁴ “Freight Analysis Framework Data Tabulation Tool,” Freight Analysis Framework Version 5, National Transportation Research Center, <https://faf.ornl.gov/faf5/> accessed December 17, 2019).

⁵ Ibid.

⁶ Ibid.

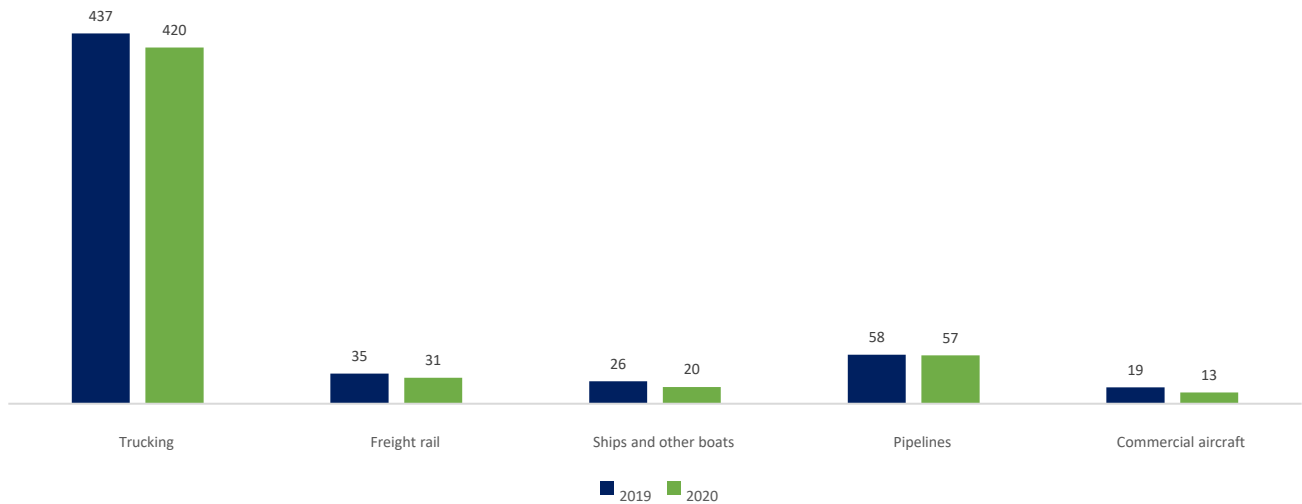
⁷ Freight Analysis Framework, National Transportation Research Center.

⁸ Freight Transportation Energy Use & Environmental Impacts, accessed June 1 2022 [Freight Transportation Energy Use & Environmental Impacts \(bts.gov\)](https://bts.gov)

⁹ Freight Transportation Energy Use & Environmental Impacts, accessed June 1 2022 [Freight Transportation Energy Use & Environmental Impacts \(bts.gov\)](https://bts.gov)

the COVID-19 lockdown that restrained movement. Furthermore, new models of trucks dramatically reduce the amount of air pollution compared to older models. As seen in Figure 3, these new model trucks can reduce fine particulate matter by up to 97% and nitrogen oxides by 80%.¹⁰ Even with these advancements, freight trucks remain a major source of air pollution today.

Figure 2: U.S. greenhouse gas emissions from domestic freight transportation (millions of metric tons of CO₂ equivalent)¹¹



¹⁰ Jarrett Smith, Amanda, Cassie McMahon, and Barbara Conti. Rep. The Air We Breathe: The State of Minnesota’s Air Quality. Minnesota Pollution Control Agency, 2017.

¹¹ ibid

Figure 3. Compared to models produced today, a comparison of air pollutants generated from an older model diesel freight truck.¹²

One old truck can pollute more than 30 new diesel trucks

Depending on factors such as the age of the truck, how far it travels, and how much it idles, one old diesel truck can produce as much particle pollution as 25-50 modern trucks under the same operating conditions.



Freight movement, regardless of mode, requires a significant amount of energy. Today, diesel engines power most freight trucks. Trucks are the least efficient mode for moving freight in freight moved per mile and total energy used.¹³ Truck fuel consumption increased by 3% from 2009 to 2019, while truck vehicle miles traveled increased slightly more (4.1%). Fuel use in Class I freight railroads increased by 7.1%, from about 3.2 billion gallons to 3.4 billion gallons for the same period.¹⁴ As seen in Figure 4, freight trucks accounted for the majority of freight transportation energy consumption, followed by pipelines in 2019. Truck-based freight transportation in the United States uses approximately 5,490 trillion Btu of energy to carry goods to market.¹⁵ Pipelines used about 979 trillion of Btu energy, class 1 rail used about 470 trillion Btu, while water used 864 trillion Btu.

This energy consumption growth is concerning because it impacts the environment in several ways and is a significant contributor to air pollution and greenhouse gas emissions. Shifting to electric vehicles could serve as an opportunity to reduce environmental impacts. As of 2020, all-electric freight trucks that will lower emissions are in development but have not been deployed for mainstream use.

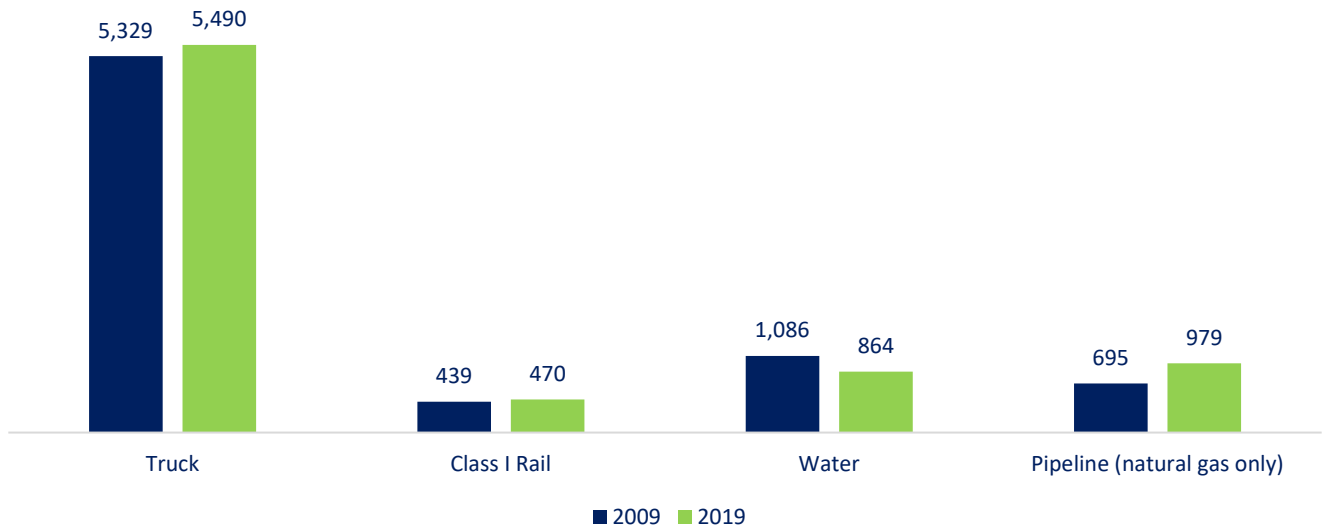
¹² Ibid.

¹³ "Energy Consumption by Select Freight Transportation Modes," (Bureau of Transportation Statistics), accessed March 2020, <https://www.bts.gov/energy-consumption-select-freight-transportation-modes/>.

¹⁴ Freight Transportation Energy Use & Environmental Impacts, accessed June 1 2022 [Freight Transportation Energy Use & Environmental Impacts \(bts.gov\)](https://www.bts.gov/content/freight-transportation-energy-use-and-environmental-impacts)

¹⁵ "Fuel Consumption by Mode of Transportation in Physical Units (Bureau of Transportation Statistics), accessed May 21, 2021, <https://www.bts.gov/content/fuel-consumption-mode-transportation-physical-units>.

Figure 4: Total energy consumption (trillions of BTU) by all modes in the United States in 2009 and 2019.¹⁶



LOGISTICS ORGANIZATION

Logistics firms, which are involved in the movement, storage, and flow of goods, have been directly affected by the COVID-19. Before the pandemic arrived, the nation’s transportation system moved about 51.0 million tons of goods worth \$51.8 billion each day, or about 56.9 tons of freight for every resident of the United States.¹⁷ The pandemic, however affected both demands on the freight transportation system and the capacity of the freight transportation system to respond to demands. The modest growth in the demand for goods to be moved throughout 2019 reversed dramatically with the arrival of COVID-19 in the spring of 2020 and has increased significantly after the pandemic. The demand for moving freight rebounded quickly.

After the COVID-19 pandemic, data is becoming of significant importance in the logistics sector. Big data is pushing the logistics sector to rethink long-held business models. Logistics firms now use data to build forecasting models and event management algorithms that works well. Data analytics can provide information about shipments, select optimum routes, and precisely time deliveries. This promises to increase efficiency, reduce the number of freight vehicles and reduce the environmental footprint of the logistics industry. Improvements in information technology (IT) practices may help limit the total mileage of trucks on the road system and will likely result in vehicles being filled.¹⁸ Further discussion on how big data transforms how we navigate and plan transportation systems can be found in the Cyber Security and Big Data trend analysis.

Many companies are also building more distribution centers than ever before. Walmart, for example, has more than 150 distribution centers in the U.S. today, compared to only 12 in 2005.¹⁹ Amazon operates more than 200

¹⁶ Ibid.

¹⁷ Transportation Statistics Annual Report. <https://www.bts.gov/tsar>

¹⁸ Levinson et. al., 2015

¹⁹ Our Business. Walmart. Accessed May 21, 2021. <https://corporate.walmart.com/our-story/our-business>.

active fulfillment centers across the U.S. and plans to add 33 soon.²⁰ Multiple factors drive the increase in distribution centers:

- Truck drivers in the U.S. who are unwilling to take on long-haul shipping routes.²¹ The trucking profession has struggled to attract a younger, more diverse workforce. This issue is shown in driver demographics and labor shortages.
- Additional distribution centers help to facilitate same-day delivery. More warehouses allow for product flexibility. Amazon announced in 2019 that it would offer free same-day shipping to Prime members across the U.S. Other large retailers like Walmart and Target acquire logistics firms to compete and offer free two-day shipping.²²
- By building more distribution centers, shipping companies can perform “drop-and-hook” movements of freight around the county. This is the practice of a single driver dropping off a shipment at a destination and picking up another shipment. Drop-and-hook allows for more short-haul freight movements and additional time at home for truck drivers.²³
- Additional distribution centers allow online retailers flexibility in managing returned and replacement items. Retailers with widespread brick and mortar presence, like Target, are beginning to use strategies to transform their existing stores to function more like distribution and fulfillment centers.²⁴
- Industrial users are moving toward distribution centers for on-demand product availability. To meet these evolving expectations, distributors need to have products nearer to customers. Smaller, more prolific distribution centers are replacing large regional distribution facilities to maximize flexibility and profits by providing precise product supply.²⁵

Customer preference, workforce pressure, and technological advances blur the line between online retailers like Amazon and more traditional retailers. These same trends are being seen in industrial manufacturing, with customer demands on distributors mirroring those on the consumer retail side of the economy. These trends are expected to continue and strengthen in the future.

LOGISTICS TECHNOLOGY TRENDS

At the end of 2018, the U.S. Department of Transportation (USDOT) launched the Non-traditional and Emerging Transportation Technology Council to identify and resolve any jurisdictional or regulatory gaps that may impede the deployment of emerging or novel technologies. The council comprises senior leaders within USDOT who meet to review and coordinate actions on new technologies. This council intends to reduce the barriers between

²⁰ Christine Wen, “Mapping Amazon,” Good Jobs First (accessed June 16, 2021), <https://storymaps.arcgis.com/stories/adc5ff253a3643f88d39e7f3ef1a09ee>.

²¹ Levinson et. al., 2015.

²² Melissa Repko, “Walmart Winds down Jet.com Four Years after \$3.3 Billion Acquisition of e-Commerce Company,” CNBC (NBC Universal, May 19, 2020), <https://www.cnbc.com/2020/05/19/walmart-winds-down-jetcom-four-years-after-3point3-billion-acquisition.html>.

²³ “Target to Acquire Same-Day Delivery Platform Shipt, Inc. to Bolster Fulfillment Capabilities,” A Bullseye View (Target Brands Inc., December 17, 2017), <https://corporate.target.com/press/releases/2017/12/target-to-acquire-same-day-delivery-platform-shipt>.

²⁴ Levinson et. al., 2015.

²⁵ Craig Guillot, “For a Fast Supply Chain, Target Is Betting on In-Store Fulfillment,” Supply Chain Dive (Industry Dive, August 6, 2019), <https://www.supplychaindive.com/news/fulfillment-brick-and-mortar-retail-inventory/560262/>.

²⁶ Karen Kroll, “Today’s Distribution Center: You Say You Want an Evolution?,” Inbound Logistics (Thomas Publishing Company, March 4, 2019), <https://www.inboundlogistics.com/cms/article/todays-distribution-center-you-say-you-want-an-evolution/>.

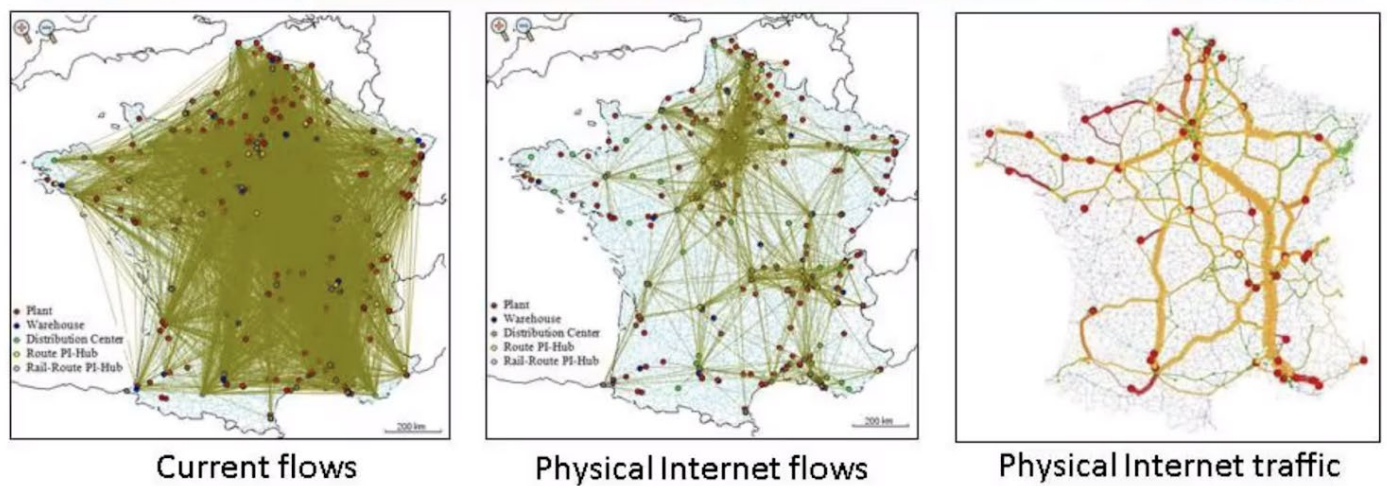
traditional modal silos found at many state DOTs and the USDOT and aid in adopting emerging technologies by coordinating and streamlining environmental, safety, and funding review as USDOT or other relevant DOTs evaluate them.²⁶ The pace of technological change is increasing, and logistics firms are increasingly accessing new data and novel strategies to streamline operations and improve efficiency. In 2022, these changes will continue and progress further. The way logistics operate will be significantly influenced by digitization and sustainability. The following are key logistics industry trends that will acquire traction in 2022:

THE PHYSICAL INTERNET

The “Physical Internet” concept offers potential for reorganizing the freight industry. The Physical Internet Initiative, backed by the National Science Foundation and Mitsubishi Heavy Industries, imagines a reorganized system for how companies and freight carriers interact and move goods. Companies using this concept ship goods using a series of pod containers that homogenize the exterior packaging of goods, much like shipping containers on oceanic cargo ships.²⁷ This eliminates the need for multiple loading devices, standardizes shipment size across industries and countries,²⁸ and minimizes the amount of unused space on freight vehicles.²⁹

As seen in Figure 5, transitioning to this concept would change how freight is transported. The supply chain would be streamlined, and physical bottlenecks in infrastructure would become more important to logistical efficiency. The Physical Internet model would create concentrated freight traffic along the most efficient and centralized routes between large urban areas. This could result in higher freight volumes along Minnesota’s interstate routes with lower volumes along other corridors. If the Physical Internet takes hold in the United States, highway investment strategies may need to change to further prioritize key freight corridors.

Figure 4: Simulated example of the impact of the Physical Internet on two selected retailers in France.³⁰



²⁶ “Overview,” Non-Traditional and Emerging Transportation Technology Council (U.S. Department of Transportation, July 28, 2020), <https://www.transportation.gov/nettcouncil>.

²⁷ Treiblmaier, et al, “The physical internet as a new supply chain paradigm,” International Journal of Logistics Management, July, 14, 2020, <https://www.emerald.com/insight/content/doi/10.1108/IJLM-11-2018-0284/full/html>.

²⁸ The U.S. uses a different pallet size for shipping products than European or Asian countries.

²⁹ Ibid

³⁰ Shenle Pan, Eric Ballot, George Q. Huang & Benoit Montreuil (2017) Physical Internet and interconnected logistics services: research and applications, International Journal of Production Research, 55:9, 2603-2609, DOI: [10.1080/00207543.2017.1302620](https://doi.org/10.1080/00207543.2017.1302620).

Today's decentralized and often inefficient nature of trucking logistics means the average semi-trailer in the United States is only at 50% capacity.³¹ Studies show that the Physical Internet model could yield up to a 60% reduction in CO₂ emissions by significantly increasing the efficient use of cargo space.³² As data and connections increase with technological advancements, logistics will continue to adapt, whether using the physical internet model or another model; inefficiencies are being remedied by technology and ever-growing access to data. MnDOT will need to understand these changes to optimize future investments to position Minnesota to take advantage of evolving logistics systems.

LAST-MILE SHIPPING

The trend of companies turning to last-mile delivery is growing. Many entrepreneurs are focusing on delivering items locally to give a more personalized experience for their clients. This has impacted the logistics industry, as they strive to figure out how this transformation would impact their future business models and procedures. The term "last-mile delivery" refers to the final leg of the delivery process from warehouses and distribution hubs to the ultimate client. Last-mile deliveries have been more popular in recent years as they have become less expensive and more convenient. For example, in May 2022, it was reported that UPS acquired a last-mile technology provider delivery solution.³³

INTEGRATION OF BLOCKCHAIN TECHNOLOGY

In the logistics business, blockchain technology is a relatively new notion. It's a decentralized ledger that keeps track of all transactions and allows users to collaborate without needing a third party. This technique has the potential to prevent fraud by making it extremely hard for someone to change data without being noticed. The technology is primarily known for its role in crypto currencies like Bitcoin, but blockchain has practical applications in logistics. Organizations can gain better visibility into their inventory levels by utilizing blockchain technology for the supply chain management. This can be accomplished by providing customers with timely updates on when their orders are shipped or delivered. Because of this transparency, businesses may provide real-time updates on when things will be restocked after being sold out. New solutions based on blockchain technology might make logistics operations more efficient, safe, and transparent. Food tracing and cargo shipment tracking are two examples of blockchain's possible applications. Blockchain technology has the potential to simplify customs clearance and handle global trade documentation.

GROWTH OF AUTOMATED VEHICLES

Automated vehicles that can read and sense the environment and use minimal or no human information to drive. Covid-19 has impacted the demand for goods in an increasingly globalized economy. With so many companies competing for high-quality cargo, it's hard to keep up with demand. Thus, automated vehicles are beginning to trend freight movement to reduce cost and increase efficiency. Automated vehicles may make it easier to ship goods worldwide without worrying about driver shortages. The internet, computers, smartphones, and advanced

³¹ Meller, R. D., K. P. Ellis, and B. Loftis. 2012. "From Horizontal Collaboration to the Physical Internet: Quantifying the Effects on Sustainability and Profits When Shifting to Interconnected Logistics Systems." Fayetteville, AR: In Final Research Report of the CELDi Physical Internet Project.

³² Plasch, Michael et al, "Why Collaborate in a Physical Internet Network?," Journal of Business Logistics (Johannes Kepler University, October 27, 2020), <https://onlinelibrary.wiley.com/doi/full/10.1111/jbl.12260>.

³³ Brian Straight, UPS acquires last-mile tech provider delivery solution, assessed June, 02, 2022. [UPS acquires last-mile tech provider Delivery Solutions - Modern Shipper \(freightwaves.com\)](https://www.freightwaves.com/news/ups-acquires-last-mile-tech-provider-delivery-solution)

technologies merge with vehicles to assist and automate driving operations. Highly automated vehicles have already been tested and used in Texas, Arizona, Washington, Michigan, California, and other states of the United States.

Vehicle automation also creates opportunities for vehicles of different shapes, sizes and designs. Several companies have started using small, automated delivery vehicles that can travel on shoulders, sidewalks or on lower-speed urban streets for last mile delivery.

ARTIFICIAL INTELLIGENCE APPLICATIONS (AI)

In the field of freight management, AI has numerous applications. Using data analytics tools and AI, fleet management has the potential to become more efficient. It can assist in route optimization based on weather or traffic patterns. As it allows you to prepare more efficiently for changes in demand and supply, this form of software provides competitive advantages. It also aids in making more accurate predictions about a vehicle's condition, which can aid in fuel allocation and maintenance schedules. Although AI is currently being used in the freight management industry, there is still room for it to expand. AI will become an integral aspect of fleet management as innovation and development continue.

DRONES FOR FREIGHT MOVEMENT

Unmanned Aircraft Systems (commonly referred to as drones) have been around for a while, and they're commonly utilized for photography, monitoring, and search and rescue activities. However, with corporations like Amazon and UPS aggressively investing in drone fleets for cargo delivery, the concept has taken on a whole new meaning in freight transportation. Amazon began drone delivery experiments in the United Kingdom last year for its Prime Air function, allowing consumers to have their purchases delivered directly to their homes using drones. Cargo drones open a whole new field of labor, requiring drone operators with skills in unmanned flight testing to pilot the delivery drones. With current technology, it is unrealistic to expect heavy haulage by drones. One can expect light household products to be carried via such services.

THE CHANGING FACE OF AMERICAN SHOPPING

E-commerce in the U.S. has explosively grown since the early 2000s. In 2021, total e-commerce was 13 times greater than in 2000. COVID-19 revolutionized several aspects of American life, including shopping. Most people became accustomed to ordering practically everything online, having it delivered, or picking it up at the store during the nearly year-long lockdown. Some of these are likely to persist as the country gradually returns to normal. In 2021, E-commerce accounted for more than 14% of all retail sales.³⁴ Amazon's sales have seen extraordinary growth as the pandemic drove shopping online³⁵, while malls and other large retailers closed thousands of stores, and dozens of retailers have filed for bankruptcy. This pattern is fundamentally changing the way retail goods are shipped and consumed. The USPS delivered 3.1 billion packages nationwide in 2010, doubling in a decade to 7.3 billion packages in 2020.³⁶ This growth is in stark contrast to USPS mail delivery, which

³⁴ "Latest Quarterly E-Commerce Report," United States Census Bureau (May 2021), <https://www2.census.gov/retail/releases/historical/ecommerce/21q1.pdf>.

³⁵ Amazon's Profit Tripled in First Quarter, assessed June, 02, 2022. [Amazon's profit soars 220 percent as pandemic drives shopping online. - The New York Times \(nytimes.com\)](https://www.nytimes.com/2022/06/02/business/amazon-profit.html)

³⁶ United States Postal Service, "A Decade of Facts and Figures," Postal Facts - U.S. Postal Service (United States Postal Service, June 16, 2021), <https://facts.usps.com/table-facts/>.

declined from 171 billion pieces of mail delivered in 2010 to 129 billion in 2020. Dramatic growth in package delivery is industrywide, with similar growth for private operators like UPS and FedEx.

Traditional retailers are helping to drive growth in package delivery as they pivot to online sales and home delivery to compete with online retailers. The line between traditional retailers and online retailers is blurring. In-store pickup, free shipping, same-day delivery, and other practices by traditional retailers like Target and Walmart continue to evolve and will likely impact the transportation system.³⁷ More delivery vehicles of all sizes will be on the roads from distribution centers, fulfillment centers, and repurposed big-box stores. Amazon and other retailers offering home delivery have deployed fleets of delivery vehicles smaller than traditional UPS or FedEx trucks, while newer and smaller automated drones could deliver packages from trucks without needing a human driver to step out of the vehicle.

TRENDS IN FREIGHT MODES

Technology is fundamentally altering the organization of the logistics industry. New supply management techniques and shifting customer demands to impact the movement of goods. Today, most freight is moved by truck or rail, which will likely continue, but who or what is operating the vehicles is likely to shift as automated technologies mature. Firms and governments are investing more than ever into intermodal terminals and air freight operations to better handle freight moving from one mode to another to add capacity and increase operational efficiency. Amazon, for example, leads in air freight expansion and is constructing a billion-dollar air freight hub in Kentucky. While an overall small portion of the industry, air freight continues to grow in importance and will be a vital element of the industry as delivery speed for both the end customer and the retailer becomes more important.

Trucking

Trucking has dominated the freight U.S. freight industry for decades. The interstate system made intercity travel faster and more reliable and led to major growth for trucking. Trucks will continue to dominate freight in the U.S. for the long-haul, and first/last mile hauls. However, freight brokers, logistics firms, and tech start-ups are rethinking cargo transport using data and automation technologies.

Helping the drive to automation is a dwindling labor pool, especially for long-haul trucking.³⁸ About 1.5 million people work as professional truck drivers, which is less than the industry requires.³⁹ Logistics firms are increasingly confronted with driver shortages. In 2018, the American Trucking Association reported that the trucking industry was short approximately 60,000 drivers, representing a 20% increase from 2017.⁴⁰ Additionally, they estimate another 1.1 million new drivers will be needed by 2028 to keep up with rising freight demand.⁴¹ If not addressed, this trend will lead to the industry experiencing a critical shortage of 160,000 drivers by 2028. A

³⁷ Allan Rutter et al, "How Will E-Commerce Growth Impact Our Transportation Network?," Texas A&M Transportation Institute (Texas A&M University, August 2017), <https://static.tti.tamu.edu/tti.tamu.edu/documents/PRC-17-79-F.pdf>.

³⁸ Marc Amblard, "The Future of Trucking," The Startup (Medium, March 28, 2020), <https://medium.com/swlh/the-future-of-trucking-7b8208e7a29f>.

³⁹ Truck driver demographics and statistics in the US, assessed June 02, 2022. <https://www.zippia.com/truck-driver-jobs/demographics/>

⁴⁰ Bob Costello and Alan Karickhoff, "Truck Driver Shortage Analysis 2019," trucking.org (American Trucking Association, July 2019), <https://www.trucking.org/sites/default/files/2020-01/ATAs%20Driver%20Shortage%20Report%202019%20with%20cover.pdf>.

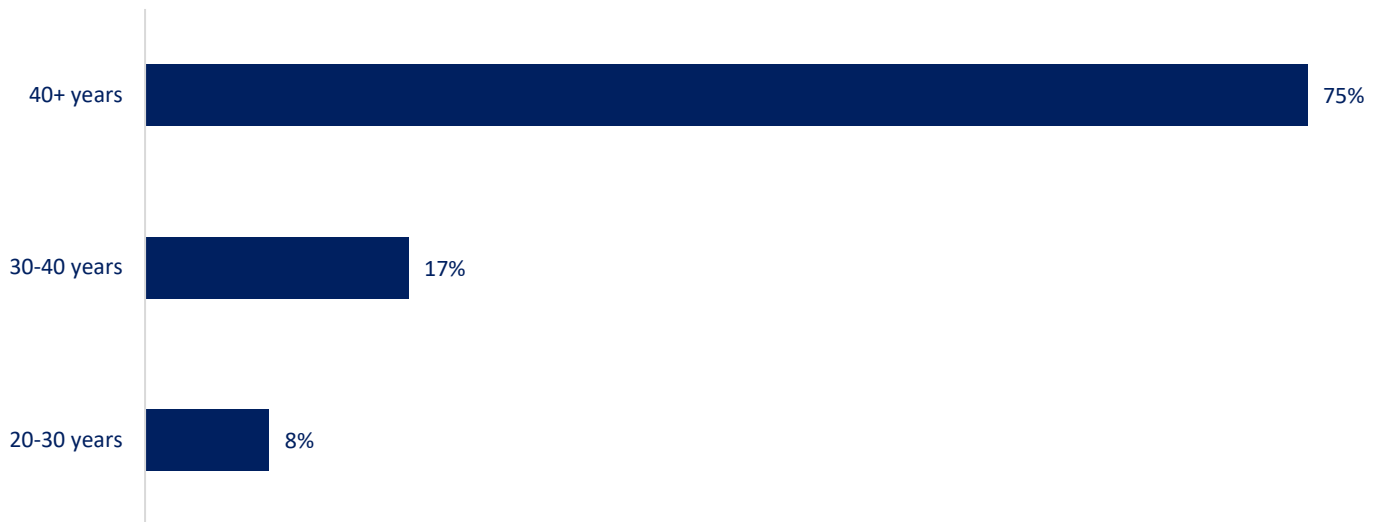
⁴¹ Ibid.

shrinking driver pool combined with increasing demand for freight has several tech start-ups and industry leaders leveraging shared data platforms and self-driving technology to streamline and automate logistics.

Figure 6 shows the average age of truckers is steadily increasing as younger Americans avoid the industry. In 2019, the average truck driver was 48 years old, compared to 42 years for all occupations in that same year. Long hours—most drivers will spend 100 plus days away from home in a single year⁴²—and historic discrimination against women and drivers of color in the industry⁴³ discourages young drivers from entering the market. Of the 1.5 million truckers in the U.S., only 8.4% are women.⁴⁴ Simply put, the trucking industry is not attracting younger, more diverse drivers while the existing white, male-dominated workforce is aging out of the industry.

For people in the trucking sector, these ages are concerning, as it is thought that the older ages of the drivers contribute to the country's existing and projected trucker shortage. A person must be 21 years old to drive a tractor-trailer over state lines, which means that adults between the ages of 18 and 20 may be working in another profession when they are ready to pursue trucking as a career.⁴⁵

Figure 6: Distribution of truck driver age, 2019.⁴⁶



On-Demand & Automated Trucking

The same idea that makes Uber and Lyft so popular is also propelling the growth of on-demand trucking. Some of the most well-known on-demand trucking platforms include Overhaul, Convoy, Uber Freight, Loadsmart, and Flexport. Uber Freight started in 2016 when Uber acquired Otto's self-driving trucking firm. Otto became known for completing a fully driverless delivery of Budweiser beer from Fort Collins to Colorado Springs, Colorado.⁴⁷ The

⁴² "Trucking Facts," OOIDA, June 10, 2019, <https://www.ooida.com/trucking-facts/>.

⁴³ Rick Rojas, "The Uphill Battle for Minorities in Trucking," Pacific Standard (Maven, June 14, 2017), <https://psmag.com/social-justice/the-uphill-battle-for-minorities-in-trucking>.

⁴⁴ Sean Kilcarr, "Demographics Are Changing Truck Driver Management," FleetOwner.

⁴⁵ 2021 Truck Driving Industry Statistics, assessed June 02, 2022. <https://www.alltrucking.com/articles/trucking-industry-statistics>

⁴⁶ Truck driver demographics and statistics in the US, assessed June 02, 2022. <https://www.zippia.com/truck-driver-jobs/demographics/>

⁴⁷ Alex Fitzpatrick, "Uber's Self-Driving Truck Unit Otto Makes Budweiser Delivery," Time (Time, October 25, 2016), <https://time.com/4544135/uber-otto-self-driving-trucks-budweiser-beer/>.

feat marked the first step for Uber, which launched a service similar to their ridesharing app aimed at truck operators and shippers continuing to grow and enter new markets, including Canada, in 2021.⁴⁸ The benefits of on-demand trucking extend to clients, fleets, and individual drivers. These benefits include the capacity to save costs, prohibit trucks from moving while they are empty, improve container use, automate the process, and reduce administrative work. Drivers will also be able to earn more money, reduce the number of empty hauls, and receive payment sooner. Goldman Sachs has estimated that the trucking industry could shed 25,000 jobs or 300,000 a year if automated vehicles become more widely adopted by the peak of automation. Furthermore, truck owners can view shipping contracts offered by suppliers in real-time and accept or reject contracts based on cargo demand, pay, and hauling distance. Meanwhile, suppliers can contract directly with drivers without going through freight brokers, who act as intermediaries connecting suppliers to available shippers. As suppliers experience growing demand for local-haul drivers, Uber Freight could allow truckers to control the contracting process and encourage more young people and ‘gig workers’ to enter the market.

Although, challenges may include many of the concerns faced by the shipping client. For example, the clients know who they're dealing with when they use brokers. But with individual drivers, on the other hand, the clients may not be aware of their driving history, insurance coverage, compliance with Department of Transportation regulations, or if they have been adequately vetted. Nonetheless, it's a movement that has the potential to upset the commercial fleet's operations. On-demand trucking is predicted to grow in the coming years because of its opportunity to minimize expenses and allow drivers to maximize their company, given challenges such as driver shortages and an aging workforce.

Driverless long hauls are in development by several private firms and could optimize shipment efficiency, and safety as driverless trucks can operate 24/7, platoon together, and better implement the Physical Internet, and some claim they could potentially create more trucking jobs for humans. Firms like TuSimple are hoping to deploy and test more autonomous trucks soon, including current test runs between distribution centers in Arizona and Texas.⁴⁹

Freight Rail

Freight rail plays a vital part in moving goods efficiently across the nation. Most goods moved by rail are larger commodity like raw agricultural products, coal, metals, and other minerals.⁵⁰ Freight rail accounts for roughly 40% of U.S. long-distance freight volume (measured by ton-miles). However, according to EPA data, they account for just 0.5% of total U.S. greenhouse gas emissions and 1.9% of transportation-related greenhouse gas emissions.⁵¹ Coal has traditionally been the single largest product shipped by rail. However, as coal power generation declines, so have coal shipments. About 202,000 fewer tons of coal were shipped in 2020 compared to 2012, resulting in a 28% decrease in annual tons shipped by rail. Other products have mostly made up for this decrease.

⁴⁸ Jeff Berman, “Uber Freight introduces new Shipper Platform for Canadian shippers,” (Logistics Management, May 27, 2021), <https://www.logisticsmgmt.com/article/uber-freight-introduces-new-shipper-platform-for-canadian-shippers>.

⁴⁹ Evan Ackerman, “This Year, Autonomous Trucks Will Take to the Road With No One on Board,” (Spectrum, January 4, 2021), <https://spectrum.ieee.org/transportation/self-driving/this-year-autonomous-trucks-will-take-to-the-road-with-no-one-on-board>.

⁵⁰ Freight Analysis Framework, National Transportation Research Center.

⁵¹ Freight Rail Facts & Figures assessed June 3, 2022. <https://www.aar.org/facts-figures#Fuel-efficiency>

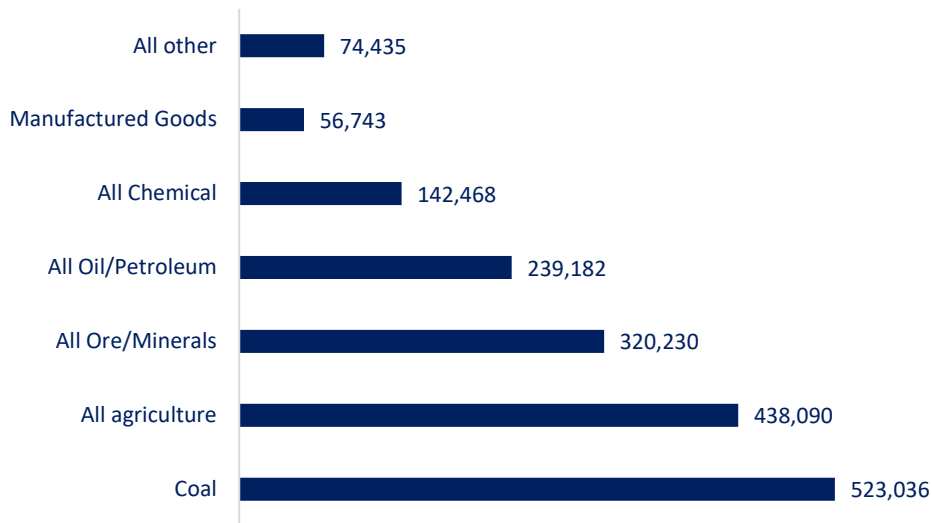
On the other hand, Minnesota was less affected by the decline in coal during the last decade. In 2012, only 15% of all rail cargo was coal, declining to 12% in 2018. In 2019, about 8 million tons of low-Sulphur coal from Montana and Wyoming traveled across Minnesota by rail to the Port of Duluth-Superior, where it was transferred to ships for delivery to utilities and manufacturing plants along the Great Lakes in the United States and Canada, as well as overseas.⁵² Coal continues to be phased out of power production nationwide, with Minnesota possibly coal-free by 2030. Freight rail will continue to move away from coal and diversify the goods shipped. Freight rail traffic in Minnesota is increasing as crude oil from North Dakota, and Canada areas grow.⁵³ Freight rail could become more competitive with trucking as congestion increases in and around major cities and highway conditions worsen as revenues in Minnesota and nationally cannot keep pace with maintenance needs and higher rates for trucking.⁵⁴ This shift will likely drive more direct competition with trucking.

⁵² Minnesota State Profile and Energy Estimates, [U.S. Energy Information Administration - EIA - Independent Statistics and Analysis](#)

⁵³ Ibid.

⁵⁴ Richard Stewart, "Intermodal Freight Transportation in Minnesota," ed. Michael McCarthy (Minnesota Freight Advisory Committee, 2018).

Figure 8. Freight shipped over rail in 2020 in thousand tons nationally



Automated Freight Rail

Rail automation has the potential to change the industry and is more straightforward compared to freight trucking. Programmers do not need to consider other vehicles, how to change lanes, stop at red lights, or anything that makes automated trucks difficult. In fact, many rail companies are already halfway to full automation. Positive train control (PTC) systems cover 96.2% of Class 1 railroads in the U.S. as of the second quarter of 2020, with another 2.6% currently testing the system.⁵⁵ All railroads are statutorily required to completely cover Class 1 railroads with PTC at the end of 2020,⁵⁶ These systems allow remote monitoring and movement control of all trains from a centralized facility, which sets the stage for fully automated trains without conductors in the future.

Other systems include trip optimizer systems for locomotives, like cruise control in a car, and automated track alignment and inspection tools. These technologies greatly increase the efficiency of freight rail operations. Rio Tinto is already testing fully automated trains in Australia, which is looking to focus first on automating the most arduous and long-distance routes. Insights from these tests could translate well to many routes throughout the rugged western U.S.⁵⁷ Fully automated trains could be a reality sooner than fully automated trucking, which would greatly drive down costs for freight rail operations and foster further competitiveness for rail.

Intermodal facilities

Intermodal facilities are large complexes found along rail junctions, industrial facilities, seaports, and airports. These facilities move freight from one mode to another, typically from freight trains or shipping vessels to and from trucks. Intermodal operations are increasing in size and capacity around the country. Given the massive scale, efficiency gains at these facilities have large ripple effects across the industry.

⁵⁵ "Implementation of Mandated Positive Train Control Systems," Steps Toward Full PTC System (United States Department of Transportation, June 30, 2020), <https://explore.dot.gov/t/FRA/views/PTCImplementationStatusReport/Overview>.

⁵⁶ "How Technology Drives the Future of Rail," Freight Rail Technology (Association of American Railroads, 2020), <https://www.aar.org/article/the-future-of-rail/>.

⁵⁷ Rodney Case, Jason Kuehn, and Bill Rennie, "Disruption: The Future of Rail Freight," Oliver Wyman (March and McLennan Companies, 2017), <https://www.oliverwyman.com/our-expertise/insights/2017/sep/oliver-wyman-transport-and-logistics-2017/operations/disruption-the-future-of-rail-freight.html>.

In Minnesota, there are four intermodal terminals in Minneapolis, St. Paul, Duluth, and the twin cities, which was recently launched in 2021. These terminals serve regional needs but do not represent significant capacity nationally. For comparison, there are 18 such terminals in the City of Chicago alone.⁵⁸ Minnesota's facilities have room for more capacity. Suppose freight rail becomes more competitive with long haul trucking. In that case, these facilities could prove to be vital for state manufacturing exports and finished product imports, two items largely moved by a truck today.

Aviation

Aviation plays a smaller role in the logistics sector but is still an important component. Air provides a faster means of moving from one location to another for higher value freight. Before the COVID-19 pandemic, air freight declined with nearly a 5% decline in global air freight.⁵⁹ Air freight is more sensitive to global trade than trucking or rail and has decreased demand as trade friction has grown between the U.S., China, and the European Union. The COVID-19 pandemic slowed global air freight even further, with freight volumes falling 29% from 2019. Air freight between the U.S. and Europe experienced a steeper decline of 50%.⁶⁰

Domestic aviation logistics continue to grow despite global trade tensions and the pandemic, primarily because of online commerce. Freight operations at many U.S. airports are at higher capacities than ever before as online shopping and medical supply-demand swelled during the pandemic. Some airports, like Chicago O'Hare, have seen cargo-only flights increase by 50% from the previous year.⁶¹ This sudden surge in demand continues a trend of growing freight flights in the U.S. In 2020, 1.8 million tons of cargo were carried by US planes.⁶² If this trend continues, air freight operations could play a more prominent role in logistics.

The rise of just-in-time delivery and online retailing is increasing pressure on air logistics in the near term and spurring investment. Companies like Amazon, Fed-Ex, and UPS are heavily investing in air logistics to ferry products around the U.S. to meet as more retailers offer and demand surges for two-day or next-day delivery options,⁶³ Amazon opened a \$1.5 billion air logistics hub at Cincinnati International Airport in 2021. The hub houses a fleet of at least 100 air cargo planes in a new three million square foot facility.⁶⁴ In Minnesota, Amazon has chartered local air carrier Sun Country to add ten additional jets to its growing fleet of air logistics operations.⁶⁵ Aviation is quickly growing in the logistics sector and will likely continue to be an important piece of the logistics industry.

Waterways and Ports

Waterways are one of the oldest forms of freight and logistics in the U.S., beginning with the construction of the Erie Canal in 1825. Water-based logistics are an important piece of moving goods around the nation. Built in

⁵⁸ "Intermodal Freight Transportation in Minnesota," Minnesota Freight Advisory Committee.

⁵⁹ "Air Cargo Demand Continues Negative 2019 Trend," Pressroom (International Air Transport Association, May 29, 2019), <https://www.iata.org/en/pressroom/pr/2019-05-29-01/>.

⁶⁰ "COVID-19: Impact on Air Cargo Capacity," Now Next (Accenture, October 19, 2020), <https://www.accenture.com/us-en/insights/travel/coronavirus-air-cargo-capacity>.

⁶¹ Eric Kulisch, "Cargo Clogs US Airports as Freighters Proliferate," American Shipper (Freightwaves, Inc, June 26, 2020), <https://www.freightwaves.com/news/cargo-clogs-u-s-airports-as-freighters-proliferate>.

⁶² Jack Flynn, "Airline Industry Statistics [2022]: 28 Facts to know before you fly," [Airline Industry Statistics \[2022\]: 28 Facts To Know Before You Fly – Zippia](#)

⁶³ "Tailwinds Report: 2018 Airline Industry Trends," PwC Airlines (PwC, 2018), <https://www.pwc.com/us/en/industrial-products/publications/assets/pwc-tailwinds-report-2018-airline-industry-trends.pdf>.

⁶⁴ Lorie Hailey, "Northern Kentucky Is a Logistics Powerhouse," The Lane Report (The Lane Report Inc, January 31, 2020), <https://www.lanereport.com/121443/2020/01/logistics/>.

⁶⁵ Leslie Josephs, "Facing a Lack of Passengers, Sun Country Airlines Ramps up Plan to Fly Packages for Amazon," CNBC (NBC Universal, April 29, 2020), <https://www.cnbc.com/2020/04/29/coronavirus-with-few-passengers-sun-country-speeds-plan-to-fly-for-amazon.html>.

1870, the Duluth Ship Canal and Harbor were the first major ship canal and harbor constructed in Minnesota and are still in operation. The Port of Duluth-Superior is the largest and busiest port on the Great Lakes, serving as the western terminus of the Great Lakes-St. Lawrence Seaway. The Port of Duluth-Superior remains a vital port to access global markets for major commodities from Minnesota, including taconite and agricultural products. Navigable rivers also serve as vital routes for freight in Minnesota, with St. Paul being the most northern point ships can navigate on the Mississippi River. River freight has been in decline for decades but still serves an important role in the nation's agricultural industry. The Mississippi River system transports approximately 60% of Minnesota's agricultural exports.⁶⁶

While American ports are an important part of the economy, antiquated infrastructure and the COVID-19 pandemic have put them under strain, putting global supply lines in jeopardy. According to the American Society of Civil Engineers (ASCE) 2021 Report Card for America's Infrastructure Report, America's ports supported more than 30 million jobs and about 26% of our nation's GDP in 2018. However, the ASCE report warns that ports confront significant obstacles in updating infrastructure and maintaining critical facilities that are threatened by sea-level rise and other climate problems. Only four American ports are among the top 50 busiest globally, and none are among the top ten. Many ports in the United States also have bridge or depth restrictions that prevent them from receiving the larger, post-Panamax boats that are the future of maritime shipping. Furthermore, the influx of goods from larger ships might burden antiquated landside infrastructure. As a result, fewer U.S. ports with the offshore and onshore capacity to handle the largest vessels and their cargo handle greater container traffic. The underfunding of America's port and waterway infrastructure has significant implications for families, the economy, and global competitiveness.

The Infrastructure Investment and Jobs Act contains an unprecedented \$17 billion to modernize infrastructure at coastal ports, interior ports, waterways, and land ports of entry along the border, recognizing the essential role American ports play in the global economy. These resources will provide immediate help while also investing long-term in supply chain resiliency. The Bipartisan Infrastructure Law, when taken together, represents the single greatest federal investment in our ports in US history.

Pipelines

In recent years, pipelines have been front page news in Minnesota as the Enbridge Line 3 pipeline continues to attract protests and lawsuits as the pipeline begins construction in Minnesota. Unlike the other modes of logistics, pipelines move through our daily lives unseen, whether buried beneath our feet or silently moving commodities overland through sparsely populated fields. Pipelines serve as a primary route to move crude oil to refineries and natural gas to power plants. As seen in Figure 1, pipelines account for nearly 8% of all freight moved through Minnesota. Pipelines will likely account for a higher percentage of freight moved as coal plants are shut down over the next decade and replaced by renewable and natural gas operations.

Nationally, demand for pipelines is anticipated to increase as power production shifts to natural gas and net U.S. natural gas and oil exports to the global market continue to grow.⁶⁷ In Minnesota, the growth of natural gas exports will have little impact on pipelines; the major driver of pipeline development in the state is crude oil from Canada and North Dakota. The Enbridge Line 3 Pipeline Replacement Project began construction in Minnesota in

⁶⁶ "St. Paul Shipping Stats," Saint Paul Port Authority (Saint Paul Port Authority, 2020), <https://www.sppa.com/harbor-management/st-paul-shipping-stats>.

⁶⁷ "EIA forecasts the U.S. will import more petroleum than it exports in 2021 and 2022," Today in Energy (U.S. energy Information Administration, February 17, 2021), <https://www.eia.gov/todayinenergy/detail.php?id=46776#:~:text=EIA%20forecasts%20that%20net%20petroleum,the%20first%20half%20of%202020>

early 2021 and is intended to replace an existing line to add capacity and replace the aging pipeline identified as integrity risk.⁶⁸ This line moves from the eastern border with North Dakota to its terminus in Superior, Wisconsin, where the crude oil is shipped to refineries across the U.S. and the world.

In today’s economy, pipelines serve a vital role in moving liquid fuels from origin points to destinations across Minnesota and nationally. However, that same green push will impact pipelines extensively in the long term as more power is generated from renewable sources and the nation’s vehicle fleet is extensively electrified. As long as fossil fuels power our economy, pipelines will remain a vital element of the logistics industry, but as those sources wane, so will pipelines.

RELATED TRENDS

- [Connected and Automated Vehicles](#)
- [Climate Change](#)
- [Cyber Security and Big Data](#)
- Shared Use Mobility
- [Telework and E-Commerce](#)

Minnesota's vision for transportation is known as Minnesota GO. The aim is that the multimodal transportation system maximizes people’s health, the environment, and our economy. A transportation vision for generations, Minnesota GO, guides a comprehensive planning effort for all people using the transportation system and all travel modes. Learn more at [MinnesotaGO.org](https://www.minnesotago.org).

REVISION HISTORY

Date	Summary of revisions
May 2016	Some content originally part of the New Logistics trend completed as part of the University of Minnesota’s Transportation Futures Project.
June 2022	Updated to reflect new data and information.

⁶⁸ “Enbridge Line 3 Pipeline Replacement Project,” Project Summary (Minnesota Public Utilities Commission, n.d.), <https://mn.gov/puc/line3/summary/>.