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SUSTAINING THE U.S. ADVANTAGE IN GLOBAL TRANSPORTATION AND LOGISTICS

TRANSPORTATION AND LOGISTICS INDUSTRY STUDY

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Seminar 4 – TLIS

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Acronyms

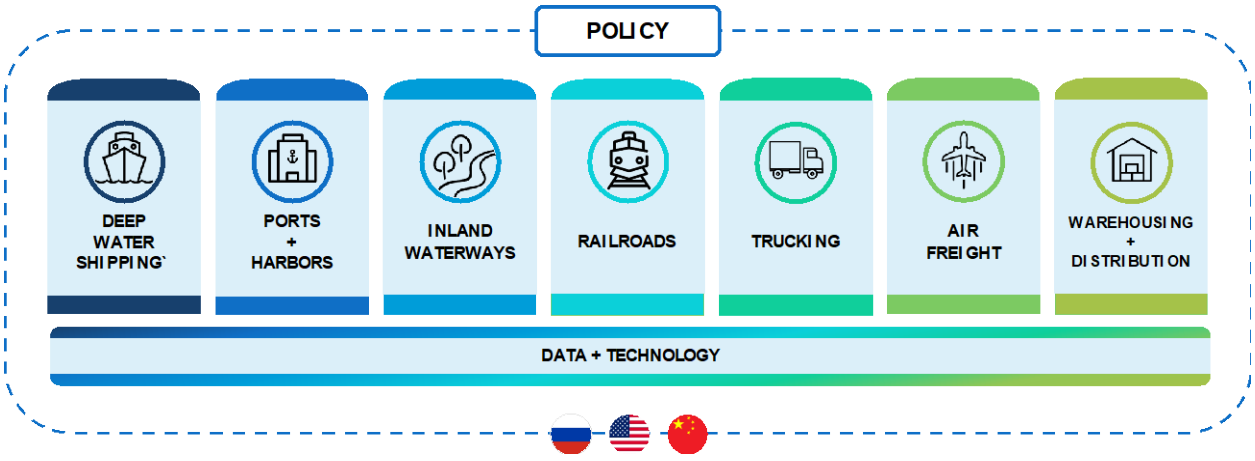
ATA	American Trucking Association
ATO	automatic train operation
BRI	Belt and Road Initiative
BUILD	Better Utilizing Investments to Leverage Development
CBP	Customs and Border Protection
CPTPP	Comprehensive and Progressive Trans-Pacific Partnership
CRAF	Civil Reserve Air Fleet
DARPA	Defense Advanced Research Projects Agency
DCSA	Defense Support for Civil Authorities
DHS	Department of Homeland Security
DLA	Defense Logistics Agency
DSR	Digital Silk Road
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Education
DOL	Department of Labor
DOT	Department of Transportation
ESG	environmental, social, and governance
EU	European Union
FAA	Federal Aviation Administration
FASTLANE	Fostering Advancements in Shipping and Transportation for the Long-term Achievement of National Efficiencies
FEMA	Federal Emergency Management Agency
GDP	gross domestic product
GHG	greenhouse gas
GHS	Global Heavyweight Shipment
GPC	Great Power Competition
IATA	International Air Transportation Association
ICC	International Chamber of Commerce
IIJA	Infrastructure Investment and Jobs Act
ILWU	International Longshore and Warehouse Union
IMO	International Maritime Organization
INDOPACOM	Indo-Pacific Command
IPEF	Indo-Pacific Economic Framework
IWS	inland waterways system

IWTF	Inland Waterways Trust Fund
LOE	line of effort
LTL	less-than-truckload
MARAD	Maritime Administration
ML	maching learning
MSC	Military Sealift Command
MSP	Maritime Security Program
NAICS	North American Industry Classification System
NATO	North Atlantic Treaty Organization
NGDS	Next Generation Delivery Service
PTC	positive train control
RND	Railroads for National Defense
RORO	roll-on roll-off
SAF	sustainable alternative fuels
STEM	science, technology, engineering, math
STRACNET	Strategic Rail Corridor Network
T&L	transportation and logistics
TL	truckload
TSA	Transportation Security Administration
UAV	unmanned aerial vehicle
UNCLOS	United Nations Convention on the Law of the Sea
USACE	United States Army Corps of Engineers
USEUCOM	United States European Command
USG	United States Government
USTRANSCOM	United States Transportation Command
VISA	Voluntary Intermodal Sealift Agreement
WTO	World Trade Organization

Executive Summary

The U.S. transportation and logistics (T&L) ecosystem – composed of multiple sectors through a complex system of freight forwarding, storage, and distribution – is an essential pillar of the economy and contributes to U.S. economic prosperity and thus U.S. national security. This paper provides a brief overview of U.S. Deep Sea Shipping, Inland Waterways, Ports and Harbors, Railways, Trucking, Air Freight, and Warehousing sectors of the T&L ecosystem. It also considers how digital infrastructure bridges and connects each of these elements. By analyzing T&L's role in supporting the U.S. and global economy, national security, and its contribution to mobilization efforts, the paper identifies significant issues and concerns within the T&L ecosystem. It concludes with policy recommendations to strengthen the U.S. position.

Figure 1. Scope of Research



An aging U.S. infrastructure, a shrinking skilled workforce, environmental issues, and the lack of global digitization standards across the T&L ecosystem impact U.S. economic and national security interests. Through four drivers – Government Enablement, Infrastructure, Innovation, and Human Capital – this paper utilizes a line of effort (LOE) comparative analysis of the U.S. and its main competitors, China, and Russia, in the context of a 21st century Great

Power Competition (GPC). Based on a five-step research process consisting of Engage, Assess, Analyze, Deliberate, and Recommend, the authors developed policy recommendations for the U.S. Government (USG) to improve U.S. competitive advantage over its most powerful adversaries.

While the U.S. still maintains a position of advantage in overall transportation, logistics, and mobilization, it is no longer the undisputed leader across all industry sectors. China's rise over the past two decades, coupled with the U.S.' inattention toward its T&L ecosystem, puts the U.S.' long-held advantage in jeopardy. China's rapid progression through focused planning and aggressive execution of its 2049 National Rejuvenation Strategy sets it on a trajectory to surpass the U.S. and gain a competitive advantage in the T&L industry.

The authors of this paper recommend USG policies that address the following overarching priorities:

- Multimodal physical and digital infrastructure that relieves congestion from overburdened nodes;
- Strengthen the enabling environment for a secure, interoperable T&L ecosystem to advance efficiency, visibility, and security within the supply chain;
- A long-term plan and regulatory framework that supports an environmentally friendly and sustainable T&L ecosystem;
- A national training and education initiative that maximizes available talent.

SUSTAINING THE U.S. ADVANTAGE IN GLOBAL TRANSPORTATION AND LOGISTICS

> There is nothing more common than to find considerations of supply affecting the strategic lines of a campaign and a war.
>
> -- Carl von Clausewitz, *On War*

Transportation and Logistics Strategic Environment

In the 21st Century Great Power Competition, the global economy connects world powers, international actors, state and local leaders, and businesses big and small. It drives the behavior and decision-making of all of them. Today's geopolitical environment presents the U.S. with supply chain foreign dependency and concurrent multi-domain threats in the Indo-Pacific and European theaters. The flow of global logistics is challenged, and the U.S. is operating at, and in some cases beyond, capacity. The recent e-commerce boom, triggered by a global pandemic, changed consumer behavior. Today's consumer demands more goods and wants them express shipped with as few stops and as little handling as possible. Consumer spending on manufactured goods and express delivery soared in 2021, leading to port and route congestion and supply shortages that experts predict will continue into 2023.[1] The ongoing U.S.-China trade wars and the Russia-Ukraine conflict have created an environment of persistent demand despite backlogs, inflation, and higher fuel costs resulting from sanctions on Russian energy.

Unprecedented friction at ports and industry-wide labor shortages led to multilayered problems in the T&L industry. Between 2020 and 2021, the industry experienced a paradigm shift. Companies operating on a "just-in-time" business model found their stocks unreplenished and customers unsatisfied. At the same time, containers full of goods sat on inbound ships outside congested ports or in crowded container yards waiting for transportation delayed by a perfect storm of high demand and low supply of space, equipment, and labor.

As disruptions continue in the global supply chain, "decoupling" from China trends across the industry, causing stateside manufacturers and retailers to reconsider their lean systems that eliminate redundant inventory and optimize working capital. Military missteps in Russia's invasion of Ukraine punctuated the realization that resources are ineffective without a synchronized effort to employ them.[2] Despite Russia's massive inventory of weapons and manpower, its army is currently stumbling over itself, failing to produce the expected "shock and awe."[3]

This paper will discuss sectors of the T&L ecosystem, its role in the GPC, and make recommendations for improving U.S. competitive advantage compared to its most significant adversaries. It concludes with recommendations of USG policies focused on the following overarching priorities: multimodal physical and digital infrastructure that relieves congestion from overburdened nodes; enabling the T&L environment with secure interoperability to maximize visibility and fidelity of the supply chain; a long-term path and regulatory framework that supports an environmentally friendly and sustainable T&L ecosystem; and promotion and support of a national training and education initiative that maximizes available talent.

Figure 2. Research Methodology

The questions remain: Does the U.S. still have a competitive advantage in transportation and logistics? Can the U.S. mobilize quickly enough to protect and project power and national interest? Is the U.S. moving at the appropriate trajectory to regain its advantage? The U.S. national security apparatus is at an "inflection point" and needs to seize the opportunity to modernize its T&L ecosystem for maximum performance. With $550 billion in new spending through The Bipartisan Infrastructure Investment and Jobs Act (IIJA), the USG has an opportunity to invest in its future, including in the infrastructure needed to facilitate a more efficient and secure T&L ecosystem in support of sustained economic strength and national security. To meet the nation's economic demands, support U.S. national security, and win in the 21st century GPC, USG policies must address the T&L industry's challenges of aging infrastructure, a shrinking skilled workforce, environmental issues, and lack of global digitization standards.

Industry Overview

In the T&L ecosystem, manufacturers connect to consumers through a complex multimodal network of nodes, routes, and waterways traveled by planes, ships, trains, and trucks. In addition to the modal and nodal sectors mentioned above, T&L includes transportation facilities operators, such as port and warehouse owners, and logistics service providers, such as freight forwarders. The North American Industry Classification System (NAICS) classifies the T&L industry as Transportation and Warehousing (48-49). Transportation and Warehousing's five-year annualized revenue was $1.3 Trillion in 2021, expected to increase by 4.2 percent to nearly $1.6 trillion over the next five years.[4] The industry's contribution to the U.S. economy is far more than just its revenue. In 2020, the industry shipped, distributed, and moved more than $16 trillion worth of goods, which is more than ten times its revenue and 30 times more than its calculated contribution to GDP.[5] As consumer spending rises, industrial output and trade will increase. Demand for optimized transportation will also rise, including third-party logistics and technology to maximize shipping speed, accuracy, and integrity. Critical external drivers for industry performance include global consumer spending and the world price of crude oil.[6] Current estimates indicate that American transportation infrastructure does not meet the demands or the needs of our growing economy for today or future generations.[7]

Deep-Sea Shipping. The industry provides freight and passenger deep-sea transportation over oceanic waterways but excludes marine operations such as port operations and stevedoring.[8] The main shipping segments include tankers, bulk carriers, container ships, and specialized ships, including roll-on/roll-off (RORO) ships, ferries, and cruise and passenger ships.[9] Entry barriers are medium with increasing trends, a high degree of globalization, and a

low threat of substitute services. [10,11] With low concentration, competition within the industry is high with steady trends.

Inland Waterways. The U.S. inland waterway industry provides barge transportation of freight, dry bulk, container, and liquid bulk cargo, towing services, and passenger transportation on lakes and rivers.[12] The Inland Waterway System (IWS) is a minor player in the U.S. transportation network but serves as a critical enabler, moving "large quantities of non-time-sensitive commodities at relatively low cost."[13] The industry relies on the federally run "fuel-taxed inland waterway system consisting of 11,000 miles of navigation channels with 186 lock sites and 225 lock chambers."[14] (See Figure 3) The U.S. Army Corps of Engineers (USACE) manages the construction, operations, and maintenance of the IWS.[15] The industry benefits from government regulation and financing of the inland waterways, including The Merchant Marine Act of 1920, also known as The Jones Act, which protects industry operators from foreign competition, and the Inland Waterways Trust Fund (IWTF), which funds rehabilitation and capital construction.[16]

Figure 3. Fuel Taxed Inland Waterways

Source: CRS, based on Corps data.
Note: Alaska and Hawaii have no fuel-taxed waterways.

Ports and Harbors. Ports and harbors are a crucial convergence between land and maritime transportation and continue to be an essential aspect of the national and global economy because ports handle more significant amounts of freight than any other transportation terminal.[17] The U.S. has 25,000 miles of navigable rivers, 1,500 harbors, and 159 ports responsible for moving more than 99 percent of annual imported and exported goods.[18] Marine

transport through U.S. ports and harbors provides a low-cost, high-volume mode of transportation for consumer goods and bulk commodities crucial to the national and global economy.

Railways. Railroads and trains have been a critical component of U.S. growth and development since the 1820s, spurring the Industrial Revolution and U.S. westward expansion. The rail transportation industry comprises companies that operate railroads, carrying freight and passengers across over 140,000 miles of rail track. Demand for rail transportation is directly related to consumer demand for domestic and foreign goods. Pandemic-related friction in the global supply chain has led to increased demand for the age-old freight train to relieve congestion at sea ports.

Trucking. The U.S. trucking industry is highly diversified and fragmented. It operates in various road freight transportation markets, transporting overland freight in the U.S. Couriers, truckload (TL), and less-than-truckload (LTL) are the main markets.[19,20] The industry estimates there are approximately 1.2 million trucking companies, with 90 percent operating six or fewer trucks.[21] Being responsible for roughly 70 percent of the total freight tonnage shipped throughout the U.S., trucking firms are a fundamental economic component. Due to the size and geography of the U.S., eighty percent of communities rely on the trucking industry to cover their daily demands.[22]

Air Freight. The global air freight industry is mature, fiercely competitive, and highly regulated. Structurally, integrated express and regular carriers transport goods via scheduled and unscheduled routes to 220 countries and territories.[23] Integrated carriers, including FedEx and UPS, dominate global market share, manage the world's biggest large-cargo-only aircraft fleets, and operate in tandem with multimodal partners (i.e., rail, sea, freight, ground).[24] Regular freight

carriers transport passengers and cargo in commercial passenger aircraft cargo hold.[25] Global air freight carriers cover eight geographic market segments and specialize in small, high-value commodities, including perishable goods and electronics. Airfreight carriers have the least tonnage of all transportation modes but are the fastest-growing transportation mode at a growth rate of 234 percent.[26]

Warehousing. Warehousing is the process of storing physical inventory for sale or distribution. Categories include general storage, special storage, or farm product storage. Warehousing demand follows consumer purchasing. U.S. warehouse usage was one billion square feet in 2021. To meet growing demand, American firms and real estate investors are planning an additional 500 million square feet.[27,28] Companies are increasing warehouse space worldwide to accommodate the greater freight volume and shrinking delivery timelines associated with the recent e-commerce boom, a trend expected to continue over the next five years[29]

Digitization. Trading across borders is a complex process that is highly dependent on paper documents, despite decades of digitization efforts. Cross-border transactions involve multiple actors and an average exchange of 36 documents and 240 copies. Fewer than one percent of trade documents are exchanged digitally and travel through onerous manual touchpoints from origin to destination.[30]

This complexity brings several risks to national security, as goods are subject to several dependent events and relationships to move from points of origin through multiple transit points to their destinations. As a result of this complexity, multimodal T&L operations are vulnerable to shocks and contestation related to geopolitical tensions, climate volatility, weather events, and global health crises like the recent COVID-19 pandemic. The digital transformation of the T&L

industry needs to be driven by industry standards, supported by digital ecosystems, and enabled by rigorous cyber security measures to mitigate such risks and build resiliency.

Role in support of National Security, Global Economy, and Mobilization

President Joe Biden's Interim National Security Strategic Guidance defines "expanding economic prosperity and opportunity" as one of the U.S. national security priorities.[31] To ensure U.S. primacy compared to global competitors like China and Russia, the U.S. has to "defend and nurture the underlying sources of American strength, including [its] economy."[32]

In the 21st century GPC, national economies depend on all instruments of national power. The U.S. exercises diplomatic, information, military, and economic instruments to maintain and strengthen its position as the largest, freest, most sophisticated economy and preferred ally and strategic partner. Global trade, valued at $28 trillion, is the backbone of the world economy. T&L supports international trade, connects all other industries, and enables assured power projection and deployment of freight, personnel, and military might to foreign and domestic destinations.

U.S. and Global Economy

Deep-Sea Shipping. Even though the U.S. comprises only 0.4 percent of the world's commercial merchant vessels, 180 out of 43,000 ships, the deep-sea shipping industry is crucial for our country's economic health. Shipbuilding and repair provided over 100,000 jobs, $12 billion to the U.S. gross domestic product (GDP), and $9 billion in taxable income.[33]

Deep-sea shipping generates more than $45 billion in revenue annually, providing over 650,000 jobs domestically. Globally deep-sea shipping, coastal and inland water transportation

generated more than $570 billion of revenue with a $40.5 billion profit in 2020, and over 26,000 businesses employed 2 million people.[34] In freight rates alone, the industry contributes around $380 billion annually to the world economy.[35]

Inland Waterways. The inland waterway industry consists of 2,893 businesses with 20,768 employees and provides $1.6 billion in annual wages.[36] The sector carries between 4 and 5 percent of commercial tonnage shipped annually, primarily supporting the agriculture, energy, and construction sectors.[37] The IWS carries bulk coal and petroleum products to energy generating facilities, petroleum and gas products between refineries on the Gulf Coast, and iron ore, steel, cement, and phosphate rocks to manufacturers and construction workers.[38] The IWS also provides low-cost transportation for farm crops. Corn, soybean, and wheat farmers move goods on the IWS, saving between $7.0 billion and $9.0 billion annually.[39]

Ports and Harbors. United States ports and harbors must embody the role and functionality of ensuring the transport of commercial goods, protecting the nation with the movement of military weapons and equipment, and supporting our allies and partners. In 2020, marine transport accounted for $132 billion and over 25 percent of the overall transportation revenue. It was one of the more lucrative segments of the industry due to its widespread capabilities and cost-effective methods.[40]

Railways. The freight rail industry is a "regional oligopoly"[41] composed of four major rail companies that account for 82.7 percent of the industry's $76.5 billion in revenue.[42] According to the American Association of Railroads (AAR), America's freight railroads spent nearly $740 billion from 1980 to 2020 on capital expenditures and maintenance expenses.[43] These include new and emergent technologies to improve the overall safety, reliability, and efficiency of operating railroads in the United States.[44]

Trucking. Trucking provides market accessibility – domestically and globally – by linking producers and consumers and plays a vital role in the U.S. and the global economy. The value of goods shipped in the U.S. amounts to $11.5 trillion, far beyond the trucking industry's direct contribution of 1.7 percent, or $368.9 billion, to GDP.[45] The various road freight transportation markets were worth approximately $730 billion in 2020.[46] The American Trucking Association (ATA) lists 3.36 million truck drivers and 7.65 million people employed in trucking-related jobs.[47] Responsible for about 70 percent of the total freight tonnage shipped throughout the U.S., trucking firms are a fundamental element in the global economy.

Air Freight. The air freight industry supports U.S. diplomatic, information, military, and economic instruments of power through various mechanisms. The global air freight industry is an important economic driver within the U.S. economy, generating $122 billion annually while sustaining 2,745 businesses and 2.2 million jobs while supporting 4.2 percent of the U.S. GDP.[48] The U.S. Transportation Command (USTRANSCOM), the Federal Emergency Management Agency (FEMA), and interagency partners contract charter flights to support the response to domestic and international natural disasters and humanitarian efforts to strengthen relationships with allies and partner nations.

Warehousing. In the U.S., warehousing generates $38.78 billion and employs over 1.7 million people.[49,50,51] As products maneuver through the complex array of vessels over air, land, and sea, warehousing provides the critical joints connecting each transportation mode. Uncertainty in the supply chain and transportation drives higher demand for warehousing space. Companies are not only increasing their stock; they are reshoring some of their manufacturing and bringing inventory closer to their customers to decrease time, distance, and cost of

transportation.[52] Based on the market trends, experts believe the warehousing market will grow to an estimated $605.6 billion in 2027 or a compound annual growth rate of 4.9 percent.[53]

Digitization. A robust digital infrastructure is critical for maintaining visibility of opportunities and barriers and enabling near-real-time insights for decision-making on logistics movements. Therefore, it is no surprise that global supply chain management software is one of the critical growth industries, with a market size that was valued at $15.85 billion in 2019, projected to reach $37.41 billion by 2027, and growing at a compound annual growth rate of 11.2 percent from 2020 to 2027."[54] The potential for expanded supply chain digitization has also earned the market a strategic focus by venture capital and private equity firms. According to the talent recruiting firm Hunt Club, the seven most promising logistics start-ups in 2021 are software companies seeking to enable integrated end-to-end solutions across logistics partners.[55]

Mobilization

Our national security depends on our ability to project power and influence globally, including crisis response and support to our partners and allies. Consistent, reliable access to global logistics and distribution systems is critical to support our efforts.[56]

Deep-Sea Shipping. The U.S. military must move large amounts of cargo to support operational plans to foreign and sometimes hostile locations.[57] As of March 2018, U.S. sealift capacity includes 61 government-owned vessels held in reduced operating status, of which 15 are under the Military Sealift Command (MSC) and 46 are managed by Maritime Administration (MARAD). Additionally, 113 U.S. flag oceangoing commercial vessels (including 32 eligible Jones Act vessels operating domestically) can reinforce the sealift effort.[58] These ships must be ready for mission within five days of activation.

Deep-sea transportation is mainly a commercial market, but it can be considered a dual-purpose market in times of need. There are two critical programs between the federal government and private civilian deep-sea shippers that support the government's ability to support sealift requirements. The Maritime Security Program (MSP) is a financial incentive program for U.S. shipping companies capable of supporting military sealift requirements to keep active ships in their inventory. The Voluntary Intermodal Sealift Agreement (VISA) program is a partnership between the U.S. government and shipping companies with American flagged vessels that receive priority for federal agency cargo. The MSP and VISA programs provide maritime shipping capabilities for the federal government with incentives to companies that can maintain a role in the global shipping industry.

Inland Waterways. During national wartime mobilization, the inland waterways industry continues to deliver critical materials to manufacturers of military equipment. Additionally, the sector provides alternatives to compromised transportation networks for deploying military equipment and supports the forward movement of equipment from production lines to the front lines.

Ports and Harbors. Ports and harbors play a significant role in our mobilization with direct interagency links to the Departments of Defense (DoD), Commerce (DOC), Transportation (DOT), and Homeland Security (DHS) supporting vessels that carry valuable payloads transiting between land routes and waterways. Ports and harbors are critical infrastructure for United States Navy ships and vessels and provide outlets for the United States Coast Guard to protect our national waterways. In addition to enabling the national economy and mobilization, U.S. ports and harbors serve as power projection platforms for U.S. national strategy. The nation's sealift capacity links the DoD and the DOT, including MARAD's

management of the government-owned reserve fleet and the marine capacity associated with the VISA program.[59]

Railways. USG has used railroads to move troops, supplies, and military equipment since the 1820s. Congress authorizes the President of the United States to move troops when mobilizing for war. The President exercised this authority during the American Civil War, World War I, and World War II.[60] Designed "to ensure critical railroad infrastructure and rail lines are not abandoned and meet defense readiness requirements, the Railroads for National Defense program was created in the 1970s and is updated every five years.

U.S. railroad companies' infrastructure, equipment, and capabilities remain critical for DoD mobilization efforts. They are vital infrastructure for moving materials for production, equipment, vehicles, and the fuel used in manufacturing and using that equipment.[61] According to a U.S. Senate report for mobilization efforts, rail is the most cost-effective and expeditious means of moving large quantities of equipment over long distances. If the U.S. Army were to mobilize for war, approximately 67 percent of Army unit equipment would move from its fort or base of origin to a shipping port by rail."[62]

Trucking. In support of mobilization, truck carriers play a critical role in transporting sensitive freight such as munitions, classified communications equipment, and weapons as part of the Transportation Protective Services.[63] During the recent COVID-19 pandemic, trucking was a crucial player in domestic crisis management, transporting vaccines, personal protective equipment, food, and other critical medical supplies and equipment. In support of Defense Support for Civil Authorities (DSCA) operations, fuel trucks were instrumental to FEMA and other interagency partners, completing over 800 fuel missions and providing nearly two million gallons to victims of Hurricanes Harvey, Irma, and Maria.

Air Freight. During contingency operations, including Operations Iraqi Freedom and Enduring Freedom, and the war in Ukraine, USTRANSCOM augments military transportation systems through worldwide Global Heavyweight Shipment (GHS) and Next Generation Delivery Service (NGDS) contracts, which account for 45 percent of goods issued by Defense Logistics Agency.[64] Under the Civil Reserve Air Fleet (CRAF) program, the DoD mobilizes commercial air freight and passenger aircraft to support worldwide military operations through congressional authorities and Executive Orders.[65] Finally, air freight carriers support the economic instrument of power by connecting the U.S. economy to global trading partners and consumers.

Warehousing. The U.S. economy and military depend on a mature logistics network that optimizes the time and space of goods and services during distribution to key locations or end-users. Warehouse capacity and trafficability enable mobilizing forces to equip for their overseas deployment or respond to a domestic or international crisis. Speed, accuracy, and efficiency are critical in warehouses and distribution centers, where supplies are received, stored and staged for onward movement. Warehousing enhances fidelity in the supply chain and concentration of force to achieve national security objectives.

Issues/Concerns

Deep-Sea Shipping. The industry faces many uncertainties and challenges, ranging from globalization through dispersed manufacturing, world trade fluctuations, and demographic shifts to uneven global economic growth.

Section 27 of the Merchant Marine Act of 1920 (P.L. 66-261), known as The Jones Act, requires ships transporting cargo between two U.S. locations to be built in the U.S., owned, and crewed by the U.S.[66] The Jones Act contributes to the poor state of maritime infrastructure. By

guaranteeing demand for the U.S. Deep Sea Industry, the USG reduces competition and the incentive to innovate. Thus, the current number of U.S. flagged merchant ships and pool of professional mariners is insufficient. On the other hand, the Jones Act protects U.S. control of the domestic transportation system by keeping out the foreign, often subsidized competition.[67] Elimination of the Jones Act would have negative repercussions, including possible reduction of U.S. flagships and displacing trained U.S. mariners with foreign nationals, increasing national security risk. There is an opportunity to modify The Jones Act to meet the challenges of the U.S. shipping industry and enhance mobilization capacity in a rapidly evolving global environment.

In the deep-sea shipping industry, suppliers have significant bargaining power. The leading suppliers include highly concentrated shipbuilding companies, labor providers, and fuel distributors. Environmental regulations pose another challenge to the industry.[68] The International Maritime Organization (IMO), in April 2018, adopted the goal of a 50 percent reduction in greenhouse gas emissions from the shipping sector by 2050.[69] The European Union (EU) CO2 emissions reduction plans call for the inclusion of transport in the emission limits. Low carbon-emitting fuel, like green methanol, is more costly than fossil fuel, increasing operating costs. Additionally, some shippers find that the supply of alternative fuels is still too low to transition away from fossil fuels.[70]

Inland Waterways. Aging infrastructure degrades efficiency and reliability while lagging inland port development fails to capitalize on the full extent of the system. The industry is concerned about lock and dam consistency given increased traffic, reducing the system's effectiveness.[71] Old lock infrastructure cannot support modern 15-tow barges; therefore, operators must separate to pass, increasing the operator's lockage time from 45 minutes to over two hours.[72] Delays cost operators up to $739 an hour and approximately $44 million annually.[73]

Reduced system efficiency increases the cost of exports in the energy and agriculture sectors, reducing their competitiveness in international markets and impacting the balance of trade and the national economy.[74] USACE has a $6.8 billion backlog in Congressionally authorized IWS projects but must operate within appropriations and cannot advocate for additional funding.[75]

Ports and Harbors. Ports and harbors suffer from inadequate physical infrastructure, port congestion, and ongoing national human capital challenges. Despite increasing trade volumes and rising consumer spending improving the nation's ports and harbor demand, insufficient U.S. port infrastructure limits revenue growth. Many U.S. ports do not have the infrastructure or depth of waterways to support or unload large ships, such as the post-Panamax ships.[76] Congested ports limit the flow of goods to and from a port, even if the port's internal capacity to handle cargo has expanded. Human capital challenges include the growing number of discouraged workers, demographic shifts, and harsh working conditions. A prolonged labor shortage in the maritime sector would be a devastating challenge to the port industry and the global supply chain.[77]

Railways. Freight railroads operate overwhelmingly on infrastructure that they own, build, maintain, and pay for themselves.[78] U.S. railroad companies invest "19 percent of their revenue on capital expenditures, six times more than the average U.S. manufacturer." [79] Continued reliance on rail to support mobilization efforts requires investment in the infrastructure network used to accomplish that mission. The government cannot continue to rely on privately funded rail infrastructure to support its mobilization and national security objectives.[80]

The technological advances and automation intended to increase safety and efficiency, such as automatic train operation (ATO) and positive train control (PTC), create vulnerabilities

that threaten national security.[81,82] These vulnerabilities include cyber-attacks that compromise data or physically damage rail infrastructure or rolling stock. As Stuxnet and the Saudi Aramco attacks demonstrated, network security precautions such as encryption, password protection, radio communication, and air-gapped networks are not infallible.[83] Despite the vulnerabilities, these advances maintain the viability of the industry and timely, efficient response to USG needs. The USG has a responsibility to provide safeguards against these threats and vulnerabilities.

Trucking. The industry's issues and concerns have remained relatively consistent over the past 40 years. Major problems include the ongoing shortage of available and trained drivers, the aging infrastructure network, and the industry's environmental impacts.

The shrinking skilled workforce poses a significant threat to the whole U.S. economy.[84] The ATA projects a need for 1 million new drivers by 2030 compared to the current employment of approximately 3.6 million.[85] The current shortage amounts to 80,000 drivers in 2021 and a projected 160,000 in 2030.[86] The main reasons for the gap are an aging workforce, gender inequities, demanding lifestyle, available job alternatives, and regulations. The industry's fragmentation and the considerable number of small and medium companies competing for the same workforce exacerbate the situation.

Air and noise pollution are among the most severe environmental challenges in freight transportation and pose significant business risks to the trucking industry through increasing regulatory requirements or the growing need to invest in greener vehicles.[87] The trucking industry contributes significantly to air pollution by emitting nitrogen oxides (NOx), particulate matter (PM), volatile organic compounds (VOC), and greenhouse gas (GHG) emissions.[88] Long-haul trucking accounts for 16 percent of all emissions.[89] Trucking is the primary source of noise

pollution in the U.S. Currently, more than 13 percent of the U.S. population suffers from road-noise, a steadily increasing number.[90]

Aging infrastructure and stagnant transportation networks also pose a significant challenge for the trucking industry. Continued congestion at critical chokepoints and the health of intermodal connectors are significant industry concerns. Current ground lines of communication cannot sustain the increased trucking traffic, thereby costing the industry billions of dollars in lost productivity.[91] The roads that connect the different modes of transportation are critical to the health and capability of the domestic supply chains. The quality of these connectors (9 percent are in "good" condition, 19 percent are in "mediocre," and 37 percent are in "poor" condition)[92] is critical to ensuring the supply chains maintain seamless interchangeability, adding an essential layer of flexibility to logistics and transportation networks. Furthermore, the congestion and requirements for re-routing to more suitable connectors cause over one million hours of truck delays each year, resulting in a more than $70 million loss.[93]

Air Freight. The air freight industry is highly regulated and adversely impacted by geopolitical, economic, and military disruption--all of which are external and outside the control of industry leadership.[94] Overall, the single-most cited industry concern is trade instability. Trade embargoes, sanctions, and tariffs disrupt demand, reduce volume, and negatively impact revenue. Next is physical and cyber (data) security. The Federal Aviation Administration (FAA), DOT, and DHS govern U.S. domestic air freight security. Still, the International Air Transportation Association (IATA) sets global cargo standards and advises on security and sustainability matters, which vary by region and country.[95] As a result, air freight carriers are subject to a constantly shifting regulatory environment that imposes steep costs for non-compliance.

Sustainable alternative fuels (SAF) and cargo security highlight this tension between policy and operational efficiency.

The U.S. aviation industry emits 11 percent of all carbon emissions across the transportation industry.[96] The Biden Administration recently set a 20 percent aviation (carbon) emission target by 2030 and a zero-emission goal by 2050.[97] However, SAF is currently not cost-effective to produce or use without government incentives.

Congress remains concerned about air freight security, pushing the Transportation Security Administration (TSA) to review two primary concerns, including explosive devices on a passenger aircraft and hijacking an all-cargo plane for use as a weapon of mass destruction. Despite TSA's effort for all-cargo security, terrorists still probe for vulnerabilities while the cost of new security measures grows.[98,99]

Warehousing. Retailers, wholesalers, trucking, and third-party logistics companies are skeptical as their estimated arrival dates become increasingly unreliable. "It can now take 28 to 52 days to ship a pair of shoes produced in China, from Shanghai to Los Angeles, up from the 17 to 28 days before the pandemic."[100] Lean, "just-in-time" strategies have shifted to a "just-in-case" model; thus, storage and distribution facilities are unable to process goods quickly. Over 60 percent of U.S. companies increased inventory of critical products, and 55 percent took action to ensure they have at least two sources of raw materials.[101] Demand for warehouse operators to manage additional inventory exceeds the number of workers firms can attract, despite wage and compensation increases.[102] According to a January 2022 survey of several hundred light industrial businesses conducted by Instawork and the Logistics Management Institute, flexibility (of hours) and career development were among the top worker requests. Only 44 percent of

surveyed companies invested in flexible scheduling options, and only 39 percent increased their headcount.[103]

Warehouses in the U.S. average dangerously low vacancy, at 3.4 percent, and increased e-commerce sales by businesses without brick-and-mortar facilities will likely boost demand for third-party warehousing.[104] Low warehouse vacancy and industrial space scarcity in cities drive real estate prices higher, but multinational companies in the U.S., Europe, and Asia invested heavily in 2021 to increase supply. China doubled its number of overseas warehouses in the last two years and plans for expansion in its Industrial 5-Year-Plan. Chinese policymakers and industry experts regard domestic-owned and operated overseas warehouses as a critical element of national competitiveness.[105]

Digitization. While international standards are widespread in some industries, T&L still lags due to the persistence of legacy systems, highly manual processes, paper-based compliance requirements, and the anticipated costs associated with the subsequent digital transformation. The challenges of modern global supply chains bring new urgency to establishing and adopting such standards. The ability to identify, capture, and share supply chain data in a standardized manner is critical for digital communication and interoperability. The lack of collaboration results in the inefficient distribution of goods and services in the U.S. and globally. Further, it exacerbates recent supply chain challenges resulting from an insufficient workforce and inadequate infrastructure investment by perpetuating the need for time-consuming manual intervention in the exchange and interrogation of trade data. Thus, the industry would benefit from congruous, harmonious regulation across major economies to define the basic data standards necessary to transition to the efficient execution of digitized global commerce over the next several years.

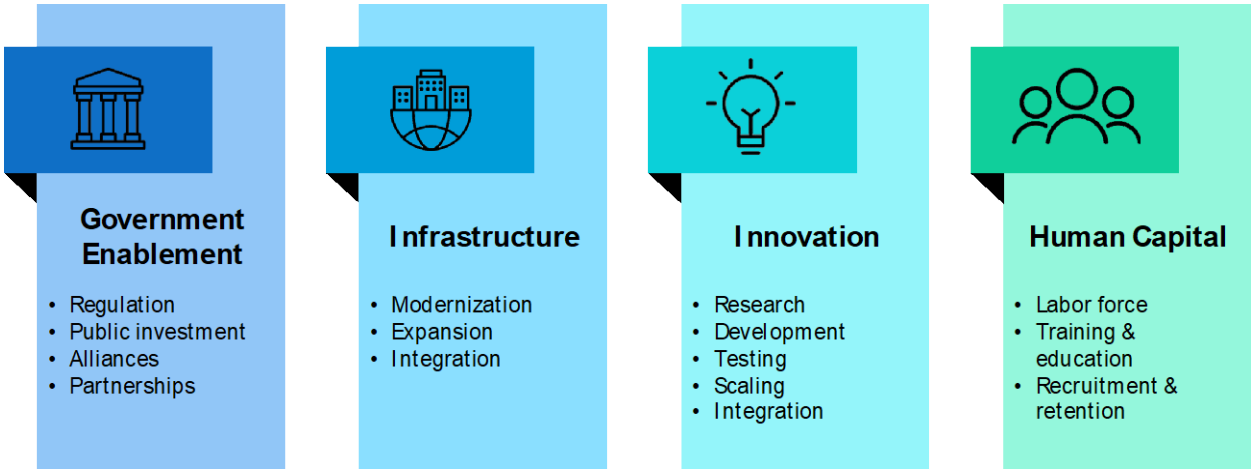
Greater data visibility and transparency across the supply chain reduce risk and improve resiliency in logistics operations by enhancing line of sight in logistics providers' value chains. Public agencies like port authorities, Customs and Border Protection (CBP), and federal agencies tasked with monitoring trade and distribution within specific industries (e.g., Food and Drug Administration (FDA), U.S. Department of Agriculture (USDA)) seek enhanced visibility to support regulatory oversight and compliance roles. “Rapid digitalization and finite resources of individual companies lead to a natural desire for a long-term partnership between market participants, which involves improving and updating enterprises’ business models,” and developing partnerships based on shared digital ecosystems.[106] As the T&L industry looks to the future, whole-of-industry digital ecosystems need to emerge to enable accurate multimodal, end-to-end data visibility.

With the rise of digitization in the global T&L industry and the dependency of the global economy on its data comes an increased threat of nefarious cyber activity. In recent years, some of the most prolific cyber-attacks targeted the T&L industry. The June 2017 ransomware attack on 80 logistics and transportation ports cost A.P. Moller-Maersk up to $300 million.[107] The May 2021 attack on the Colonial pipeline cost $5 million in direct payments and had an economic impact on the lives of millions of Americans.[108] Effectively cybersecurity measures are particularly challenging in the T&L industry because of industry fragmentation, a high number of independent contractors, the proliferation of communication networks, the lack of harmonized global regulatory requirements, and deficient cybersecurity and human resources systems.[109] There is an opportunity for USG to leverage the work done by the EU Network and Information Security (NIS) directive to establish broad cybersecurity requirements across industries, with specific standards created for critical sectors.

Comparative Analysis

Below is a comparative analysis of U.S. performance in the various T&L industry sectors and its comparison with China and Russia. Our teams selected four drivers of U.S. competitiveness: Government Enablement, Infrastructure, Innovation, and Human Capital.

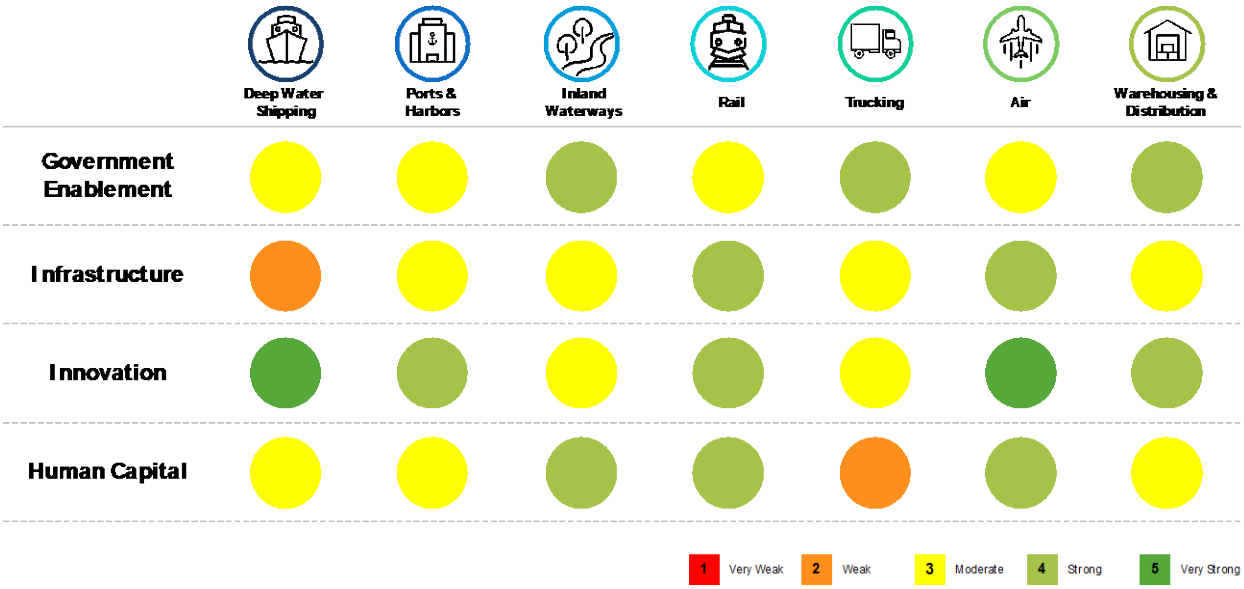
Figure 4. Analytical Framework Drivers



Government Enablement includes regulations and government support to the T&L industry, including the rule of law, Government financial support, free trade agreements, public-private partnerships, alliances, strategic partnerships, and integration strategies to expand influence and enhance competitiveness. Infrastructure includes the safety of domestic T&L infrastructure and existing plans to improve, modernize, and expand domestic and global multimodal capability. Innovation includes research, development, testing disruptive technology, and adopting technology that enhances performance and optimizes resources. It also includes the integration of modern technology across modes and state borders. Finally, Human Capital includes the availability of willing and able workers, access to education and training, emphasis on science, technology, engineering, and math (STEM) education, recruiting and retention of workers, and labor cost.

The U.S. is the world's wealthiest nation and depends on the T&L industry to maintain its leading status. While government policies exist in the industry, many of them are outdated and, as a result, do not address the issues presented in the industry over the past few years. Furthermore, decisions made at the county or state level without thorough reconciliation with other authorities increase friction in other states. Years of neglect and complacency eroded U.S. primacy compared to its most consequential competitor, China. The IIJA and DOT FY22-26 Strategic Plan are encouraging steps in the right direction but only begin to answer the call for modernizing infrastructure and addressing industry-wide challenges.

Figure 54. U.S. Performance Assessment



Deep-Sea Shipping. The U.S. capability to deploy and sustain large forces in two separated theaters suffers from inadequate infrastructure and shipbuilding compared to competitors. Ports are critical infrastructure for deep-sea shipping.

The deep-sea shipping market is highly structured at international, regional, and national levels. International agreements include the United Nations Convention on the Law of the Sea (UNCLOS) and more specialized agreements by the International Convention for Safety of Life

at Sea or International Regulations for Preventing Collisions at Sea. Regional regulations such as those imposed by the European Union or nationally, like the U.S. cabotage laws, also guide or regulate the industry. U.S. labor regulations (certifications, training, and education requirements) impose additional requirements on U.S. flag operators, increasing operating costs. Chinese adventurism in the South China Sea and Russian posturing in the Arctic demonstrate a willingness to violate the principles of UNCLOS but also bold confidence in seafaring.

Ports and Harbors. Despite the national attention and historic funding given to ports and harbors, there are critical industry issues and concerns that the USG and private industry need to address. The problems and concerns discussed previously relating to physical infrastructure, port congestion, and ongoing national human capital challenges constrain the efficiency and capability of U.S. ports and harbors.

A survey by MARAD showed that at 17 of the largest U.S. container ports, foreign headquartered companies operated 45 terminals (66 percent), five terminals (seven percent) by a joint venture between a domestic and foreign company, and 18 (26 percent) by domestic companies.[110]

New technologies are changing how ports and terminals operate, driving new efficiencies while creating an advanced ecosystem that will eventually encompass the whole supply chain. The ports and harbors industry identifies five emerging technologies that will catapult the industry into the future: simulated training, internet of things/vehicles, 5G Networks, drones, and augmented reality. Implementing these five emerging technologies would make ports and harbors more interactive, immersive, practical, and adaptable, improving traffic safety and efficiency.

Inland Waterways. Government policies and programs strongly support the inland waterways industry. The Jones Act prevents foreign competition for industry operators, while the IWTF, supplemental appropriations, and dedicated federal operations and maintenance funding improve and maintain the IWS for industry use. Despite a strong policy and program structure, the inland waterway infrastructure is weak due to maintenance delays throughout the system and lock capacity issues. USACE schedules preventative maintenance and coordinates outages with system users; however, unscheduled maintenance and lock failures incur a higher cost of repairs.[111] USACE's operations and maintenance appropriation, set at the beginning of DoD's fiscal year, funds IWS maintenance; therefore, unscheduled maintenance detracts from preventative maintenance funding.[112]

In addition to unpredictability, the duration of an outage is not always known. For example, in September 2003, the Greenup Locks and Dam on the Ohio River closed for 52 days when scheduled maintenance revealed cracking that required emergency repairs resulting in a secondary impact of $41.9 million in shipping costs to divert cargo.[113] Additionally, delays occur because older lock infrastructure cannot support modern barges. On the Mississippi River, the older lock chambers are 110 feet wide by 600 feet long, which cannot fit a modern 15-barge tow. The larger barges must break apart and pass separately, resulting in three lock passages increasing the operator's lockage time.[114]

Innovation in the industry is weak. The inland waterways industry experiences incremental innovation by applying existing technology to make vessels more efficient and safe.[115] Large international ports are automating facilities for container shipping, and oceangoing vessel automation is in the trial phase; however, automation of inland waterway ports remains an

untapped application of proven technology, and the automation of waterway navigation is decades away.[116] In terms of human capital, the industry is strong without significant concerns.

Rail. Overall, the USG demonstrates a moderate performance in railroads. There is a history of solid government enablement for the railroad industry, including nationalization during times of war, followed by re-privatization when peace returns. Tight government regulation, such as the Interstate Commerce Act of 1887, designed to promote manufacturing and economic growth, was likewise followed by deregulation efforts, such as the Staggers Act of 1980, giving the industry control of its operation.[117] However, this government enablement stops short of providing infrastructure support and has a history of limiting free-market decisions by the railroads.

As noted above, the railroads are responsible for building and maintaining the infrastructure, including rail lines, railyards, and rolling stock. Because of the oligopolistic nature of the railroad industry, private infrastructure investment gives the industry a competitive advantage compared to other freight movers and some foreign state-sponsored railroads.[118,119] Additionally, the Railroads for National Defense (RND) program, the Strategic Rail Corridor Network (STRACNET), and Defense Connector Lines ensure critical railroad infrastructure meets DoD requirements and is updated every five years.[120]

For a mode of transportation used since the 1700s, it may be surprising that the rail industry employs artificial intelligence (AI) and automation in passenger and freight transport. A railroad can employ ATO, automatic train protection (ATP), and automatic train supervision (ATS) in a closed rail system, such as a city's metro rail line.[121] In an open system, where there is less control of the environment and operations, the Rail Safety Improvement Act of 2008

mandated PTC as a safety measure.[122] Automated technology provides increased efficiency and safety in multiple aspects of the freight rail process.

There are significant variations concerning the strength of human capital available. The U.S. has a firm immigration policy, widely available education, and labor unions to support recruitment and retention, providing a relatively steady source of qualified personnel. “Class I freight rail employee compensation, including benefits, averaged approximately $135,700 per year, more than the average U.S. employee.” [123] But, the COVID-19 pandemic caused a decline in the U.S. rail and trucking industries' workforces, leaving both unable to surge labor toward the unusually high volume of freight at terminals and distribution centers to move containers in and out in a timely fashion.[124]

Trucking. The issue of adequate infrastructure to support long-distance road freight transportation plagues the U.S. mainly due to a steady decline in public investment since the late 1960s. Nevertheless, the current administration’s approach represents a turning point.[125] The U.S. is still the most innovative country globally. To maintain its leading position, it must focus on innovation and investment policies that support both large companies and valuable small and medium-sized trucking companies to maintain the stability of the trucking ecosystem in the future. The U.S. still benefits from its superior and high-standard post-secondary education system.[126] The COVID-pandemic had severe impacts on the labor market and projections indicate that the labor remains supply-constrained for the upcoming years, exacerbating the challenge of meeting the already high demand for skilled workforce in the U.S.[127]

Air Freight. Overall, the U.S. air freight industry infrastructure, innovation, human capital, and economic policy are strong. However, government enablement is moderate because of deficiencies in central planning. Public Law, 95-163 (also known as the Air Cargo

Deregulation Act) of 1977 removed centralized economic regulation over the air cargo industry, allowing companies such as FedEx to innovate, buy larger aircraft, set rates, and horizontally integrate into multimodal networks.[128] The USG's laissez-faire approach led to the U.S. leading the world with 13,513 commercial airfields and airports, and companies such as FedEx and UPS dominating the North American and global air freight markets across 220 countries and territories.[129] Airfreight companies developed robust connections with FAA, USTRANSCOM, DOT, DHS, and TSA leadership. Still, the siloed regulations lack clear, coordinated priorities, causing U.S. airport infrastructure to degrade to the point where no U.S. airport ranks within the top 25 in the world in terms of infrastructure modernization. The Fiscal year 2022-2025 DOT Transportation Strategy and IIJA, if implemented fully, will correct these trends by allocating $25 billion toward airport modernization.[130] The IIJA and DOT strategy reorient U.S. goals and bring airport infrastructure on pace with competitors in Asia. Sustained strategic investment is necessary to dominate the world's fastest-growing transportation mode.[131]

Finally, traits of the free-market economy, specifically venture capitalism and innovation ecosystems, enables air freight companies to create innovative business units designed to research, develop, and integrate new cutting-edge technology into global operations. Based on some estimates, U.S. air freight companies will dominate a $6 billion unmanned aerial vehicle (UAV) market growth by 2025, all with a diverse workforce, strong recruiting pipelines, and no significant human capital limitations.[132]

Warehousing. Congestion at ports, space shortages in warehouses, and lack of capacity prevent containers from advancing through the supply chain, given the persistent demand for goods and fast fulfillment expectations. U.S. firms compete fiercely for human capital. Real estate prices are high in cities near key U.S. ports, creating significant challenges for expansion

near crucial ports on the west and east coasts. As U.S. firms increase their inventories, innovation is needed to optimize the flow of goods and avoid the "bullwhip effect." "The 'bullwhip effect' is the demand distortion that occurs when local decisions lack regard for the state of the larger, global enterprise."[133] In the U.S., commercial real estate firms like Hillwood created Mobility Innovation Zones like Alliance Texas, an industrial-focused, mixed-use community, enabling opportunities in the public-private ecosystem.[134]

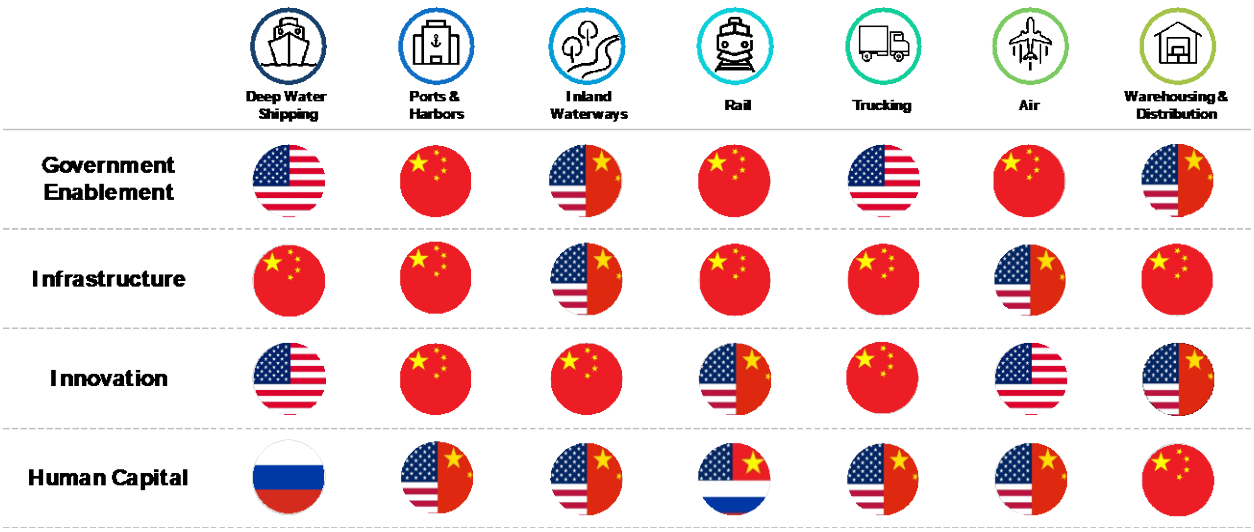
Digitization. With rapid technological advancement, digital transformation occurs rapidly across many industries, especially in T&L, spurred by the supply and demand shocks incurred due to the COVID-19 pandemic. Between 2020 and 2021, many U.S. firms and transport hubs invested in "amplifying capabilities" to help them maintain or gain a competitive advantage in the industry. These capabilities include AI and machine learning (ML) for analytics and optimization, process automation, autonomy, and robotics in warehousing and small package delivery, blockchain to simplify and build trust in transactions, and quantum to perform simulation & optimization of logistics routes at scale. These capabilities provide companies with a competitive edge vis-à-vis their peers, but in their current state, they are not supporting the more robust performance of the overall ecosystem.

In Figure 6, the U.S., China, and Russia are compared across all seven T&L sectors on how well they perform in each of the four drivers of competitiveness; government enablement, infrastructure, innovation, and human capital. As of 2018, none of the three Great Powers are top performers in logistics. According to the 2018 World Bank Logistics Performance Index, the U.S. ranks 14th, China ranks 26th, and Russia ranks 75th.[135]

The U.S. is a free market and democratic society with a solid rule of law and strategic alliances. However, U.S. policy is often subject to divergent interests of legislators, lobbyists,

and corporations of the "iron triangle," Slow political processes hinder rapid execution. The national debt constrains adequate investment in all areas of the T&L ecosystem.

Figure 5. GPC Relative Strengths Analysis



Conversely, China's centralized and future-focused decision-making enables more substantial strategic planning, and public investment has driven the implementation of innovation at scale across the industry. China's national, provincial, and municipal transportation policy intricately links its economic policy to foster intermodal connectivity in support of its global competitiveness.

Russia's economic stagnation over the last 15 years limits public investment in infrastructure. Continuing challenges with corruption and retaining talented human capital will further hinder the modernization and upgrading of Russia's T&L system. The green revolution and the ongoing conflict in Ukraine will further hinder GDP growth and public investment in T&L.

Government Enablement. Chinese government control and influence over the private sector set conditions for an industrial strategy focused on the goals of the Chinese Communist Party. Consequently, public investment in state initiatives bolsters Chinese efforts in

infrastructure and the global supply chain. China's 2049 National Rejuvenation Strategy fully integrates all instruments of power through a civ-mil fusion construct. Its granularity provides a strategic advantage over the U.S. and Russian transportation industries by aligning trade, security, sustainability, and civil-military goals.[136] The Belt and Road Initiative (BRI) and the Digital Silk Road (DSR) demonstrate China's large-scale efforts to extend its influence worldwide through widespread and highly advanced T&L systems and processes.

Conversely, Russia's sectors of T&L lack strategic direction, resources, and anti-corruption mechanisms. In Russia, policies intended to regulate the T&L industry are outdated and limit the industry's potential to expand and improve. Russia's ongoing political tensions with the European Union create an environment for deterioration of its T&L. The U.S., the United Kingdom, and other North Atlantic Treaty Organization (NATO) nations have imposed sanctions that have significantly limited Russia's ability to expand its influence within the global economy. Russia's ambitions in the Arctic represent opportunities to emerge as a strong maritime nation, but its plans are underfunded, and therefore success is questionable.[137] Military miscalculations, corruption, and economic dependence on energy exports stifle Russia from effectively modernizing its T&L industry.

Infrastructure. U.S. logistics network size and scope offer significant global reach advantages, but China's investment in Asia gives it a competitive advantage in its fastest-growing economic region. China's state-driven economic plans are rapidly expanding its modern, multimodal hubs in Asia. State-funded infrastructure includes dual-use civil-military functionality, robotics, 24/7 automation, 5G integration, and the world's most extended inland waterway network.[138] Internationally, China's investment in port infrastructure for worldwide influence is higher than the United States.

China has invested over $110 billion in 139 countries, primarily middle and developing economies, through the BRI, enhancing its global economic connections to more than 80 percent of the world's population.[139] China's lack of legacy technologies has enabled the country to "leapfrog" without incurring high switching costs or grappling with change management woes that accompany transitioning from old to new. The lack of traditional technology plays a critical role in accelerating the adoption of fintech and e-commerce and will have a similar effect on the supply chain.

China has a competitive advantage in warehousing, given its acquisition rate. China doubled its overseas warehouses between 2020 and 2022 and plans for more development in its industrial 5-year-plan. Russia's warehouse vacancy rates averaged 2.3 percent in 2020, and its plan to expand is moving very slowly.[140]

Chinese and Russian companies are expanding their control over critical port infrastructure around the globe, including Chinese operators of the Panama Canal.[141] In 2006, the U.S. Congress successfully blocked a deal with Dubai-based DP World to purchase terminal concessions in six ports and stevedoring operations in another 16 locations. Since then, Canada's CPP Investment has controlled Ports America operating 70 locations in 33 U.S. ports. China-based COSCO Shipping has access to Middle Harbor in Port of Long Beach. The UAE-based Gulftainer leased Delaware's Port Wilmington. The Mississippi State Port Authority is discussing port expansion with Turkish Yilport Holding.[142]

Despite continued interest from the government in Russia, the lack of infrastructure, integration, and networks hinder its ability to compete globally. The ongoing conflict in Ukraine and the global response against Russia will undoubtedly delay the Russian government's progress.

Innovation. China and the U.S. compete fiercely to develop and employ innovative technology, albeit via different economic models. The Chinese state-controlled system creates innovation ecosystems to execute five-year economic plans and priorities using foreign technology as a platform.[143] China has an advantage in adopting new technology as it is still building much of its infrastructure to support a growing economy.[144]

The U.S. leads the world in patents and disruptive technology such as AI/ML and e-commerce supply chain technology.[145] One market analysis posited that 80 percent of automation efforts came from the Americas in 2020 but stated that growth will shift to the Asia-Pacific by 2024.[146] Russia is advancing slower U.S. and China despite years of state-led initiatives and directives.

The China Standards 2035 initiative will accelerate digitization efforts to establish the global standards for the next generation of technology and standards within strategic sectors like agriculture, telecommunications, and logistics. China also has a comprehensive cybersecurity and data management regime that addresses whole-of-market risk, including a cybersecurity law, a multi-level protection scheme, critical information infrastructure designations across commercial and government systems, essential data protection, and critical data protection.[147] Further regulations are self-developed by state-owned enterprises for critical industries, and restrictions are in place to oversee cross-border flows of any data deemed essential to national security. The U.S. T&L industry lacks an overarching regulatory cyber security framework, despite cyber threats being a top concern for the private sector and USTRANSCOM. There is an opportunity for the U.S., building on industry-specific projects in the EU and China, to develop regulations for the industry and standards by sector.

Human Capital. The U.S. has a firm immigration policy and a steady source of qualified personnel. The U.S. also benefits from its superior and high-standard post-secondary education system.[148] However, the inability to attract and retain quality labor from hourly workers to managers is a problem that predates the Trump-era trade wars and COVID pandemic shutdowns.[149] Additionally, labor unions create tensions between workers and companies because of the effect of their strict contracts on productivity. The U.S. is starting to prioritize and reward those with STEM talent and education. President Biden's elevating of the Office of Science and Technology Policy to his cabinet is an encouraging sign that our nation's leaders prioritize innovation and modernization.

China has the largest education system in the world, with 270 million students and 16 million teachers.[150] China also has the highest ratio of STEM graduates of any developed nation and pursues a distinct strategy of sending students to Western countries to study. [151,152] Nevertheless, China is behind the U.S. because its citizens lack access to education, especially in rural areas. China has a large pool of cheap labor but invests extensively in automation and robotics to increase productivity across all T&L sectors.[153] Chinese ports are operating 24 hours which has caused them challenges with worker recruitment and retention.

Despite aging workforce demographics, China's Hukou system manages workforce demographics, education, and training to align industry needs with worker skills. At the same time, government-sponsored automation decreases human capital demand for inefficient industries. This systemic approach to the industry and individual matchmaking is relatively efficient, albeit void of diversity and inclusion. Russia faces systemic education, healthcare, and demographics that severely limit long-term human capital viability.

Policy Recommendations

To compete and win in GPC, the U.S. needs to prioritize public investment in the overall health of the T&L ecosystem. Without a clear direction for advancement, private industry will make investment decisions based on expected returns. While corporate investment strategy allows companies to increase efficiency and build value within the industry, it falls short of improving the overall T&L network performance.

China addressed its vision for the future of transportation in the 14th Five-Year Plan (2021-2026). The plan focuses on "infrastructure development and foster[ing] infrastructure investment" as well as "environmental, social, and governance (ESG) considerations."[154] Referred to as a "Modern Comprehensive Transportation System Development Plan" by the State Council, the plan intends to create a globally dominant transportation system.[155]

Likewise, in 2021, the Russian government approved the Transport Strategy of the Russian Federation until 2030. The Russian strategy is more inwardly focused, stressing "socio-economic development" and improving "citizens' quality of life."[156] Because the strategy includes industry support, it is designed to be updated regularly to keep pace with changes in domestic and international markets.

In conjunction with the IIJA, the Biden administration tasked the DOT with developing a roadmap to invest allocated resources to provide "good-paying jobs […], confront the climate crisis, and equitably grow the economy, and reinforce America's global competitiveness."[157] The FY22-26 DOT Strategic Plan identifies national goals for the U.S. T&L industry and benchmarks or metrics for achieving those goals. In addition to concurrent efforts to modernize transportation infrastructure and strengthen its associated workforce, we recommend the below policy implementation.

USG policy should include an integrated interagency approach that prioritizes infrastructure improvement projects, investing federal dollars in building and maintaining the infrastructure. Since intermodal connectors lie across national, state, and district lines, the federal government must assist in setting priorities for states and incentivize their allocation of funding for infrastructure improvement within their respective boundaries. The DOT should identify strategic nodes related explicitly to ensuring national security and provide guidance, direction, additional funding, and oversight in improving and maintaining the infrastructure at these nodes.

Develop a long-term path for environmental regulations for the trucking industry. Air and noise pollution are among the most severe environmental challenges in freight transportation and pose significant business risks to the trucking industry through increasing regulatory requirements or the growing need to invest in greener or quieter vehicles. Different global and different domestic standards already lead to competitive disadvantages. Regulations should aim to stabilize the trucking industry's ecosystem by emphasizing environmental issues. Since the investment requirements are immense, USG policy must provide a long-term path regarding future regulations and related investment needs, thus providing certainty for the industry. As a mid-term goal, electrification – focusing on the last mile-delivery – should be used to replace combustion engines and mitigate the impacts in highly stressed urban regions. Because of the industry's importance, the policy must be comprehensive and implemented in a coordinated approach with the industry. Policymakers must also consider the fragmentation of the industry and the importance of small and medium-sized companies. In addition to the domestic focus of the policy, USG should advocate for common transportation, security, and climate control regulations within the World Trade Organization (WTO) to mitigate different global approaches that lead to competitive disadvantages (e.g., common carbon neutrality goal).

Negotiate multilateral trade agreements with Indo-Pacific partners. The DOC should re-negotiate and join the Comprehensive and Progressive Trans-Pacific Partnership (CPTPP) trade agreement in coordination with the WTO and Indo-Pacific partners. Alternatively, the USG should enter new free trade agreements in the Indo-Pacific region, such as the U.S.-led Indo-Pacific Economic Framework (IPEF). The Biden administration has been non-committal to the CPTPP and is leaning toward IPEF. However, according to the Japanese Trade and Industry Minister, the IPEF may not lower U.S. tariffs enough to level the playing field with China.[158]

Renegotiation of either of the two agreements should include (in priority order): commercial air and shipping routes, airport and seaport access conditions, country clearance criteria, cargo clearance security standards, merger and acquisition business rules (to reduce host nation protectionist labor practices), and greenhouse gas emission standards. Asia is the fastest-growing economic region. Preferably, the U.S. should select either the CPTPP or IPEF based on the level of participating allies and partners and U.S. economic interests.

Develop Multimodal Port Infrastructure. In the DOT Strategic Plan 2022-2026, Secretary Buttigieg highlights the need to "improve infrastructure at coastal ports, inland ports and waterways, and land ports of entry along the borders to strengthen our national supply chain."[159] Many U.S. ports do not have the channel depths or portside infrastructure to support the inbound cargo from new post-Panamax ships.[160] Ports require improved infrastructure to accommodate the larger vessels, integration of autonomous cargo transfer systems, and development of more extensive multimodal cargo facilities that link import cargo to a waterway, railway, and trucking capabilities necessary for inland transportation. Railway and highway transportation systems are the predominant solutions for inland transport. For the IWS to be an

option, it must be accessible to inland customers through technologically modern multimodal inland ports that connect the IWS tributaries to railway and highway systems.

Combining visionary public leadership with entrepreneurs can pair federal grants with private partnerships to overcome the gaps in connecting railways and highways to inland waterway port infrastructure that can move goods to coastal ports for export. Federal programs like Better Utilizing Investments to Leverage Development (BUILD) and Fostering Advancements in Shipping and Transportation for the Long-term Achievement of National Efficiencies (FASTLANE) provide grants to support states with the development of transportation infrastructure.[161] Assess and prioritize BUILD and FASTLANE grants based on their ability to improve multimodal access and relieve congestion on transportation infrastructure. Like BNSF's Mobility Innovation Zone in Alliance, TX, these public-private partnerships can increase multimodal options and expand commercial and technology businesses into rural communities using federal assistance grants in potentially strategic locations**.**

Focus on Public-Private Partnership for rail infrastructure improvement. Public-private partnerships designed to enhance cross-utilization of track systems, rail yard efficiency, and climate change initiatives will expand that advantage and U.S. competitiveness. Already the most environmentally friendly mode of ground transportation, facilitating the use of rail as close as possible to last-mile delivery enhances existing environmental initiatives.[162]

More government capital investment in the rail industry, through tax-supported subsidies, needs to be put into routine infrastructure maintenance. Government policy and regulations should not interfere with the progress made by the Staggers Act of 1980 that allows the rail industry to continue to make the capital investment necessary for U.S. national security.

With the introduction of the IIJA, the Biden Administration is doing an admirable job in investing in America's infrastructure. However, in the IIJA, only $5 billion is allocated for "consolidated rail infrastructure and safety improvements."[163] While a $5 billion investment is a good start, from 1980 to 2020, America's freight railroads privately invested an average of $25 billion a year, or 19 percent of their annual revenue, into infrastructure. [164] The privately funded infrastructure improvements also serve the needs of the federal government to support the mobilization and deployment of U.S. forces. Thus it is tax-free and ensures critical railroad infrastructure and rail lines are not abandoned and meet defense readiness requirements for maintenance condition, clearance, and gross weight capability for the 36,000 miles of track serving over 120 defense installations.[165] However, policymakers cannot rely on private industry to pay for this critical infrastructure and must prioritize public investment for railway and rail stations.

Amend the Jones Act. The Jones Act is critical legislation to protect domestic shipbuilding capability and maritime workforce, a crucial enabler of national mobilization. On the other hand, it limits the domestic market's competition, resulting in a lack of innovation incentives.

There is no simple way to reinstate lost capabilities in shipbuilding capacity. The U.S. must retain its exclusivity in constructing smaller, domestically used ships. Maintaining the knowledge, skills, and training platform required to preserve an educated workforce essential for military shipyards is necessary. However, the Jones Act should be amended to allow large, oceanic vessel procurement. While domestic demand for small, locally employed vessels can sustain that industry segment reasonably, it cannot achieve economies of scale because demand for larger ships is so modest, leading to increased costs, which again leads to smaller orders.

The ability to procure large oceanic vessels from foreign contractors is essential for U.S. companies but will not result in significant job loss. To avoid possible dependency on contractors from adversarial countries, production should be limited to allied or partner countries possessing the required expertise, efficiency, and, most importantly, compliance with the U.S. regulations concerning security intellectual property (IP) protections. Maintaining a pool of larger vessels is essential to retain platforms to train mariners and provide incentives and professional development for the U.S. workforce.

Digital twin development for federally funded transportation systems. Advances in AI and ML could improve our national infrastructure's operations and maintenance planning efficacy. Congress should authorize and fund digital twin development for federally funded transportation systems. Digital twin technology is "a virtual representation of an object or system that spans its lifecycle, is updated from real-time data, and uses simulation, machine learning, and reasoning to help decision-making."[166]

For the federal highway system, the focus should be first on bridges and tunnels, then on expanding road systems. For the IWS, the priority would be to lock and dam infrastructure, then expand to complete IWS characteristics like levees and bank erosion. For U.S. airports, the emphasis is on traffic control systems and runways. Congress does not have to allocate additional funding for digital twin development; instead, they could direct execution using funding earmarked for research and studies. For example, Congress could require the Mississippi River and Tributaries account to fund the IWS digital twin project. Implementation of digital twin development could be through government partnerships with academia or other innovation centers. For example, USACE can initiate the IWS project through ERDCWERX, an extension of the DEFENSEWERX innovation hub with connections to private industry and academia.[167]

Digital twin development will enable the government to predict federal infrastructure maintenance requirements and prioritize funding before a catastrophic accident or outage occurs.

Public-private partnership (PPP) for technology sharing. The USG should partner with tech companies for cost-sharing of research and development (R&D) in tech that provides dual-use benefits to the T&L industry and national mobilization enterprise. Through PPP, USG can support the resourcing, development, and transition of cutting-edge technologies between government and private sector T&L entities. Organizations such as federally-funded research and development centers (FFRDCs), Defense Advanced Research Projects Agency (DARPA), and other innovation offices (SOFWERX, AFWERX, NavalX) regularly work on capabilities that align with the same challenges that private industry does. For example, the Logistics and Information Omniscience program, known as LogX, a DARPA project, can support real-time logistics and supply chain diagnosis and prognostics.[168] Information sharing through LogX could assist manufacturers and wholesalers in anticipating and mitigating situations where "disruptions 'cascade throughout the system' and the 'bullwhip' effect when local decisions disregard the state of the larger, global enterprise."[169] Automation, robotics, sensors, and cloud computing are technology areas that are ripe for partnership between the DoD and our industrial base.

Establish national SAF goals and incentives. Congress should pass legislation to establish alternative fuel goals and incentives across the transportation industry. Proposed legislation aimed at the aviation sector provides a pathway for other sectors. Previous tax incentives for private vehicles increased electric vehicle purchases, with one study citing a 2.6 percent increase in electric cars for every $1,000 in incentives.[170] The recently announced Carbon Reduction Program provides funding to cities and states to develop and improve carbon emission reduction programs.[171] Because the transportation industry, specifically trucking, is the

largest producer of carbon emissions, an incentivized SAF program aimed at T&L will have a significant effect when combined with hybrid or electric technology.

Legislation should include tax breaks for carriers to use SAF and spur demand and production capacity to meet U.S. goals for 2030 greenhouse gas reduction. The switch to SAF reduces dependence on foreign fuel, creates a new industry, and stabilizes fuel costs. Once prices self-regulate, tax incentives should phase out. Policy efforts should focus on public-private partnerships to enhance the cross-utilization of networks and new directives such as offshore wind initiatives that will significantly impact land and resource availability and infrastructure. Once commercial sector SAF manufacturers produce the White House target of three billion gallons of SAF annually at an affordable price, the Defense Logistics Agency (DLA) and USTRANSCOM should consider integrating SAF into the distribution infrastructure and using it for military operations. This recommendation assumes SAF meets military specifications.[172]

Incentivize warehouse optimization of energy and space. The government should incentivize warehouse optimization through government subsidies, assumption of risk, and tax concessions for companies that adopt energy and space-saving technology. Space-saving systems include "smart" inventory management for special warehousing and storage of supplies deemed critical to national security, such as fuel, munitions, critical repair parts, and perishable medical supplies. Incentives should include retraining the labor force and integrating innovative capabilities to improve space management, such as multi-story vertical storage and automated climate control and energy conservation. Unions such as International Longshore and Warehouse Union (ILWU) have challenged the adoption of technology that displaces human labor in the past.[173] However, recent surveys have shown that even with the adoption of automation, the demand for warehouse labor exceeds the overall number of available warehouse operators.[174]

Whole Government human capital policy. A national policy on human capital targets the needs of each T&L enterprise sector. This strategy will require partnership in a whole-of-government approach. Collaboration with the Department of Education (DOE) and the Department of Labor (DOL) is necessary to understand growing concerns and future demands. Creating a mutual understanding and future picture of education needs and labor demands will help balance societal needs and the future needs of the industry. There is also an opportunity for expanded partnership with academia and private industry to research and understand challenges and provide government-sponsored STEM education and leadership opportunities.

The USG, in tandem with the DOE, should incorporate Commercial Drivers Licensing, Heavy Equipment Operation, and industry-wide vocational training at the high school level to bring attention to the benefits associated with the industry and capitalize on a younger, more enduring population. The DOT should launch a messaging campaign targeting a more diverse population, including minorities and women, in cooperation with the ATA.

Growing the merchant mariner fleet. Review the nation's Selective Service program in conjunction with an expanded and updated national recruiting campaign. Adding more enforceable requirements for the Selective Service and expanding the candidate pool for women will help highlight the importance of national service to the two target populations of people, those transitioning out of high school and those transitioning out of college about to join the labor force. The opportunity to amend Selective Service requirements is favorable. While attempts to include women in the Selective Service are gaining traction in the 117th U.S. Congress, with more members of both House and Senate in favor of the change than in previous Congresses, the details and scope of proposed changes are still undetermined. An expanded recruitment effort is also necessary for the DOT and MARAD to partner with the DoD to include

merchant marine service and other service-based organizations in broader national service opportunities. National marketing and advertising can highlight the benefits and stability of national services like access to healthcare, education, and financial stability that are often unknown to young students.

Accelerate Digitization. There is a significant opportunity to strengthen the regulatory environments for trade data standards and cybersecurity requirements. The IIJA provides funding and flexibility to incorporate these recommendations within existing budget efforts to maximize the Act's impact on accelerating digital transformation in the T&L industry. Looking to the data harmonization efforts of the International Chamber of Commerce (ICC)/United Nations (UN) and the EU's cybersecurity regulations will offer an opportunity to build on successes and seek to align to a core set of good global practices.

Successes from other industries like healthcare and retail provide a collaborative working model to drive consensus on industry standards for T&L. The DOT is well-positioned to drive progress on this issue in the U.S. Further, agencies dependent on T&L or trade data (e.g., CBP) should seek to engage in the design, piloting, implementation, and scaling of data sharing networks established by industry (e.g., TradeLens) to accelerate the adoption of digital ecosystems and modernize their sharing and analytics processes. A specific initiative should address unique cybersecurity challenges by establishing standards and implementation roadmaps segmented by sector to mitigate the risk of nefarious cyber activity on the nation's T&L infrastructure.

Finally, human capital for cybersecurity and analytics remains a challenge, particularly in sectors that cannot compete with salaries from major technology firms. In addition to expanding training and education opportunities for skilling and reskilling cyber professionals, there is an

opportunity to look to community colleges in semi-rural and rural areas to expand the potential talent pool. Given the remote-work nature of many cyber and data security jobs, there is an opportunity to create hubs for talent specialization in non-metropolitan areas or smaller cities and towns close to cross-sectoral transportation hubs.

Conclusion

Does the U.S. have a competitive advantage? Our findings tell us that it is an uncomfortably close competition, and China has the momentum to eclipse the U.S. Current T&L systems are inadequate and do not support the current needs of our nation. Can the U.S. mobilize at the speed and trajectory to protect national interest? The U.S. has demonstrated its capacity to mobilize and maintains an advantage over China. However, unlike previous mass deployments, any mobilization to war with a near-peer will be contested with deliberate attacks on homeland vulnerabilities. U.S. and industry partners must address the challenges posed by an aging infrastructure and a shrinking skilled workforce. Environmental issues and the establishment of global digitization standards present an opportunity to leapfrog competitors and take on the role of global leadership that is both responsible and sustainable. Is the U.S. moving at the appropriate trajectory to regain its advantage? The IIJA, current policies, and priorities of the USG are an encouraging "kick-start" of focused efforts in the right direction. With focused strategic engagement with industry, allies, and the American people and public investment in an innovative long-term plan to improve and modernize the ecosystem, the U.S. can regain the advantage and reestablish itself as the undisputed leader in the GPC.

Annex A

U.S. Transportation and Logistics Industry issues and policy recommendations to support Ukraine

A Wicked Problem. The Russian-Ukraine conflict is a "wicked" problem in that there is no clear path to peace and no resolution that will not have adverse effects on Ukraine, its European neighbors, and the rest of the world.

Issue: Contested Logistics/Humanitarian Assistance.

The Ukrainian problem creates an environment of volatility, uncertainty, complexity, and ambiguity (VUCA), making an already contested logistics environment more ambiguous and challenging for humanitarian assistance and general transportation and distribution.

Impact on European transportation. Russian attacks in the Black Sea blocked all imports and exports from Ukraine's two largest ports of Mariupol and Odesa.[175]Sanctions and changes to the operational status of major seaports are creating significant concerns for the movement of consumer goods and commodities by sea. In March of 2022, reports show almost one hundred foreign vessels stranded in Ukrainian and Russian ports with the potential to devastate mariner workforce capacity.[176] As a result, air freight carriers spiked shipping rates in anticipation of increased volume, utilized longer and more expensive routes to avoid hostile air space, and implemented "war surcharges" to mitigate and offset supply chain risk. The complexity of second-order effects also includes a 591 percent tanker rate increase, an 80 percent China-to-Europe air freight rate increase, and a 121 percent year-over-year increase in jet fuel prices.[177]

Food Security. Global food security is a growing concern as the Russia-Ukraine conflict continues; therefore, the U.S. should prepare to increase grain exports and review the impact of sanctions on global food security. Ukraine and Russia globally account for 29 percent of wheat, 19 percent of corn, and 80 percent of sunflower oil production and primarily export to Northern Africa and the Middle East.[178] The U.S. is the leading producer of corn and soy products globally, and the U.S. T&L industry connects those crops to international markets.[179]

Transporting humanitarian aid materiel. The U.S. network of freight rail transportation can move material and supplies needed by the government of Ukraine and surrounding allied countries to intermodal facilities for movement to Eastern Europe. Likewise, U.S. trucking networks, which proved vital during the COVID-19 pandemic relief efforts, provide supplementation for goods and supplies ill-suited to bulk rail shipment.

U.S. air freight carriers can provide Humanitarian aid supplies needed urgently by countries and agencies facing the brunt of the Ukrainian refugee crisis. Material and equipment unsuitable for transport via air freight may have to be transported by maritime shipping in coordination with NATO allies for final ground transportation from safe ports to final destinations.

Policy recommendation.

Commercial Transportation support to Ukraine. The U.S. government could provide incentives for our American logistics (Trucking and 3PL) companies to support humanitarian efforts as the war in Ukraine transitions to relief and rebuild efforts. Supplying relief materials to non-government organizations, refugee centers, and aid stations is essential to humanitarian relief efforts for those displaced.[180] USG should collaborate with U.S. companies, like Amazon,

that have already established humanitarian aid hubs in Europe to support the Ukrainian refugees and their hosts in neighboring countries like Poland and Slovakia.

Transportation expertise. In cooperation with commercial transportation and 3PL firms, DOT should provide training and job programs for Ukrainian refugees that evacuate to allied nations or the U.S. and for Ukrainian people in post-war Ukraine. Expertise in moving supplies by rail, truck, air, and shipping will be vital for Ukraine's reconstruction and recovery.

USTRANSCOM freight contracts. USTRANSCOM should leverage NGDS and GHS freight contracts to support humanitarian, supply, and commodity requirements throughout Poland, Germany, and EU nations when energy and food security issues arise. Second, USEUCOM J-4, in concert with USTRANSCOM, AMC, and the SDDC, should mobilize USEUCOM-wide existing rail, freight, and ground tenders to provide commercial multi-mode redundancy for intra-theater movements. Next, USEUCOM should mobilize active-duty Air Force and Army air mobility and surface transportation units stationed in Europe and the U.K. to augment commercial transportation and continue shipments through congested routes in or around Ukraine.

U.S. support to the agriculture industry. The U.S. is the leading producer of corn and soy products globally, and U.S. T&L connects those crops to international markets.[181] The U.S. recently supported agricultural supply chain disruptions, and the IWS moved the increased supply. In 2006, the U.S. IWS supported increased grain exports to markets impacted by grain shortages resulting from droughts in Australia's agricultural region.[182] Food security is a critical element of national security in developing nations; therefore, the U.S. and Western nations must address the disruption of global food supplies. Through humanitarian assistance or increased trade, U.S. agriculture will be necessary to fill the gap created by war in the European

breadbasket. The United States should seek opportunities to cooperate with China in a collaborative international humanitarian food security effort. Capitalizing on this relationship could be valuable step toward shifting the US's relationship with China to cooperation rather than competition (friends close, enemies closer concept).

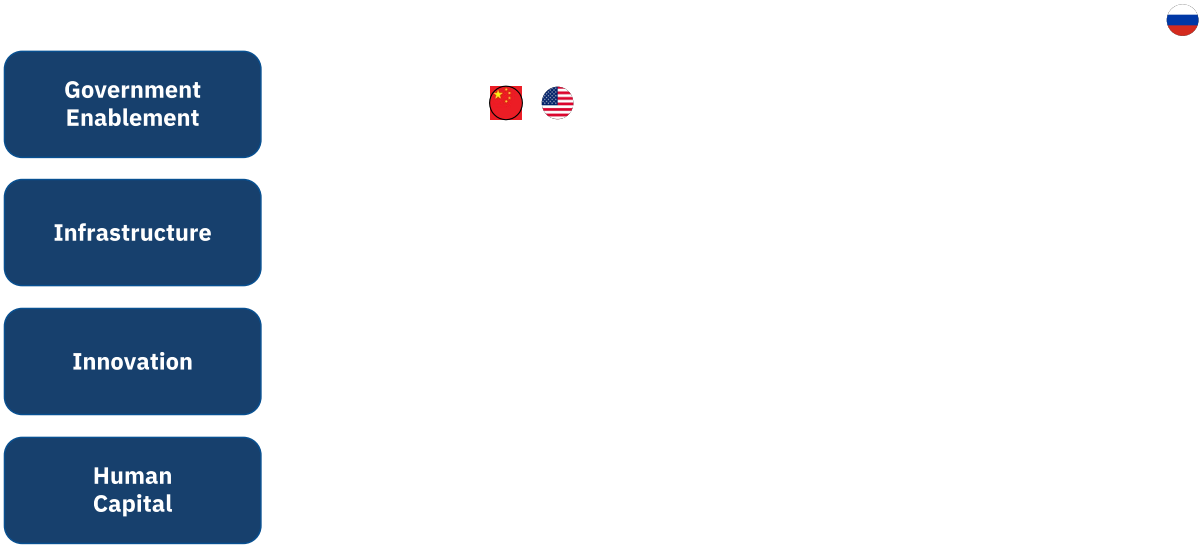
Ongoing Humanitarian Support. As of 5 May 2022, the U.S. government has provided over $688 million of humanitarian aid to Ukrainian people and organizations actively supporting the relief effort, including over $600 million from USAID/BHA and State/PRM.[183] Some existing programs (Foreign Military Sales and other initiatives that come out of the Biden-Harris manufacturing revitalization) could be combined with those specifically for Ukraine relief to create opportunities to support incoming refugees with job programs in transportation, warehousing, and tech industries. U.S. firms can work with the USG, Ukrainian Government, and NGOs to provide overseas logistics solutions, subject matter expertise, job training, and work programs in support of relief efforts for displaced people in post-war Ukraine or neighboring countries.

Annex B

Modal LOE Analysis

5	Very Strong	4	Strong	3	Moderate	2	Weak	1	Very Weak

Deepwater Shipping



Ports and Harbors

estment

Alliances & Partnerships

Education & Training			
Immigration & Social Challenges			
Labor Market / Recruiting & Retention			

Inland Waterways

Freight Railroads

Trucking

Air Freight

Warehousing and Distribution

s

Public Investment and Procurement

Integrated Logistics Command and Control

Labor Stability			
STEM Education			

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