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Maritime Freight Data Collection Systems and Database to Support Performance Measures and Market Analyses

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16. Abstract
The Illinois Marine Transportation System (IMTS) is a key component of the nation's inland waterway system. IMTS is comprised of 27 locks and dams, 19 port districts, more than 350 active terminals, and 1,118 miles of navigable inland waterways traversing along the borderline or within the state of Illinois. However, the infrastructure of IMTS is aging and its conditions are deteriorating. To monitor the performance of IMTS and guide infrastructure investment to enhance safety, efficiency, and reliability of the system, a comprehensive performance measurement program is needed. To this end, the objective of this project is to create an integrated, comprehensive, and maintainable database that facilitates performance measurement of maritime freight to, from, and through Illinois. To achieve this objective, a review of the literature on maritime freight transportation both in the United States and abroad was performed. To gauge practitioners' points of view, a series of phone interviews and online surveys of Illinois' neighboring state DOT officials, officials from the US Army Corps of Engineers, Illinois port district authorities, and carriers operating in Illinois was also conducted. With the findings from the literature review and an understanding of state DOT practices, the needed and available data sources for a maritime freight performance measurement program were identified. Building on all the above efforts, a first-of-its-kind PM database for IMTS was designed and developed, along with a detailed user manual, ready for IDOT's immediate use and future updates. In addition, opportunities for IDOT to use the database to conduct analysis are discussed. Key programmatic recommendations that outline the role of IDOT as a champion and as a facilitator are further included. The outcome of this project will help IDOT gain much-needed knowledge of and develop programs to improve IMTS performance, increase multimodal transportation network capacity, and expand the transportation and logistics sector of the state, which ultimately benefit the people and economy of Illinois.

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Members of the Technical Review Panel (TRP) were the following:

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EXECUTIVE SUMMARY

The Illinois Marine Transportation System (IMTS) is a key component of the nation's inland waterway system. IMTS is comprised of 27 locks and dams, 19 port districts, more than 350 active terminals, and 1,118 miles of navigable inland waterways traversing along the borderline or within the state of Illinois. This vast system of ports, navigable waterways, the Great Lakes, and intermodal landside infrastructure allows freight transportation to, from, and on water. It is therefore vital to maintain, enhance, and expand the system to support the continuous growth of goods movements to, from, and around the state; the leadership position that Illinois has long held in freight handling in the nation; and the economy of the state at large.

The infrastructure of IMTS, however, is aging and its conditions are deteriorating. According to the ASCE 2017 infrastructure rating, inland waterways in the state are graded as "D-" and port facilities are graded as "C-". Across the nation, nearly half of the vessels experience delays when going through locks and dams as a result of deteriorating infrastructure conditions, costing the national inland waterway system $33 billion in 2010, which was projected to increase to $49 billion by 2020. Illinois is not an exception. To monitor and guide infrastructure investment to enhance safety, efficiency, and reliability of the state's maritime freight transportation system, a comprehensive performance measurement program is much needed. A carefully devised set of performance measures (PMs) is a critical prerequisite for establishing such a comprehensive freight performance measurement program.

In view of this, the primary objective of this Illinois Center for Transportation project is to create an integrated, comprehensive, and maintainable database that enables performance measurement of maritime freight to, from, and through Illinois. To achieve this objective, a review of the literature on maritime freight transportation both in the United States and abroad was performed. A list of available PMs was developed to facilitate the development of a performance measurement program for maritime freight transportation. To gauge practitioners' points of view, a series of phone interviews and online surveys of Illinois' neighboring state DOT officials, officials from the US Army Corps of Engineers, Illinois port district authorities, and carriers operating in Illinois was also conducted. Results from the interviews and survey yield in-depth understanding of the PM status for maritime freight in the US midwestern region, as well as issues the stakeholders are currently facing. Armed with the findings from the literature review and an understanding of other state DOT practices, the necessary and available data sources for a maritime freight performance measurement program were identified. Following this effort, a first-of-its-kind PM database for the Illinois maritime freight transportation was designed and developed, along with a detailed user manual, ready for IDOT's immediate use and future updates. Opportunities for IDOT to use the database to conduct analysis are further discussed. Several key programmatic recommendations associated with this database, including establishing a data development program, championing additional funding for IMTS, and growing relationships between port districts and private operators, are also included as part of this report.

The outcome of this project is expected to help IDOT gain much-needed knowledge about the performance of Illinois' maritime freight transportation system as well as its important role and

potential for moving goods and supporting economic growth in the state. The knowledge and analytic capability provided by the database developed in this project will assist IDOT in developing a targeted and effective state program for improving the maritime transportation system, increase the capacity of the state's multimodal freight transportation network, reduce landside traffic congestion, and expand the transportation and logistics sector of the state, which ultimately benefits the people and economy of Illinois.

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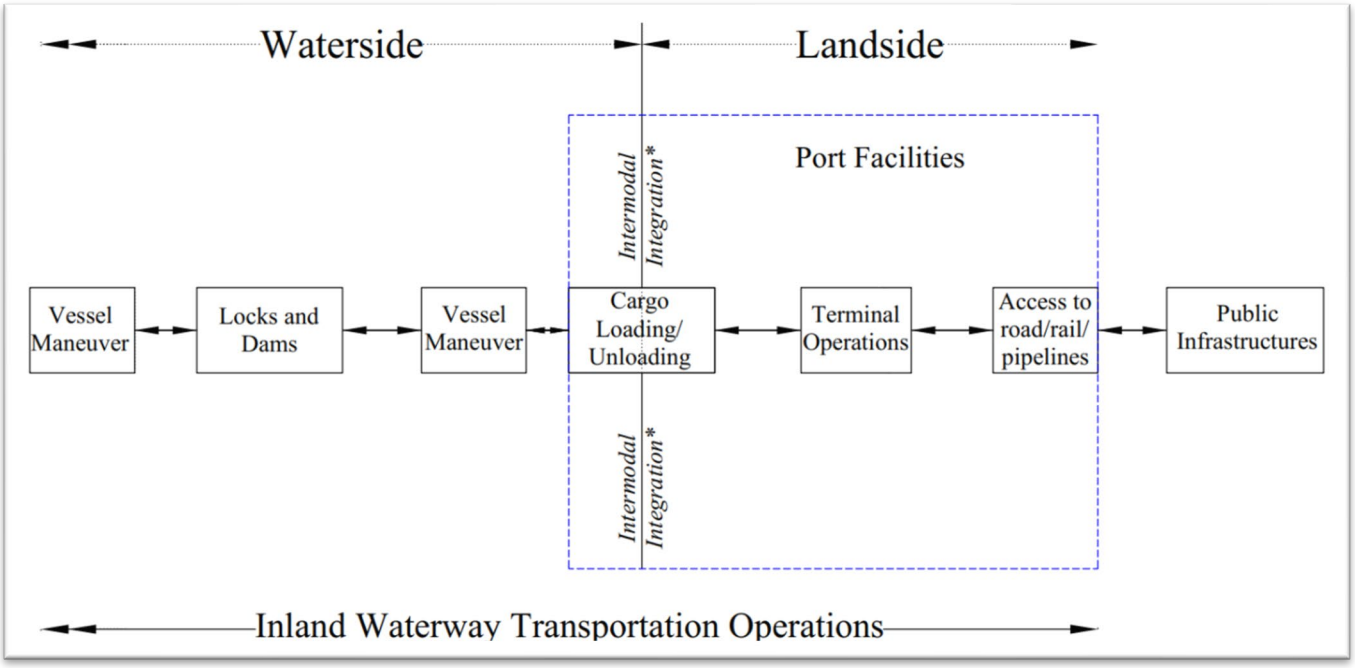
CHAPTER 1: INTRODUCTION

OVERVIEW OF THE NATION'S MARITIME SYSTEM

The US marine transportation system (MTS) is an intricate system of marine and inland waterways and infrastructures (ports, harbors, terminals, locks and dams, and intermodal connections) that facilitates the movement of peoples and goods through waterways. According to federal regulations, marine means "those areas of coastal and ocean waters, the Great Lakes and their connecting waters, and submerged lands over which the United States exercises jurisdiction, including the exclusive economic zone, consistent with international law" (C.F.R. 33). Therefore, the nation's inland waterways (IW) can be considered as a part of marine waterways and distinguished as "navigable waters of the US shoreward of the navigational demarcation lines dividing the high seas from harbors, rivers, and other inland waters of the United States and the waters of the Great Lakes on the United States side of the International Boundary" (C.F.R. 33). Throughout this study, our focus will be on freight movement in the inland side of the maritime freight transportation system.

In the United States, IW includes more than 36,000 miles of rivers, canals, channels, and waterways (NRC, 2015). About 12,000 miles of river channels are commercially navigable (USACE, 2017; Kruse et al., 2007; NRC, 2013; Grossardt et al., 2014). The nation's navigation is maintained by 239 lock chambers at 193 lock sites that are owned, maintained, and operated by the US Army Corps of Engineers (USACE) (USACE, 2017). Of the 193 lock sites, 122 are located at inland rivers, 44 at gulf intracoastal waterways, 13 at the Atlantic region, 10 at the Pacific region, and 4 at the Great Lakes (USACE, 2017). The largest inland river waterway system in the United States is the Mississippi River system, which includes the Illinois, Missouri, and Ohio Rivers. The Mississippi River system, along with its tributaries, traverses the entire eastern region of the country, starting from the Gulf of Mexico at the south and reaching all the way north to the Great Lakes. The other significant inland river systems are the Columbia-Snake River system in the Pacific Northwest and the Gulf of Mexico's Intracoastal Waterway (Kruse et al., 2007). IW is vital to the nation's economy by shipping more than 600 million tons of cargo each year (or 14% of total domestic freight) and supporting over half a million jobs (ASCE, 2017).

Inland waterway systems can be categorized by physical components, depending on whether a component is on the waterside or landside (Transportation Research Board, 2004). Figure 1 illustrates the typical physical components and operations of an IW transportation system. The components on the waterside consist of features aimed at assisting with vessel maneuverability in the form of locks and dams. Intermodal integration occurs in the vicinity of port facilities with cargo loading and unloading. Landside facilities, in contrast, include the terminal operations and connections to the public infrastructure such as roadways, railways, or pipelines.



Note: Intermodal integration is defined as the transfer of cargo from waterborne to landside modes.

Figure 1. Conceptual schematic. Illustration of inland waterway transportation system.

Source: Farazi et al., 2020

ILLINOIS MARINE TRANSPORTATION SYSTEM

The Illinois Marine Transportation System (IMTS) is comprised of 1,118 miles of navigable inland waterway traversing along the borderline or within the state of Illinois. Because lakes and rivers are important natural resources, the Illinois Department of Natural Resources (INDR) and Illinois Environmental Protection Agency (IPEA) have coordinated with the US Army Corps of Engineers (USACE) to supervise the state's waterway since 1995. To increase the state government's involvement in transportation and enrich the statewide multimodal transportation planning strategy, the Illinois Department of Transportation (IDOT) has regained oversight of transportation functions of IMTS-related activities.

Currently, IMTS consists of five major waterways, 27 locks and dams, 19 port districts, and more than 350 active terminals. IMTS is a system of ports, navigable waterways, the Great Lakes, and intermodal landside infrastructure that allows freight transportation to, from, and on water. IMTS, as mentioned above, consists of five major waterways (IDOT, 2018a):

1. Lake Michigan
2. The Illinois River system connecting Lake Michigan to the Mississippi River, including:
    a. Chicago River

b. Calumet River

c. Des Plaines River

d. Chicago Sanitary and Ship Canal connecting the Chicago River to the Des Plaines River

e. Calumet-Sag Channel connecting the Calumet River to the Des Plaines River

3. Mississippi River on Illinois' western border

4. Ohio River on the state's southern border

5. Kaskaskia River

Illinois shares Lake Michigan with Wisconsin at the north, Indiana at the south, and Michigan at the east. Along Illinois' neighboring states, the Mississippi River defines the state borders of Missouri and Iowa, as well as Minnesota on the west and Wisconsin on the north. The St. Lawrence Seaway and the Great Lakes system grant IMTS access to the Atlantic Ocean, and the Mississippi River provides access to the Gulf of Mexico. The confluence point of the Mississippi River and Illinois River is near Pere Marquette State Park in Illinois. From this point, the Illinois River runs through Illinois and ultimately joins with Lake Michigan by branching out as the Chicago, Calumet, and Des Plaines Rivers. The confluence point of the Mississippi River and Ohio River separates three states—Illinois, Missouri, and Kentucky. From the Mississippi River, the Ohio River branches out towards the east, separating Illinois and Kentucky. Defining the borders between Kentucky and Indiana, the Ohio River traverses the southeastern border of Ohio.

Locks and Dams

Navigation within the Illinois River system is controlled by 27 lock and dam facilities operated and maintained by USACE. Of these 27 locks and dams, the Mississippi River system has 15, the Illinois River system has 9, the Ohio River has 2, and the Kaskaskia River has 1. In the Ohio River, the Olmsted lock and dam was opened in August 2018. This new facility is intended to reduce tow and barge delays by replacing the two existing older and frequently congested locks and dams (No. 52 and No. 53). For the nine locks and dams in the Illinois River and canal system, the river mile-point is taken from Grafton, Illinois. For the Ohio River, the mile-point is taken from Pittsburgh, Pennsylvania. Table 1 summarizes the locks and dams in the state of Illinois, as well as in other adjacent states.

Table 1. Locks and Dams in Illinois

River	Name	Location	River Mile-point	Year Opened	Corps District
Upper Mississippi River	12	Bellevue, IA	567	1938	Rock Island
	13	Fulton, IL	522	1939	Rock Island
	14	Pleasant Valley, IA	493	1940	Rock Island
	15	Rock Island, IL	483	1934	Rock Island
	16	Illinois City, IL	457	1937	Rock Island
	17	New Boston, IL	437	1939	Rock Island
	18	Gladstone, IL	410	1937	Rock Island
	19	Keokuk, IA	364	1957	Rock Island
	20	Canton, MO	343	1935	Rock Island
	21	Quincy, IL	325	1938	Rock Island
	22	New London, MO	301	1939	Rock Island
	24	Clarksville, MO	273	1940	St. Louis
	25	Winfield, MO	241	1939	St. Louis
	Melvin Price	Alton, IL	201	1990	St. Louis
	Chain of Rocks / 27	Granite City, IL	185.5	1964	St. Louis
Illinois River and Canal System	Chicago Harbor	Chicago, IL	327 [Main]	1938	Chicago
	T.J. O'Brien	Chicago, IL	327 [South]	1960	Rock Island
	Lockport	Lockport, IL	291	1933	Rock Island
	Brandon Road	Joliet, IL	286	1933	Rock Island
	Dresden Island	Morris, IL	272	1930	Rock Island
	Marseilles [Lock]	Marseilles, IL	245	1933	Rock Island
	Starved Rock	Ottawa, IL	231	1933	Rock Island
	Peoria	Creve Coeur, IL	158	1939	Rock Island
	LaGrange	Versailles, IL	80	1939	Rock Island
Ohio River	Smithland	Hamletsburg, IL	919	1979	Louisville
	Olmsted	Pulaski County, IL	964.4	2018	Louisville
Kaskaskia River	Kaskaskia	Modoc, IL	0.8	1973	St. Louis

Note: River mile-points run north/east to south/west.

Sources: IDOT, 2018a; USACE n.d.[a], n.d.[b], n.d.[c], n.d.[d], 2018a, 2018b, 2019b

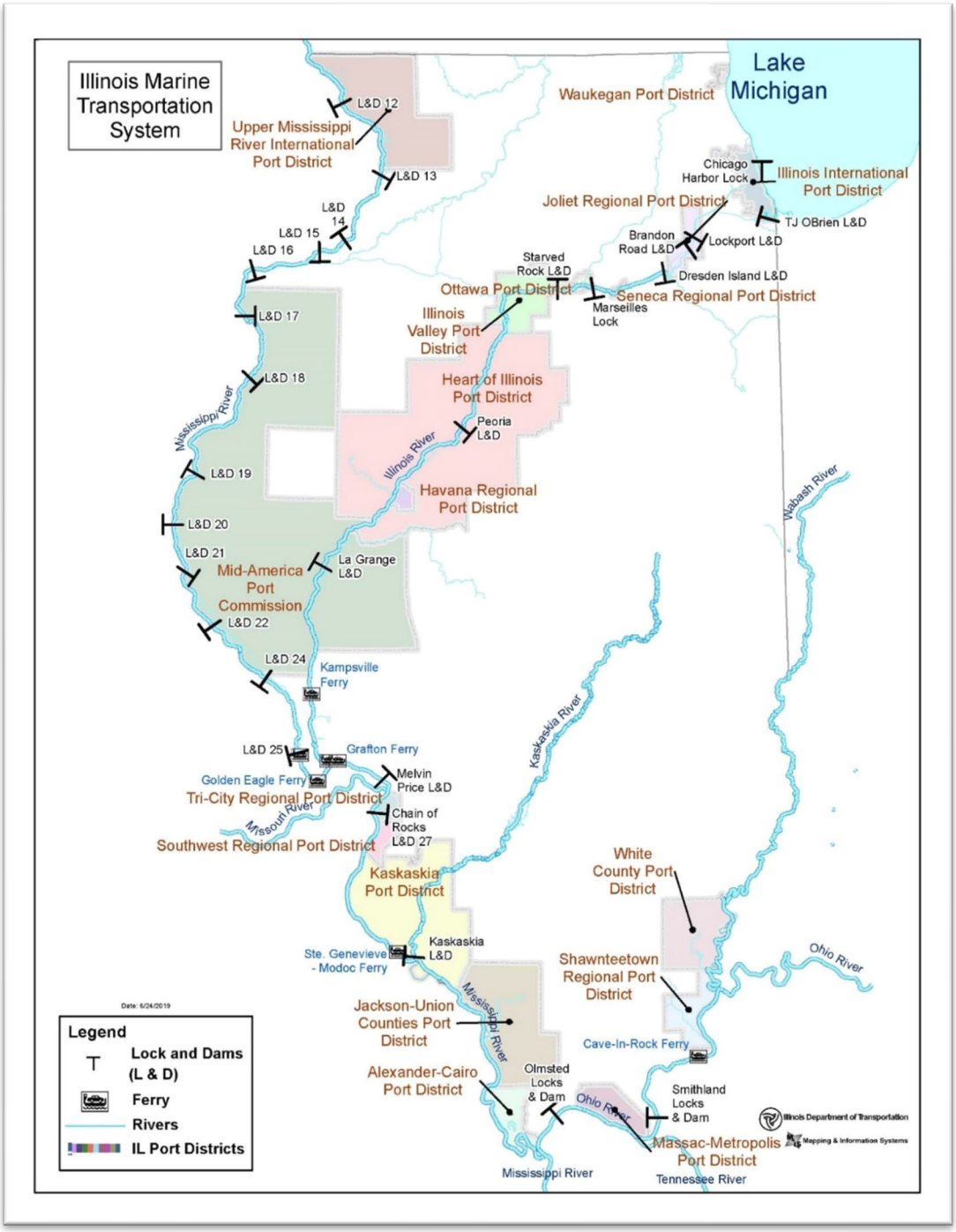


Figure 2. Map. Illinois marine transportation system.

Source: IDOT, 2020

Ports and Harbors

Ports and harbors are often used interchangeably when describing water facilities. A port provides infrastructure and services for loading and unloading cargo and passengers, while a harbor is where

ships are sheltered and can anchor close to a shore. Harbors are more often along lakes, seas, and oceans, while ports are in harbors and along rivers.

The state of Illinois is home to 19 port districts (Figure 2). Port development in Illinois is accomplished through legislatively created port districts. This legislation gives port districts tax-exempt status and the ability to issue bonds for port development. In Illinois, port development generally involves private industry. However, IDOT provides connectivity to and from port facilities by state-maintained roadways for freight movement. IDOT also provides technical and operating assistance to port districts.

Lake Michigan has three harbors for large oceangoing vessels and recreational boats. These harbors also handle freight-bearing ships. The three harbors are the Waukegan, Chicago, and Calumet Harbors. Of these, Waukegan functions as both the harbor and port.

Four of the USDOT-designated marine highway corridors overlap with IMTS: M-35, M-55, M-70, and M-90. These corridors are part of the Maritime Administration's Marine Highway Program established in April 2010.

Waterborne Traffic Flows

The Waterborne Commerce Statistic Center (WCSC) provides IW freight data (by geography) for "inbound," "outbound," and "intrastate." Inbound tonnage is counted for trips that originate outside of IMTS and have an endpoint within it. Outbound tonnage is counted for trips that have an origin within IMTS but end outside it. Intrastate tonnage is counted for trips that have both an origin and a destination point within IMTS.

Table 2 shows the total waterborne tonnage handled by IMTS from 2010 to 2017. Illinois' waterborne freight is heavily skewed in the outbound direction. This outbound traffic is led by coal and agricultural products, including cereal grains and other agricultural products heading down the Mississippi River to New Orleans.

Table 2. Waterborne Tonnage Handled by IMTS

Year	Totals (in thousand tons)	% of total National	Outbound (in thousand tons)		Inbound (in thousand tons)		Intrastate (in thousand tons)	National Rank
			Domestic	Foreign	Domestic	Foreign		
2017	90,563	3.80%	62,013	102	18,521	1,553	8,375	7th
2016	91,195	3.98%	64,423	0	17,112	1,757	7,903	8th
2015	93,994	4.12%	66,212	86	18,128	1,947	7,620	8th
2014	106,517	4.54%	79,202	5	18,665	2,074	6,571	6th
2013	92,015	4.05%	68,424	91	16,239	1,475	5,786	9th
2012	106,399	4.61%	80,424	116	17,063	1,352	7,441	7th
2011	109,663	4.63%	79,432	1,109	16,241	2,428	10,453	7th
2010	108,083	4.63%	79,209	1,073	14,725	2,080	10,996	6th

Source: USACE, 2018c

Figure 3 shows the percentages of different commodities shipping in and out of Illinois in 2017. The 14 commodity types are taken from WCSC documentation. The largest outbound waterborne commodity in 2017 was food and food products, while the largest inbound commodity was sand, gravel, shells, clay, salt, and slag.

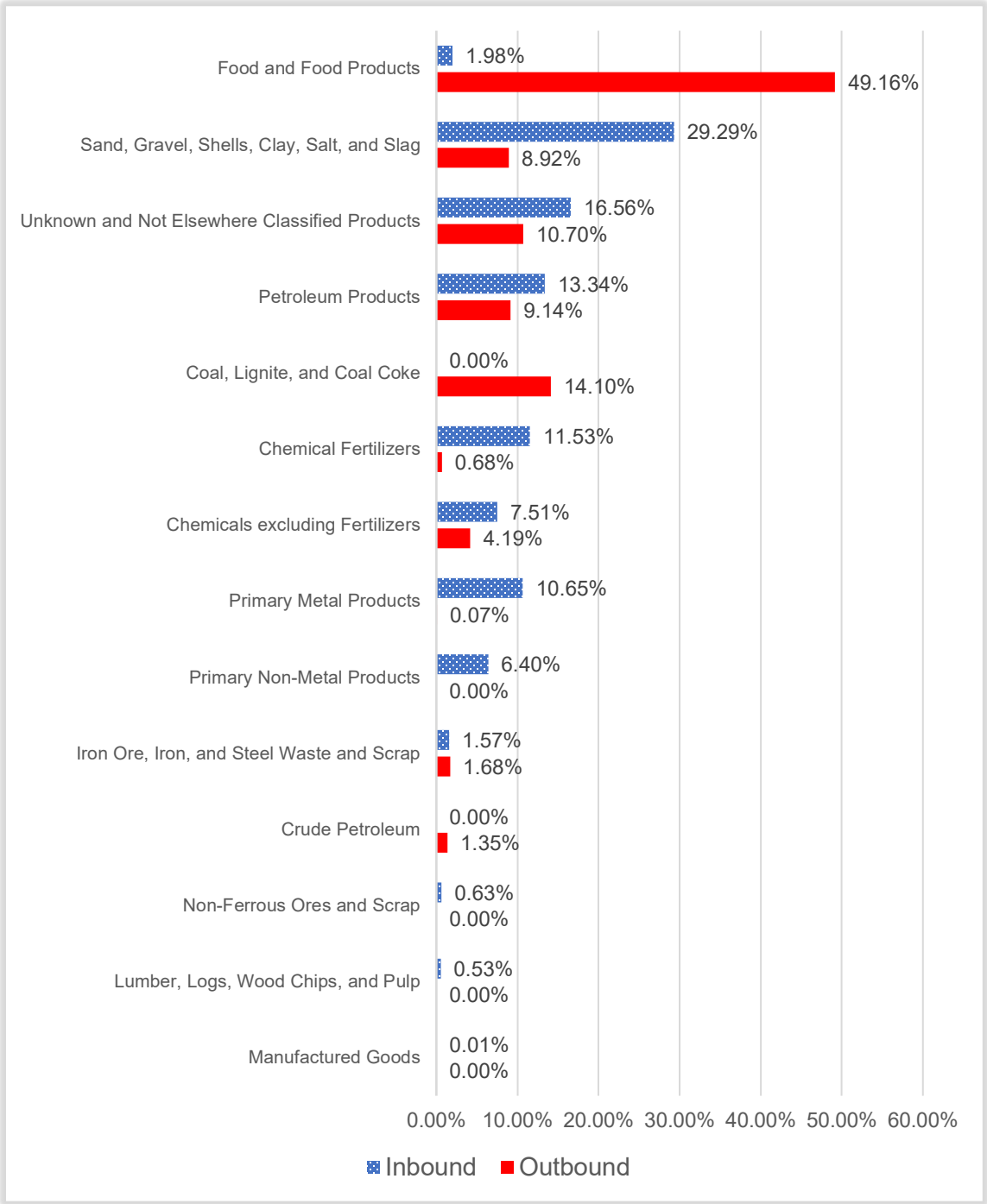


Figure 3. Bar chart. Percentage of different commodities shipping in and out of Illinois in 2017.

Source: USACE, 2018c

PROBLEM STATEMENT

The nation's maritime infrastructure is aging and deteriorating with time. Illinois is no different. For instance, according to the ASCE 2017 infrastructure rating, inland waterways in the state are graded as "D-" and port facilities are graded as "C-". Nearly half of the vessels experience delays when going through locks and dams as a result of their deteriorating conditions (Kruse et al., 2011; NRC, 2013), costing the national IW system $33 billion in 2010, which was projected to increase to $49 billion by 2020 (ASCE, 2013). One of the primary needs is appropriate levels of investment to improve the infrastructure. To monitor and guide infrastructure investment to enhance safety, efficiency, and reliability of the maritime freight transportation system, a comprehensive performance measurement program is needed. An appropriate set of performance measures (PMs) is one of the main prerequisites for such a freight performance measurement program. The use of PMs can also help with an industry-wide common understanding of maritime system definitions and measurement standards, thereby contributing transparency, benchmarking, and harmonized improvement strategies (Posset et al., 2009).

The need for PMs also arises at the individual state level, where state departments of transportation (DOTs) are responsible for developing programs for maritime transportation improvement. Maintenance and expansion of the state maritime transportation system is important for Illinois to strategically enhance its multimodal freight network capacity and sustain its substantial national position in freight handling. From a broader, multimodal perspective, the MAP-21 and FAST Act federally mandate that every state have a comprehensive freight performance evaluation program. However, a comprehensive state program for maritime transportation improvement has not yet been developed for Illinois. The absence of such a state program negatively affects IDOT's ability to make strategic decisions on maritime freight, implement state freight plans, and receive support from the USDOT's Maritime Highway Program (2017). Such a program requires identifying relevant data, developing a data collection system, creating databases to house the collected data, and ultimately applying the data to a set of developed PMs. The program is expected to strengthen IDOT's ability to monitor performance and conduct market analysis of its multimodal freight transportation system as well as inform investment decisions, as highlighted in two reports to IDOT through the University of Illinois at Chicago's Urban Transportation Center (Sriraj et al., 2015; Ginsburg and Dirks, 2017).

RESEARCH OBJECTIVES

The main objective of this research is to create an integrated, comprehensive, and maintainable database that enables performance measurement of maritime freight to, from, and through Illinois. The research will help answer the following questions:

- What are the appropriate PMs that need to be developed to achieve the above objectives?
- Where to collect the relevant data in order to develop the PMs?
- How should a database be designed to ensure that the PMs are populated in a user-friendly manner for the purposes mentioned in the problem statement?
- How should the database be managed and how frequently should it be updated?

OUTCOMES OF RESEARCH

From a broader perspective, this research is meant to draw a comprehensive picture of the maritime freight transportation system, especially focusing on the US inland waterway, and create a database framework for maritime freight data collection and maintenance systems. The outcomes of this research are summarized below:

- The first part of this research is a review of the literature on maritime freight transportation performance both in the United States and abroad. This review will cover performance measurement research in national and international scholarly articles, research, and practices; federal recommendations and initiatives; and state of the practice in the United States.

- Based on the literature review, a list of available performance measures (PMs) will be identified that can be used to develop a performance measurement program for the maritime freight transportation system.

- The second part of this research includes interviews with stakeholders. We will interview Illinois' neighboring state DOT officials, USACE officials, Illinois port district authorities, and carriers operating in Illinois. The state DOT interviews are expected to result in a better understanding of maritime freight performance measurement status of the midwestern region of the United States. This will help IDOT align its PM development efforts with the regional progress. From the port district authority and carrier interviews, the needs and expectations of these shareholders can be extrapolated. This will help to identify the issues these stakeholders are facing so that IDOT can take necessary measures to address these.

- The third part of this project involves identifying the necessary and available data sources for the maritime freight performance measurement program. From the literature review and stakeholder interview, we will synthesize available data sources and create a list of potential data sources that can be utilized to develop a maritime freight performance database.

- In the final part, we will use the available data sources to create a database to be used by IDOT. We will populate this database with available data and create a guideline for IDOT to maintain and enhance this database.

The outcome of this project is expected to help IDOT gain much-needed knowledge about the performance of Illinois' maritime freight transportation system as well as its role and potential for moving goods and supporting economic growth in the state. The knowledge and analytic capability provided by the database developed in this project will assist IDOT in developing a targeted and effective state program for improving the maritime transportation system, increase the capacity of the state's multimodal freight transportation network, reduce landside traffic congestion, and expand the transportation and logistics sector of the state, which ultimately benefits the people and economy of Illinois.

CHAPTER 2: LITERATURE REVIEW

STATE OF THE RESEARCH

Research on waterborne freight transportation traverses in many directions. Besides performance measurement, many researchers studied different critical issues related to IW. The literature review is categorized by (a) international studies, (b) national- and federal-level initiatives, and (c) state scan of strategic plan documents. The review of the literature reveals that studies in the existing literature can be categorized based on three criteria: a) studies that focused on the whole system; b) studies on inland ports and harbors; and c) studies on inland locks and dams. We present our review of the existing literature on the IW freight transportation system in these three segments.

INTERNATIONAL STUDIES AND PRACTICES

Outside the United States, a few studies have been conducted to examine performance measurement for IW freight transportation systems. In 2010, the Permanent International Association of Navigation Congresses published a report where 35 performance indicator groups under eight categories were proposed (InCom Working Group 111, 2010). The eight categories are infrastructure, ports, environment, fleet and vehicles, information and communication technology, economic development, safety, and security. Although this study was for Europe, many proposed PMs could be applied to US IW systems. Another relevant study was conducted under the European Union's South East Europe Transnational Cooperation Programme to set performance indicators and minimum service for waterway management on the Danube River (NEWADA Duo, 2014). The requirements for common service levels were identified in nine performance areas summarized in three clusters: 1) core waterway infrastructure, 2) core waterway maintenance activities, and 3) navigable waterway-related information to users. Five PMs were proposed to monitor and evaluate the level of service:

1. Availability of minimum navigable waterway parameters.
2. Availability of core waterway infrastructure.
3. Availability of locks.
4. Performance of core waterway maintenance activities.
5. Quality of information provision for users.

In the United Kingdom, a comprehensive maritime strategic plan with short-, mid- and long-term priority recommendations was developed (Department for Transport, 2019). Although no specific PMs were mentioned, the plan holds relevant authorities (e.g., Department for Transport and Maritime and Coastguard Agency) responsible for monitoring the progress of the maritime transportation system towards the milestones of the plan. The city of London implemented its own freight plan, which also outlined policies regarding IW freight. The plan established a set of PMs, termed progressive measures, to identify the progress in realizing the plan. These measures were classified as economic, environmental, and societal (Transport for London, 2007).

NATIONAL- AND FEDERAL-LEVEL EFFORTS/INITIATIVES

Federal agencies like the United States Army Corps of Engineers (USACE) and United States Coast Guard (USCG) play significant roles in maintaining safe and efficient navigability in the nation's inland waterway system. The responsibilities of USACE include facilitating the safe, reliable, and economically efficient movement of vessels by constructing and maintaining navigation channels and harbors as well as regulating water levels on inland waterways (USACE, 2019a). The role of USCG in waterways is to ensure the nation's maritime safety (marine safety and search and rescue), security (drug and migrant interdiction, defense readiness and ports, waterways and coastal security) and stewardship (environmental protection, navigational aid, and ice operations) (US Coast Guard, 2009).

At the federal level, the Committee on the Marine Transportation System (CMTS) is an interagency coordinating committee responsible for assessing the adequacy and promoting the integration of MTS with other modes. In 2009, CMTS established a research and development integrated action team (R&D IAT) to implement the National Strategy for the Marine Transportation System. At the 2010 joint conference of CMTS and TRB, five priority MTS areas with R&D needs were identified in a Strategic Action Plan proposed by R&D IAT (US CMTS, 2011): capacity, safety and security, environmental stewardship, resilience and reliability, and finance and economics. In 2017, CMTS revised the Strategic Action Plan by outlining five additional priority areas: infrastructure, MTS operations, MTS and its surroundings, data access, and high-fidelity freight flow (US CMTS, 2017).

Subsequent to the R&D IAT Strategic Action Plan, USACE has also undertaken a study and identified 17 major PMs (Kress et al., 2016), which were developed using publicly available data sources and endorsed by CMTS (US CMTS, 2015). The benefits of using these PMs are yet to be assessed by feedback from the stakeholders. The USACE study, focusing mainly on the federal-level initiative, provided a foundation for the MTS performance measurement over time as an interconnected system (Kress et al., 2016).

On behalf of the Cargo Handling Cooperative Program, the US Maritime Administration (MARAD) sponsored a study in 2010 on marine container terminal productivity and identified the most useful and relevant PMs to improve marine container terminal productivity (The Tioga Group, Inc., 2010). The identification of the PMs was based on the assets being used in terminal operations, categorized into three classes: terminal land and container yard, container cranes, and berths and vessels. It was suggested that each IW port in the United States can pick and select from these PMs that are most suitable to meet its needs.

Around 2010, the National Cooperative Freight Research Program funded a project in which a set of PMs was developed to evaluate the performance of the US freight transportation system (NASEM, 2011). The project recommended creating a "Freight System Report Card" based on existing federal data sources. The freight report card would consist of 29 PMs categorized into six classes: demand, efficiency, system condition, environmental impacts, safety, and system investment. One of the PMs specifically targets inland waterways: inland water investment to sustain age of system. Although the primary focus of the project was surface freight transportation, most PMs were generic to measure the performance of any freight transportation system.

In 2017, the Federal Highway Administration (FHWA) developed the Freight Performance Measure Primer (Easley et al., 2017) as a tool for state DOTs and metropolitan planning organizations (MPOs) to develop meaningful, effective, and consistent performance measurement practices for statewide freight operations. FHWA urged that states should work together to fulfill the federal requirements from MAP-21 and FAST Acts. FHWA also recommended that states use the existing data sources and approaches as the baseline for their performance management programs. This primer summarized possible freight PMs by modes that can be used by states and MPOs. The PMs were arranged under five categories: safety; maintenance and preservation; mobility, reliability, and congestion; accessibility and connectivity; and environment.

STATE SCAN OF STRATEGIC PLAN DOCUMENTS

The focus of this section is on reviewing state DOT planning for developing performance measurement programs for their IW freight transportation systems. Despite a subtle difference between the terms "maritime" and "inland waterway," states usually refer to their IW planning as state maritime or marine plans regardless of whether that state has sea access. In the rest of this subsection, we use "maritime/IW" to respect the term used in the reviewed documentations. We first review state DOTs that have adopted statewide freight plans (SFPs). The FAST Act (2015) mandates that each state develops an SFP that must comprehensively address the state's intermediate and long-term freight planning activities and investments.

As of July 2019, 44 SFPs were posted on FHWA's website (FHWA, 2018). For each state, the most recent SFPs were reviewed. A subset of states was selected based on whether a state has IW transportation functionality and the annual tonnage handled by waterborne modes (USACE, 2018c, 2019a). For each selected state, relevant material pertaining to its maritime/IW system planning was collected to identify which states have dedicated maritime/IW freight planning documentation. Based on the SFPs and collected material, performance measurement planning and polices were investigated. In evaluating the PM usage in a state's IW planning and policies, four questions were developed:

Q1. Does the state have any specific freight PMs?

Q2. Does the state have any specific maritime PMs?

   i. How many maritime PMs are discussed?

   ii. How many maritime PMs are reported?

   iii. Are the maritime PMs embedded in the state's SFP?

   iv. Are the maritime PMs embedded in the state's maritime/IW plan?

Q3. Is the state's maritime/IW plan embedded in the state's SFP?

Q4. Does the state have any dedicated plan for its maritime/IW freight transportation?

The first two questions are intended to find out whether the state has any freight performance measurement program. FAST Act and MAP-21 mandated states to establish a performance measurement program for their statewide freight transportation. Therefore, if a state has access to navigable water, it is likely that this state will have maritime/IW PMs along with PMs for their surface or rail transportation. The second question has four additional questions. The first two questions reveal how many maritime/IW PMs are discussed and how many of them are finally reported as of 2019. The difference between Q2(i) and Q2(ii) needs to be stressed. For Q2(i), "discussed" means that one or multiple PMs were only mentioned/proposed in SFPs and considered suitable for monitoring and evaluation of the maritime/IW freight transportation performance in a state. For Q2(ii), "reported" means that one or multiple PMs were indeed used in a state's annual freight performance report. Q2(iii) and Q2(iv) outline the documents from which these PMs have been extracted. If the PMs are extracted from the SFP, it is likely that the maritime/IW PMs are considered as a part of the overall freight performance measurement programs. In contrast, if the PMs come from the maritime/IW plans, it is evident that the state considers the maritime/IW freight performance measurement program independently.

Q3 and Q4 convey the perception of how the maritime/IW planning process is embedded within the state's freight planning. The fourth question particularly gives the answer to whether the state has any freestanding maritime/IW planning documents. A state with freestanding maritime/IW planning or policies reveals that the DOT has considered the maritime sector significant enough to commission additional and independent strategic planning. The evaluation results of 32 states show that all 32 states have discussed maritime/IW strategic planning in their latest SFPs (Table 3). Six states have dedicated strategic plans for maritime/IW freight transportation systems. Twenty-seven states have discussed PMs for statewide freight transportation, of which 12 states have included maritime/IW PMs as part of the overall freight performance measurement in their SFPs.

Figure 4 presents the number of PMs discussed and reported in the latest annual freight performance reports and performance cards for each of the 32 states, along with their waterborne traffic (for the year 2017, in million tons). In total, 12 states have discussions/reporting of PMs: Arkansas, Florida, Iowa, Kentucky, Louisiana, Maryland, Minnesota, Mississippi, North Carolina, Rhode Island, Texas, and Washington. Among the 12 states, four (Arkansas, Louisiana, Rhode Island, and Texas) have only one PM each, three have two PMs each, and four have four PMs each. The state of Maryland has seven PMs, the highest among the states. Figure 4 also shows that there is no strong correlation between the number of PMs developed and the waterborne traffic of a state. For example, Louisiana has very high traffic but only one PM, which contrasts with Maryland's very low traffic but seven PMs.

In line with Table 3 and Figure 4, Table 4 presents the specific PMs developed by the 12 states. Based on the nature of the PMs, they are classified into five categories: safety and security, economy, maintenance and preservation, mobility and reliability, and environmental stewardship. "General cargo tonnage through state ports" is the most frequently discussed PM (by five states). "Tons of freight handled by waterborne modes in state" is also highly used (by three states). "Inland waterway crashes/incidents" is discussed by two states. The remaining PMs are each discussed by just one state.

Table 3. Evaluation of State Planning and PMs for Maritime/IW Freight Transportation System

	AL	AK	AR	CT	DE	FL	GA	IL	IN	IA	KY	LA	MD	MI	MN	MS	MO	NJ	NY	NC	OH	OK	OR	PA	RI	SC	TN	TX	VA	WA	WV	WI
Q1	N	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Q2	N	N	Y	N	N	Y	N	N	N	Y	Y	Y	Y	N	Y	Y	N	N	N	Y	N	N	N	N	Y	N	N	Y	N	Y	N	N
Q2 (I)	-	-	1	-	-	4	-	-	-	4	4	1	7	-	4	2	-	-	-	2	-	-	-	-	1	-	-	1	-	2	-	-
Q2 (II)	-	-	1	-	-	4	-	-	-	0	0	0	7	-	1	0	-	-	-	2	-	-	-	-	1	-	-	0	-	2	-	-
Q2(III)	-	-	Y	-	-	Y	-	-	-	Y	Y	Y	Y	-	Y	Y	-	-	-	Y	-	-	-	-	Y	-	-	Y	-	Y	-	-
Q2(IV)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Q3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Q4	N	N	N	Y	N	Y	N	N	N	N	N	N	N	N	Y	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	Y	N	N

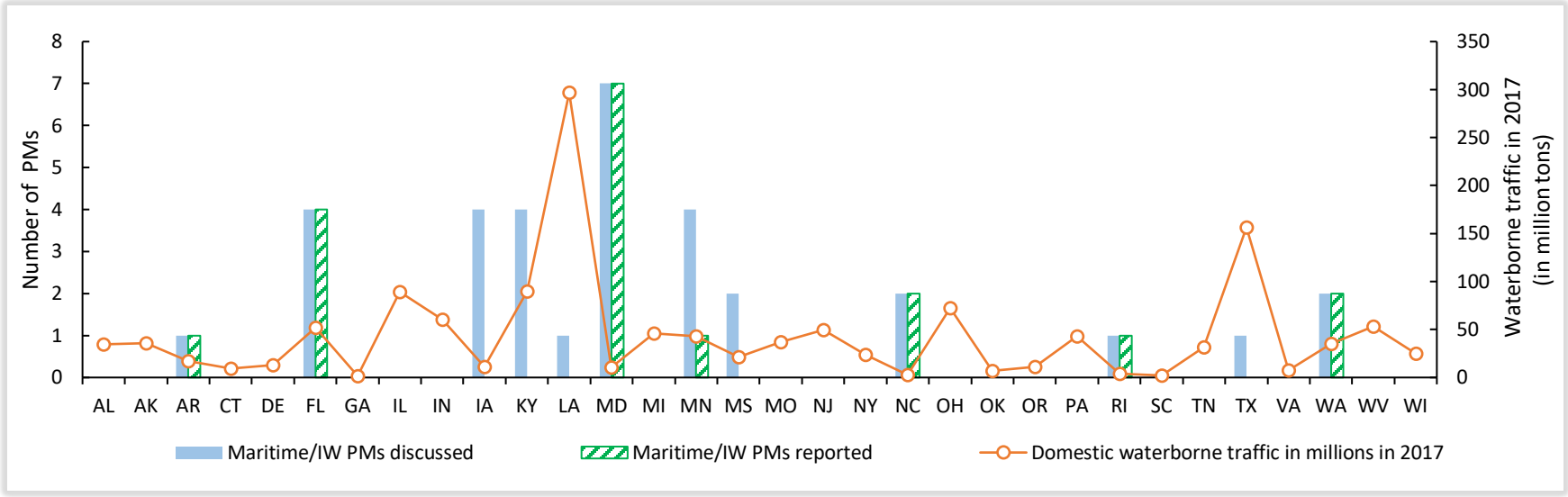


Figure 4. Combination bar and line chart. Number of maritime/IW PMs discussed/reported (bar) and domestic waterborne traffic by state (line).

Source: PMs from SFPs published by state DOTs, Tonnage (USACE, 2018c)

Table 4. Maritime/IW PMs Established by US States

Categories	Performance Measures	States
Safety and Security	Inland waterway crashes/incidents	Kentucky[1], Louisiana[2]
	Port administration compliance with the Maritime Transportation Security Act of 2002	Maryland[3]
Economy	General cargo tonnage through state ports	Maryland[3], North Carolina[4], Washington[5], Florida[6], Minnesota[7]
	Foreign cargo tonnage through state ports	Maryland[3]
	Percent import vs. export commodities by weight and value	North Carolina[4]
	Change in freight tonnage movement by values and miles	Kentucky[1]
	Port capacity	Washington[5]
	Twenty-foot equivalent units handled in state ports	Florida[6]
	Value of freight handled by state ports	Florida[6]
	Producer price index	Iowa[8]
	Annual waterborne cargo tonnage in state	Rhode Island[9], Arkansas[10]
	Freight mode share by tonnage/value	Minnesota[7]
Maintenance and Preservation	Rate of dredging	Kentucky[1]
	Condition of locks and dams	Kentucky[1]
	Dredge material placement capacity remaining for harbor and bay sections	Maryland[3]
	Channel depth for river ports	Mississippi[11]
Mobility and Reliability	Average truck turn time at ports	Maryland[3]
	Ports with active rail access	Florida[6]
	Delays at locks	Iowa[8]
	Unscheduled lock closures	Iowa[8]
	Lock availability	Iowa[8]
	Number of port-access issues addressed	Texas[12]
Environmental Stewardship	Mid-Atlantic dray truck replacement program	Maryland[3]
	Acres of wetlands and wildlife habitat created, restored, or improved since 2000	Maryland[3]
	Statewide annual number of hazmat spills across the state freight network	Mississippi[11]

Sources: 1. Kentucky Transportation Cabinet, 2017; 2. CDM Smith Inc., 2018; 3. Maryland Department of Transportation, 2017; 4. Cambridge Systematics, Inc., 2017a; 5. Washington State Department of Transportation, 2017; 6. Florida Department of Transportation, 2017; 7. Minnesota Department of Transportation, 2018; 8. Iowa Department of Transportation, 2016; 9. Rhode Island Department of Administration, 2017; 10. Cambridge Systematics, Inc., 2017b; 11. Mississippi Department of Transportation, 2017; 12. Texas Department of Transportation, 2018

Our review also revealed that further efforts have been made by several state DOTs to complement the existing PMs. For example, Texas DOT sponsored a study in 2011 that identified 46 PMs appropriate for the intracoastal waterway of Texas (Cambridge Systematics, Inc., 2011). Oregon DOT cosponsored an approach analysis for statewide freight performance measurements, which resulted in 12 identified PMs for Oregon's IW (McMullen and Monsere, 2010). Wisconsin has taken initiatives to establish strategic plans for their IW freight transportation systems (WisDOT, 2018).

SYNTHESIS OF FINDINGS

We synthesize the findings from the literature based on issues we identified. One of the main issues identified is the lack of a common understanding of the role and responsibilities from the state's perspective. We also evaluate the PMs discussed and reported by various states based on their applicability and comprehensiveness. We have come across a considerable number of PMs scattered in the literature, including scholarly articles, federal recommendations, foreign practices, state policies, and practices. We notice a lack of proper categorization and summarization of these PMs. In the following subsections we synthesize our findings based on these criteria.

Overall System

Several studies exist in the literature that concern the overall IW transportation system, but with a focus on one or a few functional issues of the system. We found that system resiliency and risk analysis is the most-researched subject of IW transportation (Folga et al., 2009; Pant et al., 2011; Baroud et al., 2014; Hosseini and Barker, 2016) followed by safety and security (Vidan et al., 2010; Martin et al., 2004; Camp et al., 2010). Issues related to sustainability (Rohács and Simongati, 2007), cost competitiveness (Platz, 2009), traffic flow forecasting (Beuthe et al., 2001), and routing and trajectory optimization (Maraš, 2008) have also been investigated.

Focusing on system resiliency and risk analysis, Folga et al. (2009) investigated the interdependency and impact of discrepancies in waterway infrastructures of the Illinois IW system. Pant et al. (2011) investigated the adverse effects of disruptions on commodity flows using the McClellan–Kerr Arkansas River branch of the Mississippi River navigation system. Baroud et al. (2014) proposed a time-dependent paradigm for resilience also in the context of the Mississippi waterway system. Two stochastic measures were put forward to identify critical waterway links that contribute to the waterway network resilience. Using Bayesian networks, Hosseini and Barker (2016) quantified IW resilience in terms of absorptive, adaptive, and restorative capabilities. Studies that focused on resiliency of the IW infrastructure systems mainly urged and made recommendations to develop some forms of measures to evaluate the system's resiliency to minimize the risk of loss due to disruptions.

For IW safety and security, Vidan et al. (2010) proposed several search and rescue measures. Martin et al. (2004) and Camp et al. (2010) investigated hazardous spill and potential measures to be adopted to manage spill information. These studies contributed to enriching the decision support system by incorporating a GIS-based water quality and air dispersion model capable of providing real-time information to emergency responders. In addition, Posset et al. (2009) emphasized developing internationally applicable performance indicators. The authors further argued that it is crucial to establish the relationship between performance indicators and stakeholders who are potential users of the indicators.

Ports and Harbors

Research on port performance measurement dates back to at least 1976 when the United Nations Conference on Trade and Development (UNCTD) published a list of port performance indicators, which are categorized into two classes: financial and operational. UNCTD provided further guidelines

on how to collect data based on the indicators. Since then, researchers have been using performance indicators for inland ports and stressed the importance of developing financial, operational, and environmental PMs to track efficiency and stewardship of a port facility. For example, Carrera-Gómez et al. (2006) and Seguí et al. (2016) emphasized environmental PMs for European inland ports. Focusing on North American inland port cities, Rempel et al. (2011) argued that a data collection methodology for container truck traffic should be developed based on drayage characteristics. One aspect that every scholar agrees on is that ports need to have a comprehensive performance measurement system.

Inland Locks and Dams

In the United States, many locks and dams are old and quickly deteriorating (NRC, 2013; Kruse et al., 2011). Lock performance was examined considering structural design, passing vessel characteristics, and weather conditions (Wilson, 2006). The heterogeneity of vessels, carriers, and locks resulted in significant vessel delays when passing locks. For lock and dam financing, Kruse et al. (2014) proposed a new approach to allocate maintenance funding. The authors argued that by modifying the current policies and funding mechanisms for project planning and implementation, it is possible to convert the existing build-and-expand approach to a repair-and-sustain approach. To understand the resilience of locks and dams, Baroud and Barker (2018) developed a Bayesian kernel approach for the Mississippi River navigation system. Five locks and dams were identified that had the most significant impact on system resiliency.

Role and Responsibilities of the State

The extent of state-level involvement in IW freight transportation varies. While the federal government plays a leading role in constructing, maintaining, and operating the waterside of the IW facilities, state governments are responsible for maintaining, supplying, and operating landside facilities with help from local agencies as well as other private entities (Transportation Research Board, 2004). The jurisdiction of a state government in an IW freight transportation system is limited to the landside. Port and terminal facilities can be owned and operated by private entities or public authorities. Nonetheless, state governments can provide financial and technical assistance to these facilities if needed. State governments also play significant roles in providing rail and road access to waterway facilities. In most cases, the state DOT is the primary agency in the state government on matters related to IW freight transportation, although some states (e.g., Indiana and Mississippi) have separate designated entities. Most states obtain IW funding on an *ad hoc* basis. A regular funding stream is highly unlikely. Some states (e.g., Indiana, Kentucky, and Michigan) have an advisory board for IW transportation as a complement of the state freight advisory board.

Issues with Existing State-level PMs

The 25 PMs summarized in Table 4 are from the reviewed 32 states. Although there are 25 PMs, if we look at the individual state level, the number of PMs for each state is very low. The highest number of PMs a state has is only four. Furthermore, the PMs developed in a state often have a focus on particular aspects of the system. For instance, Iowa's four PMs are lock and dam specific. The four PMs for Minnesota and the two PMs for North Carolina only track cargo tonnage handled. The PMs for Florida, Washington, and Texas are port specific. PMs are also scattered and sometimes not

generic. This is especially notable for PMs in the environmental stewardship category—only three PMs were found. In addition, two of the three PMs were established in Maryland and cannot be employed directly in other states. Furthermore, PMs related to mode share of the waterborne mode, i.e., "Freight mode share by tonnage/value," might not be developed for IW only but come as part of the overall performance measurement encompassing multiple modes. Because freight transportation through waterway constitutes a multitude of smaller systems, it is unlikely that the small number of aspect-specific PMs can comprehensively capture the performance of the entire IW freight transportation system of a state.

The characteristics of the PMs as observed above may be reflective of the fact that PM development needs to cater to the immediate needs of the IW freight transportation system in a state. In line of this thinking, the most-highlighted needs facing state DOTs are delays in locks and dredging of channels to maintain navigable depth. Integration with other modes and gate reliability, i.e., truck turn time at ports, are considered with high importance as well. None of the existing 25 PMs can capture the performances based on these highly discussed issues.

Performance Measures Categorization

With proper categorization, PMs enable practitioners to identify the specific aspects of a system that warrant attention if the PM values deviate from the normal range, which informs the targeted allocation of resources to improve the system. However, our review suggests that systematic ways to categorize PMs remain lacking. This is true not only for maritime freight PMs, but also freight PMs in general. Freight PMs at the state level are often listed and summarized according to the strategic goals of the SFP or by mode. The situation is similar at the federal level (Easley et al., 2017). Two exceptions are by USACE and CMTS, which grouped IW PMs into five categories: economic benefits, safety and security, environmental stewardship, capacity and reliability, and resilience (Kress et al., 2016; CMTS, 2015).

Given the dearth of PM categorization practice and in view of the existing and needed PMs for IW systems, a two-dimensional categorization of IW PMs is considered. Note that this is one way and not the only approach for IW PM categorization. The two dimensions correspond to two fundamental questions: 1) what is to be measured for a PM and 2) where a PM should be applied. The rationale for the first dimension is that a system, in general, has multiple performance areas that need to be monitored to ensure overall system functionality. For IW systems, eight performance areas are considered, as follows:

1. Safety and security
2. Maintenance and preservation
3. Resiliency
4. Mobility, congestion, and reliability
5. Environmental stewardship

6. Economic development
7. Information and communication technology
8. Customer service

Besides performance areas, the second dimension categorizes PMs based on types of infrastructure that comprise an IW freight transportation system. The rationale is that different types of infrastructure are likely to be associated with different ways to measure performance. By doing so, it is possible to obtain an infrastructure-specific understanding of IW performance. Among the four infrastructure types considered in the second dimension, the first two are in the waterside of the IW, where the federal government is the main jurisdictional body, and the last two infrastructure assets are in the domain of the states. The four infrastructure types are navigation channels, locks and dams, intermodal integration, and ports and harbors.

The main advantage of having a two-dimensional approach is to get a perspective of the whole system. From this categorization, one can easily pinpoint the system needs/deficiency in terms of both performance and assets. One drawback of such a system is that it necessitates developing a large number of PMs. Developing such a large number of PMs and starting to track data for each of these PMs at the same time can be costly given the nature of funding scarcity in this sector.

Summary of Existing Performance Measures

Based on the overall literature review, we have compiled 143 PMs, which are listed in Appendix A. We summarized the PMs based on the eight performance areas. Table 5 lists the number of PMs per performance area. We also provide the sources for each PM. The third and fourth tables in Appendix A contain a brief discussion for each PM. This discussion contains the definition, justification, and data-related issues for each PM. To the best of our knowledge, this is the most comprehensive and largest list of maritime freight PMs in the literature. We present these PMs in a generalized format so they can be easily used by any state or entity, not just the state of Illinois.

Table 5. Number of PMs Per Performance Area

Performance areas	No. of PMs
Safety and security	13
Maintenance and preservation	18
Mobility, congestion, and reliability	37
Environmental	14
Economic development	27
Infrastructure	26
Information and communication technology	6
Customer service	2

We acknowledge that a subtle difference exists between a measure and a metric. By definition, a measure is a unit-specific number derived from taking a direct measurement or count. By contrast, a metric will be derived or calculated from one or multiple measures (Nelson, 2014). Despite this difference, measure and metric are often used interchangeably in any discussion pertaining to performance measurement. Furthermore, we did not find any explicit differences mentioned by studies related to freight performance measurement. Considering the generalizability and simplicity, we list both measures and metrics together in our list of PMs. Nonetheless, we specifically identify for each PM whether it is a measure or metric in Appendix A so the interested user can use them separately if they desire. The identified PMs needed corroboration from the public and private sectors for various issues such as appropriateness in fostering strategic planning and funding initiatives, availability of data to develop PMs, feasibility in routinely updating the identified PMs over time, etc. To accomplish this, the research team from the Urban Transportation Center designed a methodology to obtain input from different stakeholders, from both the public and private sectors. This is discussed in the next chapter.

CHAPTER 3: DATA COLLECTION METHODOLOGY

The task of collecting relevant information from different stakeholder groups to inform and shape the PMs for inclusion in the strategic plan development is a complex one. The stakeholders range from public to private sector entities with a few nonprofit agencies also possessing valuable insight about the inclusion of appropriate PMs. Thus, the research team used a mixed methods approach involving semi-structured phone interviews and self-administered online surveys. The survey questions and the interview questionnaire were screened by the UIC Institutional Review Board for ensuring the protection of human subjects participating in the process. This chapter includes the description and findings of the phone interviews followed by the description and findings of the online survey.

PHONE INTERVIEWS

The research team reached out to several stakeholder groups to participate in phone interviews in order to detail each group's role regarding the maritime freight industry and interactions with each other. Interviews were structured into four categories: background and operational information, statewide planning, stakeholder relationships, data management and performance measures, and relationships with IDOT. While the general categories remained unchanged between the groups, interview questions were tailored to the unique position and operation of each individual interviewee.

Stakeholder groups identified for this study were categorized by level of government or the level of government with which each group had predominant interactions. At the federal level, interviews were held with representatives of USACE divisions. State DOT interviewees provided the perspective of state-level management and oversight of the maritime freight industry, and the local level consisted of public port districts within Illinois as well as private carriers and operators. Online survey invitations were sent to several advocacy groups and are detailed further in the section "Online Survey."

Federal

As the USACE maintains jurisdiction over inland waterway navigation and serves as the nation's largest collector and disseminator of maritime freight data, several divisions within the Corps were contacted to participate in a phone interview or online survey. Two phone interviews were conducted: one with the Institute for Water Resources' (IWR) Navigation and Civil Works Decision Support Center (NDC) and one with the Coastal and Hydraulics Laboratory (CHL) under the Engineer Research and Development Center (ERDC). The Rock Island district of USACE also submitted responses to a written questionnaire, which is discussed in the "Federal" subsection of Chapter 4.

Interviews lasted 45–60 minutes and followed the script structure, as detailed previously, with a specific focus on IWR's role as a national clearinghouse for maritime freight data and their methods of collection, management, and dissemination. The conversation with a representative from the CHL also sought to gain a better understanding of their tracking of vessel movements and relationships with USCG.

State

The research team contacted eight DOTs from Illinois' neighboring states: Ohio, Wisconsin, Iowa, Minnesota, Michigan, Tennessee, Missouri, and Kentucky. Kentucky's state government structure consists of cabinets; but for simplicity and uniformity, their transportation cabinet will be referred to as a department of transportation (KDOT) throughout this chapter. Four of the conducted interviews consisted of only one interviewee and the remaining interviews had two interviewees. The interviews consisted of two sections: Section 1—Consent Process and Section 2—Interview Script. Section 2 was split into four modules. Appendix B shows the telephone interview scripts of the DOT interviews.

Module A consists of questions related to the strategic planning of the individual state's maritime freight transportation system, its integration with the rest of the statewide transportation system plan, the amount of dedicated attention the inland waterways and ports have received in the planning process, and why the state has not created a freestanding maritime transportation plan or strategy if they have not done so already.

Module B consists of questions targeting performance measures. If the DOT already had PMs related to the maritime system, UTC wanted to know how those specific PMs were formulated. If the state did not have any maritime-related PMs, did the metrics within the statewide freight plan (SFP) apply to the maritime system in place of dedicated maritime performance measures? Other questions in this module focused on the motivation of the development of general freight performance, how those measures were developed, and which departments in the DOT were responsible for developing and/or updating/revising such freight measures. This module is also being connected to the waterway funding that some of the states receive.

Module C relates to data collection and the management system. The questions in this module aimed to understand where the interviewed DOTs collected their data (public and private), challenges to collecting their data, which division/section/group in their DOT was responsible for data collection and storage, how often these data sources and storage are updated, and if the interviewed DOTs have all the necessary resources to collect and maintain a database. Finally, Module D is about the concluding remarks. Here, the interviewees were asked about the availability of publicly available relevant published materials.

After concluding the eight scheduled interviews with the selected neighboring DOTs, each phone interview was reviewed individually to extract key points that would be beneficial to our research. The key points taken from these interviews will be discussed in Chapter 4.

Local

Port Districts: Port districts that are in proximity or connected to the MARAD Marine Highway System and/or the National Highway Freight Network were desired participants. The MARAD Marine Highway System map and the National Freight Network map were used to identify port districts within these systems and are included in Appendix C. Port performance and availability of intermodal connections via railroads, regional airports, and US/state highways were also factors in the selection of the five desired port districts. Table 6 summarizes the selected port districts.

Table 6. Selected Port District Interviewees

Port District	Access to:		
	MARAD Marine Highway System	National Highway Freight Network	Other Major Connections
Alexander–Cairo Port District	M-55, M-70	I-57	Canadian National Railroad
America's Central Port District (ACP)	M-70	I-64, I-270	6 Class-I railroads
Illinois International Port District (IIPD)	M-90	I-80, I-90, I-290	O'Hare International Airport, Midway International Airport, Illinois River, Great Lakes
Kaskaskia Regional Port District	M-55	I-64	Union Pacific Railroad, Canadian National Railroad
Massac–Metropolis Post District	M-65	I-24	Illinois Central Railroad, Canadian National Railroad, Burlington Santa Fe Railroad, Union Pacific Railroad
Mid-America Intermodal Authority Port	M-35, M-70	N/A	North Santa Fe Railroad, Norfolk Southern Railroad

Carriers: To select which operators to interview by phone, we first categorized the 98 operators in Illinois by the 14 commodity codes used by the Waterborne Commerce Statistics Center. The basis for selecting interviewees was a desire to match the share of carriers operating in Illinois per commodity code. For example, 23% of carriers in Illinois move food and food products (e.g., grain), so of the 10 target interviewees, two or three would ship food and food products.

This effort was constrained by email address availability, as only 24 out of the 98 operators in Illinois were found to have email address contacts. So, the distribution of interviewees selected by commodity differs somewhat from the overall list of carriers operating in Illinois. Once the commodity share target was established, carriers were randomly chosen per each commodity code (if available).

Table 7 shows the final breakdown by commodity codes for carriers operating in Illinois. Note that some carriers were classified by multiple commodity codes, which resulted in a higher total by commodity code than the number of unique carriers selected.

Table 7. Distribution of Carriers Categorized by Commodity Code

Code	Type	Total	% Total	with email	% Total	Number selected	% Total
1000	Coal, Lignite, and Coal Coke	6	4%	1	3%	1	17%
2100	Crude Petroleum	7	5%	2	6%	0	0%
2229	Petroleum Products	12	9%	3	10%	1	8%
3100	Chemical Fertilizers	3	2%	0	0%	0	0%
3200	Chemicals excluding Fertilizers	8	6%	2	6%	2	25%
4142	Lumber, Logs, Wood Chips, and Pulp	2	1%	0	0%	0	0%

Code	Type	Total	% Total	with email	% Total	Number selected	% Total
4349	Sand, Gravel, Shells, Clay, Salt, and Slag	19	14%	7	23%	2	11%
4400	Iron Ore, Iron, and Steel Waste and Scrap	0	0%	0	0%	0	0%
4600	Non-Ferrous Ores and Scrap	1	1%	1	3%	0	0%
5155	Primary Non-Metal Products	4	3%	2	6%	1	25%
5354	Primary Metal Products	13	10%	4	13%	3	23%
6168	Food and Food Products	31	23%	3	10%	3	10%
7000	Manufactured Goods	7	5%	1	3%	0	0%
8099	Unknown and Not Elsewhere Classified Products	22	16%	5	16%	2	9%
	Total by Commodity Code	135	100%	31	23%	15	11%
	Total Unique Carriers	98	100%	24	18%	10	10%

Potential interviewees were first solicited by email. Initial follow-up distribution emails were sent out within one to two weeks of the first contact. If no response was received, each operator was contacted by phone. Additional operators were included as initial potential interviewees declined participation or otherwise were not able to schedule an interview. One online survey respondent also engaged with the researchers in a phone interview.

ONLINE SURVEY

Online surveys were constructed and disseminated to groups of stakeholders to gain a cross-section of maritime industry perspectives as they relate to this study. Responses were collected during a two-month period between February 27, 2020, and April 27, 2020. Qualtrics survey software was used as an all-in-one online platform for invitation distributions, survey participation, and response analysis. Surveys were structured into six question blocks:

- Background and operations
- Relationships with other stakeholders
- Participation in statewide freight planning
- Data collection, generation, and management
- Use of performance measures and metrics
- Interactions with IDOT.

The selection of prospective respondents is detailed further in the following sections.

Federal

The Rock Island district of the USACE was contacted to better understand the federal government's role in state and regional inland waterway management. The district is part of the Mississippi Valley division and oversees approximately 78,000 square miles in Iowa, Illinois, Minnesota, Wisconsin, and Missouri. This area includes over 300 miles of the Mississippi River, over 250 miles of the Illinois Waterway and tributaries, and 20 locks and dams. The district's primary responsibilities include operating and maintaining the inland waterway navigation system, flood management, regulatory oversight, environmental protection and restoration, emergency management, and recreation.

The initial intent was to conduct a phone interview with a representative of the district; however, input from the district was ultimately provided via written response due to scheduling issues. The questionnaire followed the same structure as the online surveys, with questions tailored to the Rock Island district jurisdiction and responsibilities.

State

State DOTs were not solicited for participation in an online survey. The states identified for the phone interview portion of the study were chosen due to participation within the Mid America Association of State Transportation Officials (MAASTO) and proximity to key elements of the inland waterway system with connections to Illinois (Great Lakes, Ohio River, and Upper Mississippi River). While a survey of additional state DOT maritime freight planning and management would contribute additional depth to the understanding of inland waterway operations, the unique priorities of these states may not reflect those of Illinois. Thus, the perspectives of additional state DOTs were not solicited.

Local

As with the phone interviews, three groups of stakeholders—port districts, carriers, and advocacy groups—were identified as key facets of the maritime freight industry at the local and regional levels. Online surveys were drafted to better understand issues of operations, planning, and data collection and management within and among these stakeholder groups. Information gathered from these sources helps to inform pertinent performance measures and data sources relevant to maritime freight operations at these levels. Survey development and outreach for each group are detailed as follows.

Port Districts: The port districts selected for participation in the online survey constituted the 13 public port districts within Illinois that were not chosen for a phone interview. Of the 19 total port districts, six were selected for phone interviews as detailed in the section "Phone Interviews." Twelve of the remaining 13 port districts were invited to participate in the online survey. Only White County's port district was not contacted, as the district was inactive at the time of this study.

Each port district was contacted via a native Qualtrics distribution function. Follow-up emails were sent within one or two weeks of the previous contact, omitting those districts who had completed the survey or opted-out of the study. After three rounds of follow-up distributions, each remaining district was contacted via phone to verify the appropriate email contact and to request survey participation. If the listed contact was unavailable, the researchers left voicemails or messages with a

staff member detailing the study and how to participate in the survey. A final round of email invitations was then sent via Qualtrics.

Carriers: Private inland waterway operators were compiled using the USACE *Waterborne Transportation Lines of the United States* report for 2016. The report describes each operator's fleet, operations type, operating localities, USACE district, and contact information. The researchers determined operators within Illinois and surrounding comparison states by cross-referencing the inland waterways listed for operator localities with those waterways present in each state. For example, if an operator was found to operate on the Upper Mississippi River, then it was counted for Illinois, Iowa, Minnesota, Missouri, and Wisconsin.

A total of 504 unique carriers were identified as operating on maritime transport/inland waterway systems in Illinois and comparable states, with 98 operating on Illinois waterways. Email addresses for each carrier were gathered from company websites when available, resulting in 124 out of the 504 carriers with email addresses. As email contacts were found for only 24 of the 98 operators within Illinois, the research team expanded the survey availability to any carrier with email addresses (124 total). These 124 operators comprised the survey invitation distribution list and represented the pool of potential respondents.

As with the port districts, each of the 124 operators was emailed via the native Qualtrics distribution function. Follow-up emails were sent to those carriers that had yet to begin the survey or decline participation. After three rounds of follow-up distributions, each remaining carrier was contacted via phone to verify the listed email address and to request participation in the online survey. If the representative was unavailable, the researchers left voicemails or messages with a staff member detailing the study and how to participate. A final round of email invitations was then sent via Qualtrics after modifying the contact list as necessary.

Advocacy Groups: Advocacy and industry professional groups were sent online surveys to better understand their roles within the maritime industry as a nexus between private companies, policymakers, and other industries. After a preliminary screening of such groups across the country, six were identified as having members or representing interests within the state of Illinois. Surveys were designed to reflect the basic structure for all online surveys included in this study, with sections covering background and general activities; relationships with other stakeholders; involvement in statewide maritime freight planning; methods of data collection, generation, and management; and specific interactions with IDOT.

Survey instruments were likewise sent to prospective respondents in the same manner as other stakeholders. Each of the six groups received email invitations through the publicly available contact information. Follow-up emails were sent within one or two weeks of initial distributions, and, after three rounds of distributions, each group was called to verify email addresses for the proper recipient. A final round of follow-up emails was sent via Qualtrics after any necessary contact information changes were completed.

CHAPTER 4: RESULTS AND FINDINGS

ONLINE SURVEYS AND TELEPHONE INTERVIEWS

This chapter details key findings gathered from online surveys and telephone interviews, where applicable, across stakeholder groups. Commonalities and contrasts among and between these groups help to articulate planning, data management, and relationships throughout the maritime freight industry.

Federal

USACE personnel from the Institute for Water Research's (IWR) Navigation and Civil Works Decision Support Center (NDC), Coastal and Hydraulics Laboratory (CHL), and the Rock Island district provided information on USACE relationships with various inland waterway stakeholders, data collection, as well as data centers and services offered.

Data Elements and Reporting: Maritime freight operators are required to submit reports to WCSC, and ports have an opportunity to voluntarily send data, as reported to them by operators ("dock receipts"), to WCSC as a check on vessel-reported cargo data. A series of forms and regulations approved by the federal Office of Management and Budget (OMB) specify what data is collected, how it is collected, and the level and depth of information. This data includes point of origin, dock of origin, departure time, cargo type, volume, as well as vessel and fleet information. Operators are legally obligated to report within one month and 30 days of the time of movement; if a movement is made on January 1, the report must be submitted by February 28. Larger carriers may utilize business administration software that automatically transmits XML feeds to NDC to incorporate in their database. Other carriers may submit Excel spreadsheets, while some smaller carriers fax or mail paper forms. Reports are stored by WCSC and are available online.

The Corps also provides Automatic Identification System (AIS) data regarding vessel location and movements to the USCG, which is the central repository and distributor for AIS data. The CHL is currently installing AIS receivers and transceivers along Illinois waterways to communicate with commercial vessels over 65 feet, which are required to have transceivers.

Data Requests: Entities may request data from USACE by first initiating contact at the district level. From there, data requests are forwarded to IWR or other central divisions for fulfillment. IWR receives requests for customized queries, especially at the county and state levels. They provide data subject to disclosure and masking rules, although for Corps projects, disclosure and masking rules are relaxed. One interviewee noted that there are ongoing issues as to the way USACE presents and defines the public data, which contribute to its misuse due to false logical assumptions. For that reason, it is useful for government agencies to work with the Corps to customize and verify their data requests.

USACE has been developing web services and an application programming interface (API) to allow other databases to access Corps data without the need to duplicate and store locally. Overall, the goal is to develop a national system for data storage and access to prevent discrepancies between

districts or states. Under such a system, they will provide states (in response to a Freedom of Information Act [FOIA] request) with a feed or static place from which to pull information for a wide range of uses. For example, a state may wish to centralize all voluntary dock receipt reporting so that ports in that state have one system into which they submit and transmit this data to USACE. While such a transaction is not fully functioning as of this report, testing of such is a near-term goal within the next several months.

At the individual port level, the Corps currently publishes data for principal ports, which are the 150 largest ports (by tonnage) in the United States. There are three such ports in Illinois: Chicago, St. Louis, and Kaskaskia. This limits the ability to parse data for smaller ports within Illinois and elsewhere. Given that USACE has state-level data and waterway reports that contain information for these smaller reports, they are planning that future updates will make individual port data within Illinois more accessible.

AIS data may be requested from USCG. In some instances, CHL will provide historical data for planning and research purposes. They also can provide livestream data for entities that demonstrate a need for it. CHL uses an AIS analysis portal, which is a tool to perform statistical and visual analysis of AIS data.

Performance Measures: The Corps utilizes several performance measures to track inland waterway operations, as shown in Table 8.

Table 8. USACE-identified PMs Relevant to the Inland Waterway System (Kress et al., 2016)

Performance Area	Performance Measure
Economic Benefits	Total value and tonnage of international trade
	Income and disbursement of harbor maintenance and inland waterways trust funds
	Producer price index (PPI) for transportation modes
	Number of jobs in marine transportation industries, direct employment
	Inland waterway shipping barge freight rates
Capacity and Reliability	Navigation lock closures, hours, and number of scheduled and unscheduled closures
	NOAA PORTS instrumentation availability at 59 high-tonnage USACE projects
	Quarterly travel time estimates for key waterway segments
	Federal channels at project depth according to USACE eHydro
Safety and Security	Number of commercial vessel accidents
	Number of commercial mariner and passenger casualties
	USCG incident investigations
Environmental Stewardship	US petroleum-based fuel sales to the maritime industry
	Vessel pollution incidents
	Amount of dredged material reclaimed for beneficial use
	Number of reported whale strikes by vessels
Resilience	Physical condition ratings of USACE-owned critical coastal navigation infrastructure

Performance measures are primarily used to make funding allocation decisions for capital improvements. When new projects are planned, they rely on different pools of funding: operations and maintenance, construction, or general investigation. Despite the different performance areas listed, USACE is required by law to focus on transportation cost savings when considering project undertakings and generally does not include parameters such as local or regional economic priorities.

Future Efforts: When framing future efforts, one interviewee noted the need to approach maritime freight operations and planning from a systems approach. The goal is to improve the representation of different regions of the country when tracking commodities, imports and exports, and the overall movement of goods. The maritime freight industry is the only one that tracks point-to-point movements, which provides a level of granularity to enhance discourse on origin and destination of commodities and where targeted regional investments may be made. The interdependency of systems and a focus on intermodal operations is key. For example, in the event of supply chain disruptions, such as the impact felt by COVID-19, a flexible transportation network that can effectively shift freight modes is crucial to mitigate inefficiencies and absorb shocks throughout the network.

State

Strategic Planning: At the beginning of this module all interviewers and interviewees introduced themselves, and the interviewee(s) described their role within their designated state DOT. Many of the interviewees held a variety of positions. As we soon found out, many of the interviewees were multifaceted and not only held responsibilities for state maritime planning, but also for planning and or funding oversight for freight, rail, program management, logistics, or environmental. Due to this shared responsibility across different transportation modes, three of the DOTs interviewed were found to have less than one full-time equivalent (FTE) dedicated to maritime. This was identified as an issue because a lack of dedicated FTE shows that planning and creating a standalone state maritime system plan is given less priority.

Unlike a dedicated SFP that is federally mandated under MAP-21 and FAST Act to be produced by all states that receive funding under the National Highway Freight Program (NHFP), states are not required either by state or federal governments to produce a dedicated state maritime system plan. As shown in Table 9, seven of the DOTs interviewed did not have a standalone state maritime system plan. The Minnesota Department of Transportation (MnDOT) was the only state to have a fully dedicated state maritime system plan as of 2014. MnDOT's Statewide Ports & Waterways Plan helps guide the needs of the marine freight transportation system while also strengthening the benefits and economic competitiveness for the state of Minnesota (MnDOT, 2014). Without a dedicated state maritime system plan in place, there is less guidance for the short- and long-term goals and plans for improvement of the state's maritime system.

Table 9. Strategic Planning Issues Identified within the State's Maritime System

Issues Identified	Department of Transportation							
	Ohio	Wisconsin	Iowa	Minnesota	Michigan	Tennessee	Missouri	Kentucky
Does not have a standalone maritime plan	●	●	●		●	●	●	●
Dedicated maritime plan will not be created in the future					●			
Lack of port/terminal ownership					●			
< 1 FTE dedicated to maritime	●				●	●		

Although there are identified strategic-planning issues with lack of dedicated FTE and lack of a standalone state-dedicated maritime plans, opportunities were identified for many of the state's maritime systems. First, multiple DOTs have acknowledged the incorporation of a state maritime plan in the future, and this is important because they understand the importance of the marine transportation system (Great Lakes and inland waterway system) and the benefits that come from investing in it. As seen in Table 10, some DOTs have already begun to capitalize on this front through political support and or the development of stakeholder relationships with public ports, terminals, and advocacy groups. We have gathered from these interviews that the maritime industry is highly privatized, making it difficult for key maritime stakeholders to form beneficial relationships and even more difficult for DOTs to have some form of relationship with their state's port authorities due to their connection to a strongly privatized industry. Without a federal or state mandate to generate a state maritime plan, there will continue to be a slower development of stakeholder relationships with port authorities, maritime carriers, and advocacy groups.

Table 10. Strategic Planning Opportunities within the State's Maritime System

Opportunities Identified	Department of Transportation							
	Ohio	Wisconsin	Iowa	Minnesota	Michigan	Tennessee	Missouri	Kentucky
Dedicated state maritime plan				●				
Dedicated state maritime strategy	●							
Political/Lobbyist support	●							●
Developing stakeholder relationship with public ports, terminals, or advocacy groups	●	●			●			
Maritime study conducted/in progress	●		●	●		●	●	●
Publicly owned port(s) or port authorities	●	●		●	●	●	●	●
Multimodal freight planning			●		●	●	●	

Multiple states have been proactive despite the lack of a standalone state-dedicated maritime system plan. Ohio, Iowa, Missouri, Tennessee, and Kentucky have all gone forward with issuing maritime-related studies for their states. This is an opportunity that these states can build upon to create a standalone maritime plan from the identified areas of improvement as a result of their conducted studies. Although six state DOTs have issued and conducted state maritime studies, this does not mean the remaining DOTs do not have available maritime studies for their states. For example, the Wisconsin Commercial Ports Association has conducted multiple studies that include commercial port development, port planning benchmarks, as well as infrastructure and market assessment for the state of Wisconsin. Michigan DOT (MDOT) is the only interviewed state DOT to have a fully integrated freight transportation system. MDOT is focused on full integration and multimodal planning rather

than having sole planning components for rail, aviation, roadway, and maritime. MDOT's integrated multimodal planning has caused some perplexity in differentiating departments and having specific points of contact for certain planning, but this has also helped more of their staff become knowledgeable across all transportation modes.

Performance Measures and Funding: Interviewees in the second module went on to explain some of the PMs related to their maritime inland water waterway system, but for almost all the interviewed DOTs the conversation revolved more about explaining the *lack* of PMs for their state system. As illustrated in Table 11, all but one of our interviewed DOTs do not have current maritime performance measures related to their maritime system. It is important to note that maritime performance measures are also not federally or state mandated. Iowa DOT currently has existing maritime PMs that align with the national freight goals. These four performance measures are delays at locks, unscheduled lock closures, lock availability, and producer price index. The Kentucky Freight Plan has waterway indicators under some of their freight plan goals, which include inland waterway crashes/incidents, change in tonnage/value/miles, rate of dredging, condition of locks and dams, and change in freight tonnage movement by mode.

Table 11. Performance Measures and Funding Issues Identified within the State's Maritime System

Issues Identified	Department of Transportation							
	Ohio	Wisconsin	Iowa	Minnesota	Michigan	Tennessee	Missouri	Kentucky
No current maritime performance measures	•	•		•	•	•	•	•
Funding justified from roadway infrastructure usage		•						
Does not have annual state-dedicated maritime funding	•	•	•	•	•	•		•

During our interviews, the research team found a connection between a lack of PMs and lack of annual state-dedicated maritime funding. As shown in Table 11, most of the DOTs interviewed did not have current maritime PMs *and* did not have annual state-dedicated maritime funding. This was identified as an issue as well as an overarching theme in which a lack of state-dedicated maritime funding resulted in less allocated resources to put greater emphasis and attention on the designated state's waterway system, which would most likely result in not establishing maritime PMs. If there are no established maritime PMs, then states find it difficult to indicate a benchmark of their current waterway infrastructure and performance as well as indicate which area of their waterway system needs improvement.

The only state DOT found to have dedicated annual state funding for their state waterways was the Missouri Department of Transportation (MoDOT). MoDOT receives general revenue appropriations for capital improvements of its public ports that is also prioritized by Missouri's Port Authority Association. Each port receives a base amount of administrative funding, plus additional funding determined by an agreed-upon set of performance criteria, and performance is evaluated annually (MoDOT, 2019). MoDOT was unique in its nature by not only having dedicated annual state funding for its waterways, but also a framework for funding allocation based on established performance criteria.

As shown in Table 12, WisDOT, MnDOT, and KDOT had opportunities identified due to their already established maritime-related funding programs. Interviews with these DOTs showed that having a form of established PMs would allow WisDOT, MnDOT, and KDOT to allocate funding to their recipients in a performance-based manner. It is also important to note that WisDOT has had a history of receiving biannual funding for its Harbor Assistance Program (HAP); but as of 2018, HAP has an estimated backlog for harbor projects for the 2019–2021 biennium totaling $143.5 million. Eighty percent ($114.8 million) will be covered by HAP grant funds; but due to this circumstance, there will be no new grants awarded for need-based projects for 2019 or 2020 (WisDOT, 2019).

Table 12. Performance Measures and Funding Opportunities Identified within the State's Maritime System

Opportunities Identified	Department of Transportation							
	Ohio	Wisconsin	Iowa	Minnesota	Michigan	Tennessee	Missouri	Kentucky
Existing maritime performance measures			•					
Current maritime-related metrics or indicators							•	•
Acknowledged to establish maritime performance measures in the future	•					•		
Maritime-related funding program (e.g., harbor assistance program or ports / terminals / waterway infrastructure)		•		•				•
Dedicated annual state funding for maritime							•	

Data Collection and Management System: In this module of the interview, we identified a few issues relating to the data collection and management system of the maritime system for some DOTs interviewed. Many of the DOTs only collected and or had access to publicly available data such as from USACE. This reported data from USACE would at times be delayed and there would be discrepancies in tonnage reported versus tonnage moved. Another issue identified was that some DOTs did not seek out data from carriers. Carriers are required to make certain reports such as tonnage and commodity to the USACE, but not to the jurisdiction of the state DOTs in which they operate. This makes it ineffective for DOTs to pursue the collection of data from carriers when they are not federally or state mandated to report such information to DOTs. Not having additional information from carrier sources make it more difficult for DOTs to identify areas of inefficiencies within their state maritime system and more difficult to create strategies and plans for improvement. As previously mentioned, some DOTs have funding programs (e.g., Harbor Assistance Program) where data from carriers could be used to improve the criteria and funding-selection process of those programs if the data were to be shared regularly and accurately.

Despite some identified issues regarding data collection and management, there are opportunities in which the interviewed DOTs can use going forward. Many of the DOTs already have established methods of collecting maritime data, whether it is collected from USACE, carriers, public/private ports, port authorities, terminals, and or commercially available sources. As shown in Table 13, many of the DOTs that have established methods of collecting maritime data also have a form of dedicated staff/division/group for collecting, storing, and maintaining that data as well. Receiving state-dedicated funding for DOTs can provide an opportunity to help further improve data collection methods as well as staffing resources.

Table 13. Data Collection/Management Opportunities Identified within the State's Maritime System

Opportunities Identified	Department of Transportation							
	Ohio	Wisconsin	Iowa	Minnesota	Michigan	Tennessee	Missouri	Kentucky
Established methods for collecting maritime data	•	•		•	•			
Collect maritime data from ports (public/private) and or terminals		•		•	•		•	
Commercial data purchased (e.g., TranSearch)		•			•		•	
Dedicated division / section / group to data collection / storage / maintenance			•		•	•	•	

State DOTs are making efforts to establish relationships with carriers, port authorities, and other relevant stakeholders. Through the establishment of stakeholder relationships, maritime data has been able to be shared between them, although attempts to learn about specific shared data were unsuccessful during a few interviews because private data was requested to maintain private.

Local—Port Districts

Profile of Respondents: Four (67%) Illinois port districts participated in phone interviews of the six port districts that were asked to participate in the study. Each was selected based on proximity to the MARAD Marine Highway System, the National Highway Freight Network, and other major connections. One participating port district, the Mid-America Intermodal Port District, does not operate a public port and is not currently a port statistical area. While it is working to establish and operate port facilities, the district does not currently have any dedicated staff on payroll. It also does not have direct interaction with private operators and instead receives relevant maritime freight data from USACE.

Stakeholder Relationships: All interviewed port districts have varying interactions with state and federal levels of government, maritime advocacy groups, as well as private carriers and operators of Illinois waterways. Levels of state government interaction were discussed primarily regarding IDOT's relationship with the designated port district. Such interactions with IDOT include, but are not limited to, securing grants, acquiring new land for tenants, and data reporting. Federal interactions occur mainly with USACE because the port districts require tenants to self-report tonnage commodity, tonnage, and volume monthly, which is then reported to USACE. Other interactions with the federal government include working with MARAD and seeking Transportation Investment Generating Economic Recovery (TIGER) grant funding.

Multiple advocacy groups were also listed to be working with port districts. All Illinois port districts are part of the Illinois Ports Association (IPA), but two port districts specifically mentioned having a working relationship with IPA, two port districts work with Inland Rivers Ports and Terminals (IRPT), one works with the American Association of Port Authorities, and one is involved with the Upper Mississippi River Basin Association. One port district stated they make sure to network and engage with all stakeholders and another port district stated they have good relationships with economic development groups.

Interactions with private carriers and operators were primarily in the form of collecting data reports and terminal operations. Port districts try to work with them as best as possible to help secure

tenants within the port districts, but also to help generate revenue and tonnage. One port district described that they work with private carriers with their infrastructure needs and keep an open dialogue with port district projects that might affect their operations. That specific port district makes their tenants aware of new traffic patterns a project might cause, as well as the time frame, construction schedule, and goals of the project.

Statewide Planning: Despite the interviewed port districts having an array of stakeholder relationships, only one port district stated that they have previously attended meetings with the Illinois State Freight Advisory Council (ISFAC). They believe ISFAC is an important organization because the advisory council has been able to bring representation to the waterways and by helping maritime stakeholders be able to understand the issues of the trucking and rail industries. The same port district has also provided input to Illinois State Freight Plan (ISFP). One port district mentioned having had informal conversations with ISFAC and believe much of the discussion revolves around the trucking industry in concentrated areas. The same port district has also provided ideas and projects to the ISFP, and they believe that more focus will be turned toward the maritime industry once the economic impacts and need for ports are shown.

Data Collection, Generation, and Management: Three of the four port districts interviewed directly collect tonnage reports from their tenants. Additional data points that were said to be collected during the interviews include truck numbers, rail car numbers, rail inspections, annual volumes, and annual commodities. Mid-America Intermodal Port District, as detailed previously, reported that they do not directly collect data from their terminals, but rather get this information from USACE.

Each of the interviewed port districts has different uses for their collected data, but their overall goal was the same: using this collected information to improve their respective districts structurally and economically. One port district reported that they use two different datasets—one that helps to better manage and prolong the infrastructure they own and maintain and another that focuses on revenue and is based on tonnage. Another port district discussed collected data being evaluated based on safety, emergency needs, and business opportunities.

There were also slight variations in the process of collecting their respective data. One port district relies on self-reporting. This port district typically asks for an annual report but also wants to begin to receive monthly data reports. Another port district collects monthly tonnage and volume data by commodity and receives data submitted via an Excel spreadsheet. Two port districts have one staff member dedicated to collecting and updating their port district's data.

IDOT Relationship: Each of the port districts have a relationship with IDOT in one form or another. All Illinois port districts, including those interviewed, are members of IPA, which is one of the levels of connection that IDOT has with Illinois' public ports. The second level of connection is through funding programs. Port districts apply for grants managed by IDOT (e.g., Economic Development Program), which help port districts make economic and infrastructure improvements that otherwise may not have been possible through the means of individual revenue stream. More recently, port districts have kept close ties with IDOT since the passing of the 2019 Rebuild Illinois Capital Plan, which will allocate $150 million to Illinois' public ports.

Local—Carriers

Profile of Respondents: Thirteen entities participated in the carrier online survey (herein, "respondents") and two operators participated in a telephone interview (herein, "interviewees"). Most respondents (6) were towing and fleeting operators, with some reporting as bulk commodities carriers (2). Responses were also received from two marine construction firms and three passenger ferries and riverboats. Fewer than half (5) indicated operating on Illinois waterways. The nature of operations influenced each firm's perspectives and priorities regarding the planning and function of the inland waterway system. One interviewee, for example, only leased and operated barges and did not own any ships. Technology such as automatic identification systems (AIS) to track ship movements or government assistance for ship maintenance and upgrades were not regarded as priorities for the company.

Stakeholder Relationships: This diversity of operations likewise shapes relationships between different groups of stakeholders. Largely, unless there was a contractual obligation or some financial incentive, private firms were not likely to have developed robust institutional relationships with units of government. Most respondent interactions with the local government were through business licensing (6), with scheduling (4) also a popular response. Specific jurisdictions (municipal, county, etc.) were not identified in the responses.

On the state level, less interaction was reported and what was reported mainly centered on business licensing (4) and industry advocacy (3). No respondents indicated reporting shipping data to state entities or engaging with state in funding programs. One interviewee discussed intermediate interactions with state DOTs through their role with an advocacy group. They also noted varying levels of involvement between state DOTs and highlighted MoDOT as an active partner with their advocacy efforts. Missouri was also mentioned for a grant program, administered by the Missouri Department of Natural Resources, to retrofit diesel ship engines to reduce emissions.

Most governmental interactions were on the federal level, with USACE (7) and USCG (8) as the most cited agencies, with the United States Environmental Protection Agency (USEPA) (5) and MARAD (4) as additional responses. Private operators are required to report tonnage and trip data to USACE, while USCG is responsible for licensing and inspections. As such, shipping data reporting (5) and business licensing (5) were the most frequent survey responses. Some respondents (4) expressed interactions through advocacy for infrastructure upgrades throughout the inland waterway system. Both interviewees noted that infrastructure quality (mainly locks and dams) is a crucial component to support the industry and improve safety and efficiency. One interviewee has worked with MARAD and USCG's New Orleans district on a container-on-barge pilot program.

Relationships with ports and port districts were mostly operational and centered around scheduling coordination (4), licensing (3), data reporting (3), and education (3). Online survey responses were largely unchanged between public and private ports. One interviewee that provided harbor and fleeting services at ports, or otherwise had some landside operations, partnered with ports in maintenance and infrastructure upgrades. Absent this, one interviewee only took note of port infrastructure and operations when selecting locations to load or unload shipments.

Respondents claimed participation with several advocacy groups, with American Waterways Operators having the highest representation (6). However, interviews revealed this may be more of an individual role than representative of a company. One interviewee remarked that the marine industry is a tight-knit community, with informal discussions through established personal relationships as the main source of interfirm communication.

Statewide Planning: Survey respondents indicated little to no role in statewide planning, with only one of nine respondents engaged in the process. When planning was noted by an interviewee, it also appeared to be from a personal role and not representative of the individual's company. These activities may also be facilitated by advocacy groups or another intermediary group. Only one survey respondent was part of a statewide freight activity group, although half were receptive to such groups, specifically for maritime operations. Except for one respondent that assisted in project prioritization for a State Maritime Plan, all respondents expressed they either did not contribute to state freight or maritime plans or that they were unsure/not familiar with the process. Interview participants were aware of statewide planning activities, but they were not priorities from a business standpoint. Unless it pertained to the waterway specifically, interest appeared tepid.

Data Collection, Generation, and Management: Respondents most often noted infrastructure condition (4) and tonnage shipped (3) as data elements they collected. The most popular data generated was related to operations: active vessels (4), tonnage shipped (3), trip duration/distance (3), and fuel consumed (3). Data generated by respondents is primarily reported to USACE (5) and USCG (2). Likewise, these federal agencies were the main sources of data collected, with two respondents noting receiving data from advocacy groups.

Collected data was used for business marketing (3), investment (2), customer satisfaction (2), and internal tracking (2). No participant had a defined strategic plan to guide business investment and strategy, but interviewees indicated they do keep informed of regional and national trends in commodities and modal distributions. They explained that most companies are reluctant to provide any information about their business that may put them at a competitive disadvantage in the industry. However, one expressed a willingness to share data for the benefit of the maritime industry and the inland waterway system provided robust confidentiality guarantees and other incentives.

Data management ranged from manual entry and reporting to database software such as Microsoft Access or proprietary tools developed in-house. One respondent and one interviewee relied on Microsoft Excel or Access, while another respondent reports via manual entry. One survey respondent noted that the process was too manual in nature. As noted in one interview, companies may also use third-party ship tracking applications to analyze traffic on the waterway system. Interviewees were largely satisfied with their data management tools and procedures.

IDOT Relationship: Only one respondent had any interaction with IDOT, providing some form of maritime freight data. Reflecting the general attitude towards institutional relationships with units of government, participants expressed few specifics of how their company could formally interact with IDOT. Despite this, several (4) who had no prior interaction with IDOT were optimistic some level of partnership could be created. A passenger carrier suggested direct funding mechanisms, while a towing operator advocated for improved infrastructure quality, operational efficiency and safety, as

well as promoting the growth of the industry. Broadly, both interviewees and one respondent focused on IDOT's role in improving intermodal operations through landside infrastructure and access rather than directly engaging with private companies.

Advocacy Groups

Only two advocacy groups participated in online surveys, which precludes a thorough depiction of the interests and concerns from the maritime freight industry. One respondent indicated their organization had no representation from Illinois or of the eight MAASTO states included in the state DOT interviews (see Chapter 3). Without input from multiple organizations with a presence in the greater Midwest region or interactions with operators on relevant inland waterways systems, no comprehensive advocacy group narrative is possible. Future planning and study of inland waterway operations should include additional methods of outreach and incentives to participation for this stakeholder group.

ISSUES AND LIMITATIONS IDENTIFIED

Several issues hindering the use of performance measures or the adoption of more data-informed operations were noted among and between stakeholder groups. Broadly, these included issues of ownership and access, a lack of understanding the nature and use of data, and inherent limitations or lack of necessary resources to procure, process, and manage data necessary to track performance measures.

Data Ownership, Maintenance, and Access

The intrinsic nature of who owns or has access to data to support performance measurement is not unique to the maritime industry. Related issues may arise in data dissemination and use. In contrast, private operators (such as shippers and other carriers) would typically be hesitant to divulge any information pertaining to their business operations, as doing so would put them at a competitively disadvantageous position compared to those who are more restrictive in data sharing. As private entities, they are not subject to the same level of transparency as the public sector beyond reporting requirements set by federal regulation. For instance, carriers are required to submit tonnage quantities to USACE. Carriers and port tenants also submit these quantities to port districts via dock receipts. Port districts, in turn, may submit these dock receipts to USACE as a check on direct reporting data, but they are not required to do so. Given the data discrepancy between those reported directly to USACE by carriers and the information received via dock receipts, there is currently little recourse to harmonize the reporting.

Even for data that can be accessed by the public in principle, access issues may still exist. For some public data, access may only be granted upon request. However, users may lack knowledge of the correct procedures to obtain such datasets. As noted by USACE, data requests should be initiated at the district level to be fulfilled centrally by IWR. If an entity does not properly submit a request in such a fashion, whether a result of misunderstanding by the requestor or due to lack of communication, they may be delayed in receiving their information or fail to obtain it altogether.

Data management practices within organizations present additional challenges. First, data management may be divorced from operations and dissemination requests. In such a case, database use may be cumbersome or even inaccessible. In the event of needed technical support, coordination between multiple departments and protocols may need to be navigated to render an effective dataset. In this sense, resources dedicated to in-house data management will help to determine the depth or sophistication of data collection, usage, and/or dissemination. In contrast, to comply with federal reporting requirements, carriers may submit tonnage data to USACE through a variety of formats. Smaller companies may mail or fax paper forms, while larger corporations have direct data feeds to USACE databases. The data format coupled with the availability of resources to be dedicated to data management (discussed further in the section "Resource Limitations") will dictate the flexibility and usefulness of operational information.

Utility and Use of Data

In some instances, users requesting data are unaware of the limitations of the datasets they employed or their most appropriate uses. Interviews with USACE officials revealed this propensity of requesting users. Some users wished to combine data in formats not conducive to this operation, while others attempted to obtain data for geographies that did not have such information available. USACE officials noted a need to increase transparency and better communicate the functionality of marine transportation datasets they collect and host.

Finally, reflecting the barriers between data generated or collected by various MTS stakeholder groups—whether access, management, format, etc.—a lack of awareness of or access to available data diminishes the utility of data across the MTS and stakeholders. Without knowing what is available, a user cannot begin to judge the usefulness of such data for operations and decision-making. Even with this knowledge, some users (especially the private sector, as noted) are hesitant to divulge information beyond what is legally required without greater assurances of anonymity, aggregation, and incentive. This siloed network may work to weaken collaboration between users and prevent a richer description and understanding of the inland waterway system.

RESOURCE LIMITATIONS

While data ownership and utility are obstacles preventing the development and usefulness of PMs, other restrictions also exist such as proper staffing, readily available technology, and the knowledge of where and how to obtain such data. This list is affected by the amount of funding maritime stakeholders receive.

Staffing

Properly staffed stakeholders can be key to being able to develop PMs. It can be challenging for understaffed stakeholders to manage other tasks while also trying to manage their maritime waterway systems. For example, a few state DOT interviewees would manage other aspects of transportation, in addition to managing their state's maritime system. This prevents further dedication to their state's waterways. In this regard, additional funding and/or dedicated funding will be very helpful.

Technology and Knowledge/Awareness

Besides staffing issues, resource limitations also arise from lack of technology as well as knowledge and awareness of relevant available data. Based on the information from our stakeholder interviews and survey responses, we realized that much of the data collection process by the stakeholder groups is still manually input. One state DOT interviewee stated that they manually enter collected data from surrounding ports into an Excel spreadsheet. Another port district interviewee stated that they manually enter infrastructure data into a tablet, which is later analyzed internally. Also, if the employees within these maritime stakeholders are not aware of *where* to retrieve data, *how* to retrieve it, and how to *process* it, it may also pose a problem.

Multiple state DOT interviewees stated that they only use publicly available data from USACE and some also noted that purchasing additional data (e.g., from TranSearch) can be costly. This highlights the role dedicated funding plays on this matter. Stakeholders want to seek out and obtain other sources of data apart from the typical publicly available data sources, but that is difficult when dedicated funding cannot support such expenses.

CHAPTER 5: DATABASE FRAMEWORK

PERFORMANCE AREAS AND STRATEGIC GOALS

The literature review identified performance areas, performance measures (PMs), and data sources that were used to select the components to be considered for the database. Additional PMs and data sources to be considered were identified within the stakeholder survey and phone interview results. PMs were then organized according to performance areas found in the literature review and related to the performance areas within the Illinois State Freight Plan. The Illinois State Freight Plan further relates its performance areas to the Illinois Long-Range Transportation Plan (LRTP) and national freight strategic goals, making this exercise unnecessary for the purposes of this project (IDOT, 2018a, 2018b). The prospective measures identified were then related to the relevant strategic goals within the IDOT Marine Transportation System planning process. The goal of this study was to identify and collect a set of PMs that can be related through an established upward hierarchy: IMTS Plan, Illinois State Freight Plan, the Illinois LRTP, and finally the national freight strategic goals.

PMs identified in the literature review were further organized according to data sources and availability. Public data sources for specific PMs were identified and PMs were examined for relevance to our project, utility, scale, and availability. Additionally, PMs identified in the stakeholder surveys and phone interviews were considered under the same criteria. The result was a list of measures to be examined for suitability for our project and potential for development.

The “Guiding Principles” of the Illinois Marine Transportation Plan were organized according to their relationship to the Illinois State Freight Plan Goals. This exercise was done to demonstrate that each of the IMTS Guiding Principles is aligned with the Illinois State Freight Plan and that progress towards IMTS goals supports Illinois Freight Plan goals. Additionally, system-level PMs developed for the Illinois Marine Transportation System should allow for inclusion and comparability in strategic planning for intermodal freight within the Illinois State Freight Plan.

The Illinois State Freight Plan (IDOT, 2018b) identifies the following performance goals: improve safety, improve efficiency, grow the economy, preserve existing infrastructure, expand infrastructure strategically, and support freight multimodal transportation. The Illinois Marine Transportation System Guiding Principles are aligned with the Illinois State Freight Plan goals as follows in Table 14.

PMs were considered according to their utility to IDOT in the following areas:

- Support Illinois Marine Transportation Plan objectives and goals and provide a basis for measuring Illinois Marine Transportation System performance.
- Support intermodal analysis and integrate marine transportation into the freight network.
- Provide measures and metrics to support regional and local analysis, including economic analysis, intermodal freight, infrastructure management, operations, project evaluation, leveraging funding, and other activities.

This range of purposes requires measures and metrics to be gathered at scales that reflect state- and system-level performance, and those that are useful for regional and local analysis.

Table 14. IMTS Guiding Principles Supporting Illinois State Freight Plan Goals

Illinois State Freight Plan Goals	Illinois Marine Transportation System (IMTS) Guiding Principles					
	Prioritize intermodal / multimodal assets	**Mitigate congestion**	**Increase sustainability**	**Increase system utility**	**Better leverage the overall freight transportation portfolio**	**Avoid introduction of additional burden**
Improve Safety		•		•		
Improve Efficiency		•	•	•	•	
Grow the Economy		•	•	•	•	
Preserve Existing Infrastructure			•			•
Expand Infrastructure Strategically			•	•	•	•
Support Freight Multimodal Transportation	•	•			•	•

SELECTION OF PERFORMANCE MEASURES FOR DATABASE

Overarching Approach

The identification of appropriate PMs for inclusion in the database involved three steps. Step 1 was the identification of the initial PM pool and involved casting a wide net to assemble a laundry list of relevant PMs identified in various literature sources. As discussed in the earlier sections of this report, the literature review (Step 1) produced a list of 143 PMs (Appendix A). The PMs identified were made complete with the development of appropriate metadata about their sources along with general descriptions such as definition, justification, and data description. It was agreed that these PMs needed to be whittled down to more manageable numbers. To prune down the initial pool of 143 PMs, a two-step process was adopted. In the first step, the candidate PMs were identified by considering their relevancy in federal, state, and stakeholder perspectives. This is described in the subsection "Step 2: Refinement by Federal, State, and Stakeholder Relevance." In the second step, the research team focused on data availability and suitability. This is described in "Step 3: Refinement of Candidate PMs by Data Format and Processing." At the end of the two-step process, the list of 143 PMs was distilled down to 21 PMs for inclusion in the database. The three steps are recapped below.

Step 1: Identification of Initial PM Pool

Literature Review: Overall, the literature review identified 143 PMs organized within eight performance areas. This included 25 marine PMs identified by 12 of the states reviewed. PMs related to mobility and reliability, economy, and infrastructure were the most often mentioned in the literature, with maintenance and preservation, environmental and safety, as well as security also largely mentioned (see Table 5). These measures synthesize the various sources reviewed.

Scan of State DOT Plan Documents and Phone Interviews: In the scan of the state DOTs and their strategic plan documents, the most frequent PMs mentioned were cargo tonnage through ports and other waterways as well as incident reports. This was corroborated in the state DOT phone interviews, where tonnage and commodities were most often referenced, along with USACE mentioned as a data source. Port authorities were also cited as a data source in the state DOT phone interviews.

Illinois Port Authority and Carrier Phone Interviews and Surveys: Stakeholder interviews and surveys with port authorities identified the performance areas and measures listed in Table 15.

Table 15. Data Elements Identified in Port Authority Phone Interviews

Maritime Operations	Intermodal Operations	Capital and Maintenance
Tonnage by commodity, direction from tenant reports	Number of trucks, tonnage by commodity, direction	Asset conditions from inspections
Licensing of private terminals by port authorities	Number of rail cars, tonnage by commodity, direction	
Incidents (collisions, infrastructure, equipment failures)		

Although only a sample of port authorities were interviewed, common data points included licensing data, tonnage and commodity data collected from tenants, and capital improvement programs. Two of the port districts interviewed collected the intermodal tonnage listed above, and one district collects rail only, citing a lack of resources to collect truck data. The data elements listed in Table 15 indicate a potential for developing data at the port level that could be used by IDOT for performing a wide range of regional and local analysis.

Stakeholder interviews and surveys with carriers identified the performance areas and measures listed in Table 16.

Table 16. Data Elements Identified in Carrier Phone Interviews and Surveys

Trip Data	Fleet Data	Waterway Data
Tonnage by commodity	Active vessels (AIS)	Lock delays
Trip duration and distance	Vessel condition	Lock closures
Fuel consumption	Collisions and other incidents	Infrastructure conditions
		River stages

Data elements identified by the carriers include data that they *generate* and are mandated to report to USACE, including trip and fleet data. Data *used* by the carriers include the waterway data listed in Table 16.

The results of the effort to identify data elements for the database took two main directions. The first track is pertaining to available data, in which USACE was identified as being the primary source. Economic data needed for regional and local analysis was and is available from the Department of Labor and the Department of Commerce, while USACE is the source for most of the public data available on marine transportation. The second track is for data that can be developed, some more readily than others. The main opportunities for data development for performance measurement will likely stem from IDOT partnering with port authorities to identify and develop data and from working with USACE to customize data requests to serve IDOT's needs.

Step 2: Refinement by Federal, State, and Stakeholder Relevance

Based on the review of existing literature and findings from the stakeholder interviews and surveys, we identified 143 potential PMs as candidates for inclusion into the database. Candidate PMs were evaluated against recommendations from the USACE's *Marine Transportation System Performance Measures* report. This report explored potential PMs for the marine transportation system (MTS) from a federal perspective and incorporated direct data sources, proxy data elements, and relevant performance areas. The goal of this work was to present a framework to view the MTS as an "interconnected system" as part of a "larger intermodal supply chain network" (Kress et al., 2016). Recommendations from this federal view of the MTS provided a reference from which to select a suite of PMs useful for the subset of the national system relevant to Illinois.

Also considered were the public availability of data for each potential PM that could be incorporated into the database. This step did not evaluate data formatting or any necessary processing, but rather

the general availability of each data element. Those elements that could be manually or automatically obtained from public sources, such as USACE's *Lock Performance Monitoring System* reports, were retained for further evaluation. Following these exercises, 31 PMs remained as candidates for the database, shown in Table 17.

Table 17. List of PMs Remaining Following Screening Process

Index	Candidate Performance Measure
1	Statewide waterborne tonnage
2	Tonnage by ports
3	Tonnage by commodity type
4	Tonnage direction by state
5	Tonnage direction by waterway
6	State government employment
7	Local government employment
8	Number of Jobs in Water Transportation Industries (State level—Private Sector)
9	Number of Jobs in Water Transportation Industries (County level—Private Sector)
10	Scheduled lock unavailabilities (#)
11	Scheduled lock unavailable time (hours)
12	Unscheduled lock unavailabilities (#)
13	Unscheduled lock unavailable time (hours)
14	Total vessels (#)
15	Total lockages (#)
16	Commercial vessels (#)
17	Commercial lockages
18	Average delay minutes
19	Percent of vessels delayed
20	Petroleum-based fuel use by the US maritime industry
21	Amount of Dredged Material Reclaimed for Beneficial Use
22	Marine Pollution Incidents and Discharge Volumes
23	Number of Commercial Mariner Deaths and Injuries
24	Number of Commercial Vessel Accidents
25	Number of USCG Incident Investigations
26	Physical infrastructure condition ratings
27	Producer price index
28	Illinois soy exports (in million(s) of dollars [$])
29	Federal Ship Channels at Authorized Dimensions According to USACE
30	Travel Time Reliability for Select Waterway Segments
31	Barge rates

Th results of the literature review, stakeholder interviews, and online surveys were cross-referenced for commonalities between identified PMs to understand which measures were germane to one or multiple subsets of the marine transportation system. PMs were grouped by performance area, as noted by Kress et al. (2016), and those sources from which each PM was identified were noted. The report grouped PMs into five organizational categories that are similar to those in previous studies:

- Economic benefits to the nation
- Capacity and reliability
- Safety and security
- Environmental stewardship
- Resilience

As the performance areas from that report aligned with the six most-cited areas from the literature review in Table 5 (with "Resilience" from the report combining the "Maintenance and Preservation" with "Infrastructure" areas in Table 5), these areas were retained as the guiding performance areas for the database. Table 18 illustrates this work for the remaining 31 PMs.

As a final step, the alignment of each candidate PM to IMTS guiding principles was looked at carefully. PMs were referenced in context of each guiding principle with the desire that at least one PM was identified for each principle. Most PMs supported multiple principles and were noted as such. Table 19 shows this categorization. The 31 PMs that remained as candidates for the database and were then scrutinized further are outlined in the next subsection.

Table 18. Source Citations of PMs (Categorized by Performance Area)

Performance Measure, by Performance Area (Kress et al., 2016)		Source
Economic Benefits		
1	Statewide waterborne tonnage	L S P C
2	Tonnage by ports	L S P C
3	Tonnage by commodity type	L S P C
4	Tonnage direction by state	L S P C
5	Tonnage direction by waterway	L S P C
6	State government employment	L S
7	Local government employment	L S
8	Number of Jobs in Water Transportation Industries (State level—Private Sector)	L S
9	Number of Jobs in Water Transportation Industries (County level—Private Sector)	L S
27	Producer price index	L S
28	Illinois soy exports (million(s) of dollars [$])	L
31	Barge rates	L

Performance Measure, by Performance Area (Kress et al., 2016)		Source
Safety and Security		
23	Number of Commercial Mariner Deaths and Injuries	L C
24	Number of Commercial Vessel Accidents	L S C
25	Number of USCG Incident Investigations	L S C
Environmental Stewardship		
20	Petroleum-based fuel use by the US maritime industry	L C
21	Amount of Dredged Material Reclaimed for Beneficial Use	L
22	Marine Pollution Incidents and Discharge Volumes	L
Capacity and Reliability		
10	Scheduled lock unavailabilities (#)	L S P C
11	Scheduled lock unavailable time (hrs)	L S P C
12	Unscheduled lock unavailabilities (#)	L S P C
13	Unscheduled lock unavailable time (hrs)	L S P C
14	Total vessels (#)	L S P C
15	Total lockages	L S P C
16	Commercial vessels (#)	L S P C
17	Commercial lockages	L S P C
18	Average delay minutes	L S P C
19	Percent of vessels delayed	L S P C
29	Federal Ship Channels at Authorized Dimensions According to USACE	L C
30	Travel Time Reliability for Select Waterway Segments	L C
Resilience		
26	Physical infrastructure condition ratings	L S C

Where L = Literature review; S = State DOT interviews; P = Port District interviews and surveys; and C = Carrier interviews and surveys

Table 19. PM Alignment with IMTS Guiding Principles (Illinois Marine Transportation Initiative, presented to Illinois State Freight Advisory Council, October 2018).

PMs Considered for Database	Illinois Marine Transportation System (IMTS) Guiding Principles					
	Prioritize intermodal / multimodal assets	Mitigate congestion	Increase sustainability	Increase system utility	Better leverage the Freight Transportation Portfolio	Avoid introduction of additional burden
Statewide waterborne tonnage	•		•	•	•	•
Tonnage by ports	•		•	•	•	•
Tonnage by commodity type	•		•	•	•	•
Tonnage direction by state	•		•	•	•	•
Tonnage direction by waterway	•		•	•	•	•
State government employment				•	•	
Local government employment				•	•	
Number of Jobs in Water Transportation Industries (State level—Private Sector)				•	•	
Number of Jobs in Water Transportation Industries (County level—Private Sector)				•	•	
Scheduled lock unavailabilities (#)		•		•		
Scheduled lock unavailable time (hours)		•		•		
Unscheduled lock unavailabilities (#)		•		•		
Unscheduled lock unavailable time (hours)		•		•		
Total vessels (#)		•		•		
Total lockages (#)		•		•		
Commercial vessels (#)	•	•		•	•	
Commercial lockages	•	•		•	•	
Average delay minutes		•		•		
Percent of vessels delayed		•		•		
Petroleum-based fuel use by the US maritime industry			•			•
Amount of Dredged Material Reclaimed for Beneficial Use			•			•

PMs Considered for Database	Illinois Marine Transportation System (IMTS) Guiding Principles					
	Prioritize intermodal / multimodal assets	Mitigate congestion	Increase sustainability	Increase system utility	Better leverage the Freight Transportation Portfolio	Avoid introduction of additional burden
Marine Pollution Incidents and Discharge Volumes			•			•
Number of Commercial Mariner Deaths and Injuries				•		•
Number of Commercial Vessel Accidents				•		•
Number of USCG Incident Investigations				•		•
Physical infrastructure condition ratings	•				•	
Producer price index	•				•	
Illinois soy exports (in million(s) of dollars [$])	•				•	
Federal Ship Channels at Authorized Dimensions According to USACE		•		•		
Travel Time Reliability for Select Waterway Segments		•		•		
Barge rates	•				•	

Step 3: Refinement for Inclusion in the Database by Data Format and Processing

The remaining 31 candidate PMs from Step 2 were evaluated to determine their eligibility for inclusion in the database. For this step, the evaluation algorithm presented in Figure 5 was used.

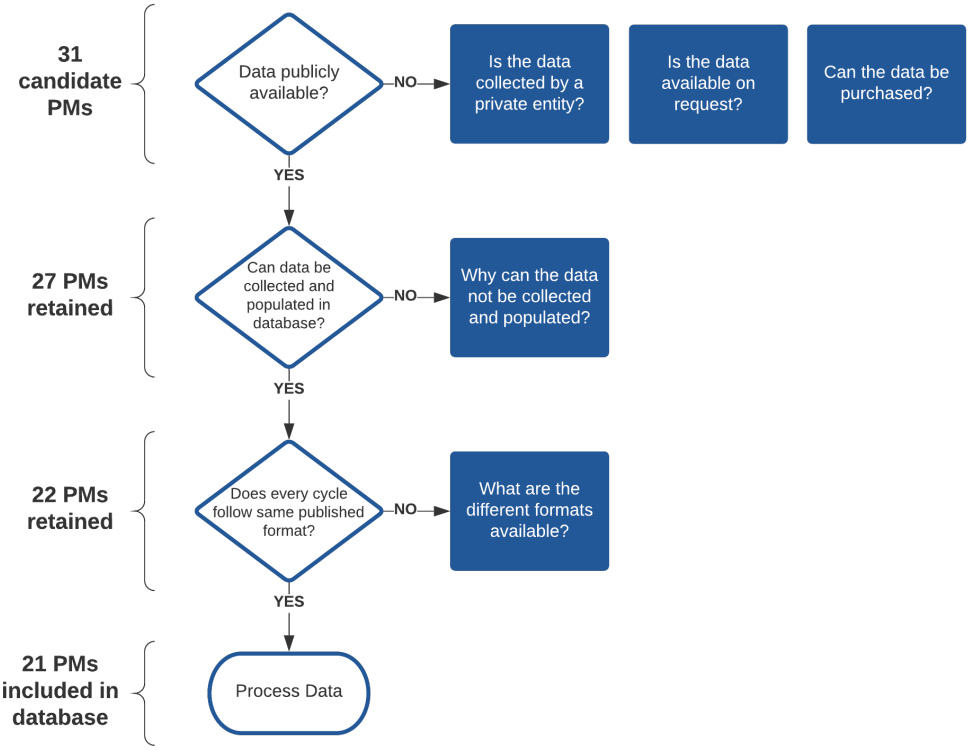


Figure 5. Decision flow chart. Evaluation algorithm for candidate PMs. Full evaluations for each PM are included in Appendix D.

The function of the algorithm was to determine suitability of a PM for inclusion in the database based on utility, spatial granularity, applicability, public availability, and the ease of retrieval of the PM from the source as well as the ease of populating the database with that PM. If a PM presented issues in one or more areas that prevented direct use, the issues were specified and any work necessary for future inclusion in the database was noted. For example, if a data element was not publicly available, ownership and request/procurement procedures were discussed, if possible. The evaluation algorithm is included in Appendix D.

Following the evaluation algorithm, candidate PMs were categorized into three groups:

1. PMs suitable for inclusion in the final database.
2. PMs eligible for inclusion in the database subject to further data processing and/or procurement.
3. PMs ineligible for inclusion due to proprietary ownership.

Category 1 PMs represent those that are readily and publicly available with no or minor processing needed for entry into the database and future updates. PMs listed in Category 2 may be included in the database following any processing steps involved with the data, procurement, or processing. Category 3 PMs were those belonging to the cluster, which was either privately collected or owned, or ownership could not be determined, and thus any additional evaluation could not be completed. At the end of Step 3, the research team had a total of 21 PMs that were ready for inclusion in the database, and these are as shown in Table 20.

Table 20. Final PMs Included in the Database, Categorized by Performance Area (Kress et al., 2016)

Economic Benefits	
1	Statewide waterborne tonnage
2	Tonnage by ports
3	Tonnage by commodity type
4	Tonnage direction by state
5	Tonnage direction by waterway
6	State government employment
7	Local government employment
8	Producer price index
9	Illinois soy exports (million(s) of dollars [$])
Capacity and Reliability	
10	Scheduled lock unavailabilities (#)
11	Scheduled lock unavailable time (hrs)
12	Unscheduled lock unavailabilities (#)
13	Unscheduled lock unavailable time (hrs)
14	Total vessels (#)
15	Total lockages
16	Commercial vessels (#)
17	Commercial lockages (#)
18	Average delay minutes
19	Percent of vessels delayed
Environmental Stewardship	
20	Petroleum-based fuel use by the US maritime industry
Resilience	
21	Physical infrastructure condition ratings from ASCE

DATABASE BUILDING

For the database building, we adopted the readily available Microsoft office tool “Microsoft Excel 365 MSO (16.0.13001.20266) 32-bit.” The following note is provided for the benefit of any user or

developer of the database regarding the features in Excel that need to be toggled on. To experience the full functionality of the database, one must enable “Macro” and “Visual Basics for Application (VBA)” in the Microsoft Excel tool. These additional functionalities are usually embedded with the standard installation package; it just needs to be enabled and does not require any additional purchasing (the step-by-step process to enable these additional functionalities is described in the “Database Update” function).

On the homepage of the database, we listed the PMs that are populated in the database and directory for other embedded essential database functions. Figure 6 presents a snapshot of the database home page.

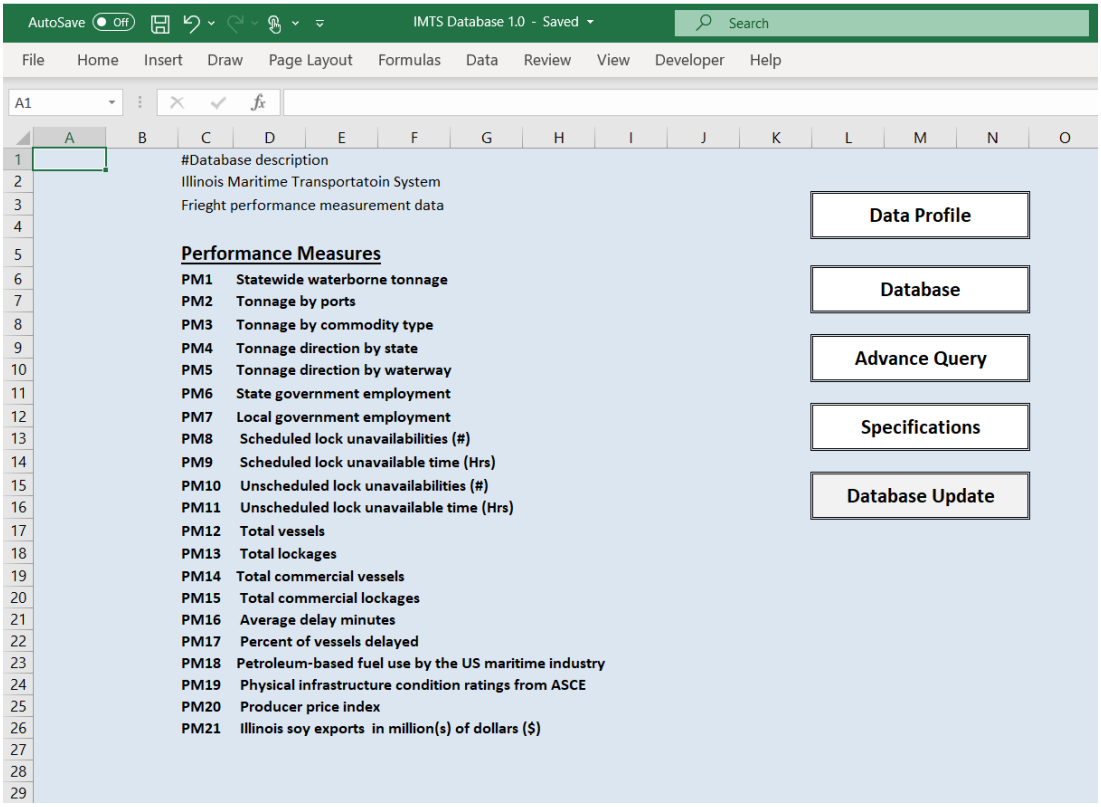


Figure 6. Image of database interface. Snapshot of the database home page.

The database home page is equipped with all the necessary options to navigate and use this database. On the right side of Figure 6, the options are visible. By clicking each of these buttons, one can go to the corresponding user options. The first option is “Data Profile,” which contains the description of each of the PMs in this database. The data profile can also be considered as the data dictionary for each of the PMs. The snapshot presented in Figure 7 shows the characteristics included in the data profile. For each PM included in the database, we populated the characteristics shown in Figure 7 in the “Data Profile.” A description for each of these characteristics can be found in the User Manual in Appendix E.

Characteristcs
PM name
Definition
Data Unit
Latest data Year
Year Collected
Source
Citation
Web Link
Update instructions: Data Cycle
Utilitity of PM
Component measures if metric? Metrics generated in combination with other measures.

Figure 7. Image of database interface. Characteristics of the data profile.

The "Database" function will direct the user to the worksheet consisting of all the PM datapoints. While populating the database, a hierarchical approach was adopted. In this approach, the name of the PM was the first level of the hierarchy, followed by the location of the entity responsible for tracking that PM and the type of functionality associated with that PM (Table 21).

Table 21. Illustrative Example of Hierarchical Levels of PM—Tonnage by Ports

Level 1	Level 2	Level 3
Tonnage by ports (in thousand tons)	1) Port of Chicago 2) Port of Kaskaskia 3) Port of St. Louis	Import Export Foreign (Import + Export) Domestic Total (Foreign + Domestic)

The following option, "Advance Query," contains several built-in customized queries to search within the database. These customized queries are based on PM, tonnage, lock and dam, and employment. In total, we have included 10 customized queries to properly navigate the database. The functionalities of each of these queries are explained in the User Manual. For example, Figure 8 provides insight into a specific query ("Tonnage by Port Query"). In this query form, one can query by port and by year. Furthermore, this sheet also includes a "General Query" option for generalized queries in the entire database.

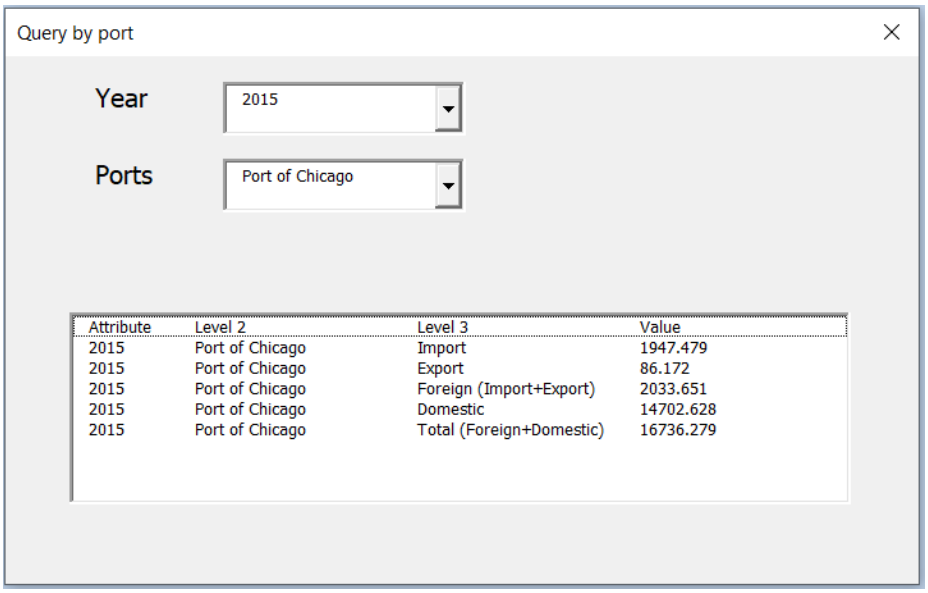


Figure 8. Image of database interface. Customized query form for query by port.

The database also has a "Specification" option that includes additional information, such as the list of 50 states along with their two- or three-letter abbreviations, 14 USACE-defined commodity types along with their ID codes, and 26 USACE-defined waterway regions along with their ID codes. The "Database Update" option is included to facilitate updating the database in the future as and when needed. For some of the PMs, considerable preprocessing is required to bring the PM under consideration into the format of the designed database. An automated preprocessing module is also included for some of the standard types of PMs that are available in general. A detailed description of this process can also be found in the User Manual.

The PMs included in the database present a significant step forward for IDOT and other stakeholders to engage in informed planning and decision-making efforts to improve IMTS. At the same time, there are some issues, challenges, and opportunities pertaining to various aspects of the database development and maintenance.

ISSUES AND OPPORTUNITIES FOR FURTHER DATABASE DEVELOPMENT

Data Sources and Issues

USACE Data Sources: Army Corps data are structured and designed around the mission of the agency to manage the waterway system infrastructure and operations and to serve the public interest with respect to supporting waterborne commerce. Notices on navigation, delays, and closures are available in real-time data feeds as well as reports on dredging and other army activities. Application programming interfaces (APIs) are available to provide data visualization and opportunities for data collection and downloading. These are all designed to serve the maritime stakeholders in one capacity or another. The Institute for Water Resources also maintains an extensive data library online, distributed across its multiple centers to support researchers and other data users. Details on USACE data and data development activities are discussed in the "Federal" subsection in Chapter 4.

USACE Data Issues: The data are not scarce. They are voluminous and specific to USACE functions, and therefore not organized in a way convenient to public access, outside of what has been designed for that purpose by the IWR. Local government agencies and other interested stakeholders seeking assistance with specific data can initiate data requests through their respective USACE district, which will then be passed upward to the appropriate IWR Center, responded to, and passed back through the hierarchy.

The following PMs were sought online and not found, but are recommended for IDOT to pursue through data requests at the USACE Rock Island district:

- **Federal ship channels at authorized dimensions according to USACE**. Channels at depth is a measure of capacity and maintenance, and it can be used as a planning tool to reflect the capacity for increased volumes. The "high-use segments" for which data are provided are the upper and lower Mississippi; the Illinois, Ohio, and Tennessee Rivers; and the Gulf Intracoastal Waterway.

- **Physical infrastructure condition ratings USACE**. Waterway infrastructure conditions impact operations, market access, and measure of the resilience of the system.

- **Amount of dredged material reclaimed for beneficial use**. This is a measure of environmental stewardship and reflects the efficiency of waterway maintenance activities.

PMs such as travel time reliability and barge rates were also examined for inclusion in the database. However, these were not included, as the samples for travel times were not specific to Illinois, and historic and current weekly barge rate data are so readily available online as to make collecting them more efficient on an as-needed basis.

The stakeholder interviews also revealed several data issues pertinent to the goals of this project and to IDOT's oversight role. These are discussed below.

USACE data issues related to Illinois Marine Transportation System interests:

- **Granularity**: USACE data are associated with physical features rather than political boundaries. Aggregating data associated with features does not necessarily capture all data within some political boundaries. Army Corp districts and waterways also do not correspond to local political boundaries.

- Port data are limited to "major ports," which for Illinois omits some port authorities and aggregates others in a way that obscures local activities. USACE reports that Illinois ports will be listed individually in the next data cycle.

- **Accuracy**: Port authorities have reported that the USACE master dock list is outdated for Illinois. This skews the tonnage and commodity data, because the data are based on reports from the listed docks.

US Coast Guard Data: The United States Coast Guard (USCG) publishes the Marine Information for Safety and Law Enforcement (MISLE) database, which reports on incidents by type, including the incident performance measures sought for the database:

- Number of commercial mariner deaths and injuries
- Number of commercial vessel accidents
- Number of USCG incident investigations
- Marine pollution incidents and discharge volumes

MISLE were collected and examined for inclusion. Location data for incidents are provided as latitude-longitude points, by USCG district and by waterway name. Additional processing of the geographic data is necessary to parse out incidents relevant to IDOT, and therefore MISLE data were not incorporated into the database. If IDOT wishes to use the MISLE data, then the GIS processing to corresponding political boundaries or waterway features could be done internally or handled as a data request to the Rock Island district. These data issues (both national and Illinois specific) are not significant enough to hamper the development of a robust database to facilitate the cause of IMTS strategic planning. The research team, through the information gathered for this project (literature review, scan of strategic documents, phone interviews, and online surveys), was able to identify a few opportunities for developing data and for analyzing those data for maritime improvement purposes.

OPPORTUNITIES FOR DATA ANALYSIS AND DATA DEVELOPMENT

Opportunities for System-level Performance Measures and Support of an Integrated Freight Network

Performance measures found in the database can be used by IDOT as system-level performance indicators for the Illinois Maritime Transportation System, as measures of an integrated freight network, and as measures of local economic activity and impacts. Specific system-level measures of the IMTS can be used to integrate waterborne freight with rail and truck modes within the Illinois State Freight Plan.

- **Waterborne tonnage** at the state level includes domestic, international, and within state shipping and receiving. This data can be used as IMTS totals or as freight mode comparisons at the state level.
- **Tonnage by commodity** includes inbound and outbound tonnage at the state and waterway levels, as well as interstate shipping and receiving to and from Illinois. These measures can be used to measure overall IMTS performance, make state-level modal comparisons, and differentiate Illinois waterways. Port-level data for major ports can also be used to show the distribution of activity along the waterways.

- **Water transportation employment** is collected for state and local government employees at the state level. These data can be used to measure the impact of waterborne freight on the Illinois economy.

- **Lock performance measures** reflect congestion and delays and the impact on commercial traffic. Infrastructure conditions and performance within IMTS determine access to markets for time-sensitive shipments and competing ports may succeed or fail based on the reliability of travel times along their routes. While individual lock performance can be tracked, lock performance at the waterway level can measure the competitiveness of IMTS for targeted markets.

- **Petroleum-based fuel use** at the state level can be used to measure the environmental impacts of waterborne freight and can serve as modal comparisons within the integrated freight network.

- **Physical infrastructure condition ratings from ASCE** reflect the overall condition of IMTS waterway infrastructure and can be used as a measure within the integrated freight network.

- **The Producer Price Index for Inland Water Freight** can be used to measure changes in the prices producers are receiving for their goods within the inland waterway system.

- **Illinois soy exports (million(s) of dollars [$])** reflect Illinois penetration of international markets, as one of the largest exporters of soy in the United States.

Port District Data Opportunities

Data collected and generated at the port level are tied to internal port management and the accuracy of data reported by USACE. There is a potential opportunity for IDOT to encourage and support the development of data within the port authorities to enhance local analysis and to validate USACE data as needed.

The following data were identified by one or more of the port authorities interviewed.

1. Commodity, tonnage, direction by vendor (monthly, annual)
2. Licensing data
3. Number of trucks, tonnage (by commodity, direction)
4. Number of rail cars, tonnage (by commodity, direction)
5. Incidents (by category, define)
6. Condition ratings based on inspections

Commodity reports from tenant and licensing data are likely to be collected by all ports. These data can be used to validate the USACE master dock list and can validate the tonnage data collected from

vessel reports. Ports that have issues with the way their data are represented within USACE should submit voluntary dock receipts to the Army Corps to offer corrections.

The numbers of truck and rail car transfers were collected by two ports and another collected rail only. These data can provide local mode splits and mode comparisons at the port or local level. The port authority collecting rail but not truck counts cited a lack of resources as the reason. There is an opportunity for IDOT to support the development of this data as part of an integrated freight plan.

All three ports collect some form of incident data, and this could be another source of local safety-related data. Additionally, two of the three ports said they were involved in improving their asset-management practices by developing inspection data. A third stated that inspection results were followed only if an issue was reported.

The data items discussed above, if developed, can be used to leverage funding and investments, assist in project prioritization, and can be used to better represent Illinois interests within the inland waterway system.

Private Sector Employment Data

Data for water transportation occupations within the private sector (related to maritime freight) was also taken into consideration during the creation of the database, but the data is only available for the year 2019. Furthermore, the 2019 data is estimated based on the responses from six semiannual panels collected over a three-year period. Therefore, we decided that populating only one year of estimated data in the database would not prove to be useful at this time, although this can be an opportunity for IDOT at a later point in time when additional data can be populated for future years. To facilitate this, we outline the characteristics associated with water transportation occupations for the private sector along with current data points in Table 22. These occupational employment statistics (OES) can be retrieved by creating customized tables within the US Bureau Labor of Statistic's Occupational Employment Statistics Query System.

Table 22. Illinois (Private Sector) OES for Water Transportation Occupations

Occupation (SOC code)	Employment	Hourly mean wage	Annual mean wage	Employment per 1,000 jobs	Location Quotient
Motorboat Mechanics and Service Technicians (493051)	400	18.44	$38,360	0.067	0.43
Sailors and Marine Oilers (535011)	730	24.57	$51,100	0.122	0.57
Captains, Mates, and Pilots of Water Vessels (535021)	1060	36.86	$76,670	0.176	0.77
Ship Engineers (535031)	110	31.04	$64,570	0.018	0.31
Bridge and Lock Tenders (536011)	300	28.88	$60,060	0.049	2.30

In addition to using the above data points (employment, hourly mean wage, annual mean wage, employment per 1,000 jobs, location quotient), short-term (2019–2021) and long-term (2018–2028) occupational projections for the listed occupations in Table 22 only became available as of 2020.

These could also be used as a benchmark for future data cycle releases and as a way for IDOT to see the possible short- and long-term growth of the maritime freight industry. Projections Central produces short- and long-term projections for all 50 states. As part of their process, they retrieve data from the Illinois Department of Employment Security. Both short- and long-term projections will be released annually starting in 2021.

CHAPTER 6: PROGRAMMATIC RECOMMENDATIONS

Following the review of existing policies and practices regarding inland waterway performance measures, data development and management, and online surveys and interviews with relevant stakeholder groups, several key recommendations were drawn to aid IDOT in their continued planning and management of IMTS. The most pertinent areas relate to establishing a data development program, championing additional funding for the IMTS, and growing relationships between port districts, private operators, and IDOT to facilitate informed decision-making. In this regard, several opportunities for IDOT to play facilitative and collaborative roles with other stakeholders are also detailed. The recommendations are clustered based on the role IDOT is expected to play in achieving the desired outcomes. Accordingly, the next sections are reflecting IDOT's role as a champion and a leader, as well as its role as a facilitator and a collaborator.

IDOT AS A CHAMPION

IDOT in its capacity as the overseer of all transportation modes in the state of Illinois is best positioned to champion strategic initiatives that will propel the growth of a mode/system. In this role as a champion/leader, it is recommended that IDOT pursue the following.

Establish a Data Development Program within IMTS

It is recommended that IDOT establish a comprehensive and continuous data development program for IMTS by identifying/creating performance measures specific to IMTS and by encouraging, supporting, and incentivizing the development of data within the Illinois Port Authorities as well as the private sector entities, such as the carriers. Data developed for IMTS can benefit IDOT, the port authorities, the shippers and carriers, as well as USACE in their planning processes and to help make the case for systemic investments in IMTS. The data that are developed will be hosted in the database from this project. Data development involves many sequential subtasks that need to be nurtured continuously. These are discussed next.

1. Establish a Data Protocol: It is strongly recommended that IDOT establish a protocol for requesting and receiving data from USACE through the Rock Island district, as described previously, in order to add to the database and to develop specific measures for IMTS. A similar protocol for requesting and receiving data for the Illinois port authorities and other IMTS stakeholders needs to be established by IDOT so that there is better communication and understanding on the part of respective constituencies regarding the requested and available information.

2. Facilitate Data Development: IDOT will also be well served by working with the various port districts to help them develop their own data for their respective jurisdictions. This will result in robust data development at all hierarchical levels of IMTS, leading to informed decision-making regarding funding, improving market share, while strategically planning for growth in the future.

3. Project Prioritization: With IDOT acting in an advisory capacity, the data development and data sharing protocol efforts could be guided to generate useful measures for IMTS in addition to supporting internal port interests and priorities. In this regard, IDOT, in conjunction with the stakeholders, can develop a template for project prioritization that is clearly understood and accepted by the relevant stakeholders. This transparency will result in strengthening advocacy efforts to request more funding for the improvement of the inland waterway system in Illinois.

Advocate for IMTS Funding

One of the most revealing findings of this project was the lack of dedicated funding, either for planning or for infrastructure improvement at the state level. The lack of dedicated personnel within state departments of transportation assigned to oversee the state maritime transportation system is a reflection of this paucity in funding. This indicates a fundamental lack of recognition about the impact of the inland waterways in states. While funding alone will not ameliorate all systemic issues uncovered through this project, it will go a long way toward establishing dedicated personnel and resources to oversee and monitor the waterway systems. Subsequently, it is recommended that IDOT explore ways to advocate for additional state- and federal-level funding that can be put toward the improvement of the Illinois maritime system. Additional funding can help IDOT provide resources in the form of technology and staffing to institute a data development program. A couple of states in the Midwest have acknowledged the importance of their maritime system through small but significant funding initiatives. In Illinois, the recently passed $45 billion capital bill (Rebuild Illinois) has dedicated $150 million towards improvement of Illinois' public ports. Another example of a state DOT that currently has obtained dedicated funding for its state maritime system is MoDOT (2019). MoDOT appropriated funds from its general revenue toward capital improvements of their public ports. While these initiatives are not the sole mechanisms for allocating dedicated funds for the improvement of the maritime system, it will behoove IDOT to explore similar mechanisms to help establish sources of dedicated funds to assure that there will be regular and guaranteed funding for its maritime system. At the same time, it is equally important to pave the way for more federal funding, if possible, to improve the inland waterway systems and to maintain them at a respectable level of service. To make that happen, the importance of the maritime system must be conveyed to the federal government by the many different stakeholders that are a part of the maritime system in the United States. Currently, there are no best practices of stakeholder involvement and engagement in a formal, structured manner that can be used as a template for Illinois. However, there are many isolated examples of various scales and size that can be used to inform a template for a robust relationship between and among IDOT and the ports and carriers in the state.

Establish Working Relationships with Ports and Carriers in the State

The intent to identify and develop appropriate metrics along with continuous and dedicated funding for the system are both important steps to understand and improve the maritime system. At the same time, abundant funding and development of metrics will be heavily dependent on streamlined communication among and between the various stakeholders that are in charge of, benefiting from, or impacted by IMTS. Published literature about the impact of communication and coordination on an industry is detailed and spans many different sectors. It is no different for the inland waterway

system and its stakeholders, which is an important finding and recommendation from this study. Bolstering communication with and between IMTS stakeholders is a foundational activity that supports other initiatives to improve the planning and function of the state's maritime system. Consistent, open dialogue between port districts and carriers will enable IDOT to better understand user perspectives, needs, and opportunities for collaboration, such as technical assistance, data development, and funding opportunities. It is also recommended that IDOT step in to take charge of the communication and coordination functionality in a manner similar to its role with other modes in the state.

In this regard, the study was able to tease out best practices from the various interviews and scans of state documents. MoDOT is an example of a state DOT taking ownership and playing an active role in fostering open communication in the industry. One of the stakeholders interviewed for this project cited the example of an entity having a close working relationship in the state of Missouri through the Missouri Ports Association (MPA), with whom the MoDOT Secretary meets regularly. Another participant in the interviews, representing a private operator, also echoed this sentiment, noting a consistent MoDOT presence with IRPT. In contrast, both of the above-referenced interview subjects observed that IDOT could seize the opportunity to increase engagement with multiple stakeholder groups in IMTS, such as the Illinois Ports Association (IPA). While the onus of leading the communication and coordination efforts invariably rests with the state department of transportation, the other players/stakeholders in the system also have a responsibility to articulate the need and do so in a manner backed by robust data and request for appropriate policy/funding interventions.

IDOT AS A FACILITATOR

These abovementioned issues require a strong, guiding hand from IDOT in a leadership role. However, full benefits of a vibrant and well-functioning inland waterway system in Illinois can be realized only when all the different stakeholders of the system understand their roles, collaborate with each other, and are participating actively toward achieving the goals of the IMTS. In this regard, IDOT has an important role as a facilitator.

Recommendations for Other Maritime Stakeholders (State DOTs, Port Districts, and Carriers)

- **State DOT Collaborative Effort to Advocate for Funding**: A joint effort by a group of state DOTs to advocate and secure federal funding for the inland waterways. Although each state DOT will have its own priorities and specific interests, and in some cases competing interests, many states share the need for a well-managed and efficiently operating inland waterway system. IDOT is an active member of the Mid-America Association of State Transportation Officials (MAASTO) and can use this membership to explore setting up a Midwest DOT collaborative to advocate and articulate the need for funding to improve the inland waterway systems in the respective states.

- **Master plan for each port district**: Promoting the development of and adoption of a master plan for each Illinois port district can provide guidance on short-, medium-, and long-term developments for the individual port districts. It was revealed in the interviews with port

districts that some had already started the process for a master plan for their respective port districts. The momentum that is seemingly being evidenced with the commissioning of the various port district master plans should not be lost or should not end up as isolated efforts. The master plan should incorporate PMs that will allow the asset owners as well as IDOT to track and measure performance as well as present areas of needed investment for all port districts. IDOT can and should explore opportunities to provide technical assistance either to help develop the master plan or provide a forum for IDOT staff to reflect on the developed plan and work alongside the ports to explore possible funding opportunities to realize the components of the plan document.

- **Streamline the process of data sharing between carriers, ports, and state DOTs**: The issue of data is central to the improvement of any system, especially a transportation system. In the case of IMTS (or the maritime system in general), the interviews shed light on a fundamental issue. The different entities that are part of the system either did not have the resources to catalogue the data that were being produced by them and their constituencies or, in some cases, did not have awareness of how to monitor the performance of their system with an eye toward presenting a data-backed request to the funding agencies for more resources. Thus, the first step is to create awareness about the importance of data and metrics to the stakeholders through a series of information campaigns.

    - *Listening sessions:* IDOT in collaboration with MARAD can conduct listening sessions to impart the necessary knowledge about data tracking and, at the same time, *provide a forum for the stakeholders to articulate the* challenges that they face to track and monitor data in their domain.

    - *Facilitate the creation of a data sharing portal:* Once there is better awareness and understanding about the importance of performance measures, the next step will be to create a streamlined data-sharing portal/process to enable carriers, ports, and state DOTs to share data in a regular, efficient, and uniform manner. This process will allow various stakeholders to benefit from data sharing, and DOTs and ports can also monitor their state's waterway system and use it to leverage additional funding based on data-driven results. This step of advocating for data tracking, monitoring, and sharing, while very important, cannot be achieved without understanding and addressing the significant challenges that lie in the path toward a statewide data portal.

    - *Guide discussions regarding sensitive issues about data sharing:* Issues such as proprietary nature of data, time sensitivity associated with data, frequency of data collection, etc., need to be agreed upon before efforts are made to stand up a full-fledged data/performance management program. Any agreed upon data/performance management program can benefit from the database developed as part of this project.

- **Establish a central repository for data access and sharing**: The efforts at improving communication and coordination can create awareness and acceptance about roles and responsibilities as it pertains to data development, tracking, and storing. At the same time, the use of a central repository in the form of an accessible and shareable database is critical to

creating and sustaining a data-driven decision-making process. The database developed for this project provides the beginnings toward the central repository. IDOT should ensure that the developed database is appropriately populated with different, relevant PMs before embarking on making it accessible in a controlled environment to the relevant stakeholders. IDOT should also institute a data-driven decision-making process to improve IMTS over the next five to ten years. It is in this context that IDOT's role as a facilitator will assume significance. IDOT will have to instill confidence on the part of the different stakeholders to believe that it will be in their best interests to be well informed and transparent about sharing data. This task, while seemingly simple, is replete with significant challenges, and it is in this context that IDOT's continuous engagement with the stakeholders in a facilitative role will lead to a data driven, well-funded Illinois Maritime System.

These recommendations were identified as the most relevant strategies IDOT may pursue in the near- and long-term to support performance-based planning of IMTS based on the information available. IDOT may expand recommendations herein with additional input from and continued interaction with relevant stakeholders. Stakeholders across maritime freight activities were contacted for interviews or surveys to supplement a literature review to best understand a cross section of the system. However, such outreach for this project was constrained by disruptions from the ongoing COVID-19 pandemic. In the future, groups may be more willing to participate in IMTS planning activities under more conventional circumstances.

REFERENCES

33 C.F.R. § 83.03. (2018). Retrieved July 16, 2019. https://www.govinfo.gov/content/pkg/CFR-2018-title33-vol1/pdf/CFR-2018-title33-vol1-chapI.pdf.

American Society of Civil Engineers (ASCE). (2013). *Testimony of Andrew H. Cairns on Behalf of the American Society of Civil Engineers before the Environment and Public Works Committee, United States Senate, on the Water Resources Development Act.* American Society of Civil Engineers. Retrieved July 15, 2019. https://www.govinfo.gov/content/pkg/CHRG-113shrg93390/html/CHRG-113shrg93390.htm.

American Society of Civil Engineers (ASCE). (2017). *2017 infrastructure report card*. Reston, VA: American Society of Civil Engineers. https://www.infrastructurereportcard.org/wp-content/uploads/2019/02/Full-2017-Report-Card-FINAL.pdf.

Baroud, H., & Barker, K. (2018). A Bayesian kernel approach to modeling resilience-based network component importance. *Reliability Engineering & System Safety*, *170*, 10–19.

Baroud, H., Barker, K., & Ramirez-Marquez, J. E. (2014). Importance measures for inland waterway network resilience. *Transportation Research Part E: Logistics and Transportation Review*, *62*, 55–67.

Beuthe, M., Jourquin, B., Geerts, J. F., & à Ndjang'Ha, C. K. (2001). Freight transportation demand elasticities: A geographic multimodal transportation network analysis. *Transportation Research Part E: Logistics and Transportation Review*, *37*(4), 253–266.

Cambridge Systematics, Inc. (2011). *TxDOT waterborne freight corridor study. Task 3: Waterborne freight performance measures*. Texas Department of Transportation. http://ftp.dot.state.tx.us /pub/txdotinfo/library/reports/gov/tpp/spr/waterborne/waterborne_phase2.pdf.

Cambridge Systematics, Inc. (2017a). *North Carolina statewide multimodal freight plan final report*, North Carolina Department of Transportation. https://connect.ncdot.gov/projects/planning /Statewide-Freight-Plan/Documents/NCDOT_SWFrtPln_FinalReport_180209.pdf.

Cambridge Systematics, Inc. (2017b). Arkansas State Freight Plan, Arkansas Department of Transportation, AR. Retrieved June 19, 2020. https://www.arkansashighways.com/Trans_Plan _Policy/freight_plan/ArkansasStateFreightPlan_20171204.pdf.

Camp, J. S., LeBoeuf, E. J., & Abkowitz, M. D. (2010). Application of an enhanced spill management information system to inland waterways. *Journal of Hazardous Materials*, *175*(1–3), 583–592.

Carrera-Gómez, G., Coto-Millán, P., Doménech, J. L., Inglada, V., González, M. A. P., & Castanedo-Galán, J. (2006). The ecological footprint of ports: A sustainability indicator. *Transportation Research Record*, *1963*(1), 71–75.

CDM Smith Inc. (2018). *Louisiana Freight Mobility Plan*. Louisiana Department of Transportation and Development. http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Multimodal/Misc_Documents /Louisiana%20Freight%20Mobility%20Plan%2004-09-18%20FINAL.PRINT%20EDITION.pdf

Department for Transport. (2019). *Maritime 2050—Navigating the future*. Retrieved July 15, 2019. https://assets.publishing.service.gov.uk/government/uploads/system/up loads/attachment_data /file/773178/maritime-2050.pdf

Easley, R., Nicole, K., Keith, K., Daniel, S., & Janie, T. (2017). *Freight performance measure primer* (Report No. FHWA-HOP-16-089). U.S. Department of Transportation, Federal Highway Administration. https://ops.fhwa.dot.gov/publications/fhwahop16089/fhwahop16089.pdf

Farazi, N. P., Zou, B., & Sriraj, P. S. (2020). Do Inland Waterway Freight Transportation Systems Need a Performance Measurement System? A Scan of State DOT Practices in the US. *Transportation Research Record.* (Under review).

Federal Highway Administration (FHWA). (2018). *Freight management and operations*, *guidance on state freight plans and state freight advisory committees*. Retrieved July 15, 2019. https://ops.fhwa.dot.gov/freight/freight_analysis/state_info/index.htm

Florida Department of Transportation (FDOT). (2017). *The FDOT Source Book*. Forecasting and Trends Office. http://www.fdot.gov/planning/FTO/mobility/2017source-book.pdf

Folga, S., Allison, T., Seda-Sanabria, Y., Matheu, E., Milam, T., Ryan, R., & Peerenboom, J. (2009). A systems-level methodology for the analysis of inland waterway infrastructure disruptions. *Journal of Transportation Security*, *2*(4), 121.

Ginsburg, R., & Dirks, L. (2017). *An analysis of the Illinois maritime transportation system*. Report prepared for the Illinois Department of Transportation. https://utc.uic.edu/research/an-analysis-of-the-illinois-maritime-transportation-system

Grossardt, T., L. Bray, & Burton, M. (2014). *Inland navigation in the United States: An evaluation of economic impacts and the potential effects of infrastructure investment.* National Waterways Foundation. http://www.nationalwaterwaysfoundation.org/documents /INLANDNAVIGATIONINTHEUSDECEMBER2014.pdf

Hosseini, S., & Barker, K. (2016). Modeling infrastructure resilience using Bayesian networks: A case study of inland waterway ports. *Computers & Industrial Engineering*, *93*, 252–266.

Illinois Department of Transportation (IDOT). (2018a). *Long range transportation plan*. Retrieved July 15, 2019. https://www.idot.illinois.gov/Assets/uploads/files/About-IDOT/Misc/Draft_LRTP.pdf

Illinois Department of Transportation (IDOT). (2018b). *Illinois state freight plan*. Retrieved July 30, 2020. http://www.idot.illinois.gov/Assets/uploads/files/Transportation-System/Reports/OP%26P /ILFreightPlan_FINAL.pdf

Illinois Department of Transportation (IDOT). (2020). *Illinois marine transportation system plan and economic impact analysis (Draft).* Retrieved November 30, 2020. http://idot.illinois.gov/Assets /uploads/files/Transportation-System/Reports/OP&P/Marine/IMTS_Plan_Full_Report_ November2020_Draft.pdf

InCom Working Group 111. (2010). *Performance indicators for inland waterways transport: User guideline* (Report No. 111 – 2010). PIANC. https://www.pianc.org/publications/inland-navigation-commission/performance-indicators-for-inland-waterways-transport-user-guideline

Iowa Department of Transportation. (2016). *Iowa state freight plan*. Retrieved June 19, 2020. https://iowadot.gov/iowainmotion/files/Iowa_State_Freight_Plan_FINAL.pdf

Kentucky Transportation Cabinet. (2017). *Kentucky freight plan*. Retrieved June 19, 2020.

https://transportation.ky.gov/MultimodalFreight/Documents/2017%20Kentucky%20Freight%20Plan/2017%20Kentucky%20Freight%20Plan%2012-4-2017.pdf

Kress, M. M., Mitchell, K. N., DiJoseph, P. K., Rainey, J. S., Chambers, M., Hsieh, J., & Lillycrop, W. J. (2016). *Marine transportation system performance measures research.* US Army Corps of Engineers. https://usace.contentdm.oclc.org/digital/collection/p266001coll1/id/3719/

Kruse, C. J., Protopapas, A., Olsen, L. E., & Bierling, D. (2007). *A modal comparison of freight transportation effects on the general public*. Texas Transportation Institute, Texas A&M University, College Station. https://rosap.ntl.bts.gov/view/dot/5800

Kruse, C. J., Protopapas, A., Ahmedov, Z., Wu, B., McCarl, X., & Mjelde, J. (2011). *America's locks & dams: "A ticking time bomb for agriculture?"* Center for Ports and Waterways, Texas Transportation Institute, Houston, Texas. https://www.unitedsoybean.org/wp-content/uploads/Americas_Locks_And_Dams.pdf

Kruse, C. J., Protopapas, A., Ellis, D. R., & Norboge, N. D. (2014). New approaches for lock and dam maintenance funding. *Transportation Research Record*, *2409*(1), 26–30.

Maraš, V. (2008). Determining optimal transport routes of inland waterway container ships. *Transportation Research Record*, *2062*(1), 50–58.

Martin, P. H., LeBoeuf, E. J., Daniel, E. B., Dobbins, J. P., & Abkowitz, M. D. (2004). Development of a GIS-based spill management information system. *Journal of Hazardous Materials*, *112*(3), 239–252.

Maryland Department of Transportation. (2017). *2017 Maryland strategic goods movement plan*. http://www.mdot.maryland.gov/newMDOT/Freight/Documents/2018/Strategic_Goods_Movement_Plan_2017.pdf

McMullen, B. S., & Monsere, C. M. (2010) *Freight performance measures: Approach analysis. Final Report* (FHWA-OR-RD-10-18). Oregon Department of Transportation. https://www.oregon.gov/ODOT/Programs/ResearchDocuments/Freight_Performance_Measures.pdf

Minnesota Department of Transportation (MnDOT). (2018). *Minnesota go statewide freight system and investment plan*. https://www.dot.state.mn.us/planning/freightplan/pdf/statewidefreightplanrevised2018.pdf.

Mississippi Department of Transportation. (2017). *Mississippi statewide freight plan final report*. https://mdot.ms.gov/documents/Planning/Plan/MS%20Freight%20Plan/MS%20Freight%20Plan%202019.pdf

Missouri Department of Transportation (MoDOT). (2019). *Waterways overview FY20*. Retrieved March 3, 2020. https://www.modot.org/sites/default/files/documents/Waterways%20Overview%20FY20_0.pdf

National Academies of Sciences, Engineering, and Medicine (NASEM). (2011). *Performance measures for freight transportation*. Washington, D.C. The National Academies Press. https://doi.org/10.17226/14520

National Research Council (NRC). (2013). *Corps of engineers water resources infrastructure: Deterioration, investment, or divestment?* The National Academies Press. https://doi.org/10.17226/13508

National Research Council (NRC). (2015). *Funding and managing the US inland waterways system: What policy makers need to know*. The National Academies Press. https://doi.org/10.17226/21763

Nelson, J. (2014). *Measures vs metrics for marketing*. Retrieved July 15, 2019 https://www.linkedin.com/pulse/20140501043526-439374-measures-vs-metrics-for-marketing

NEWADA Duo. (2014). *Set of performance indicators and common minimum level of service for waterway management on the Danube final report.* South East Europe Transitional Cooperative Program.

Pant, R., Barker, K., Grant, F. H., & Landers, T. L. (2011). Interdependent impacts of inoperability at multi-modal transportation container terminals. *Transportation Research Part E: Logistics and Transportation Review*, *47*(5), 722–737.

Platz, T. E. (2009). *The efficient integration of inland shipping into continental intermodal transport chains. Measures and decisive factors* (Report No. T2009/7). Netherlands TRAIL Research School. https://trid.trb.org/view/901194

Posset, M., Pfliegl, R., & Zich, A. (2009). An integrated set of indicators for assessment of inland waterway transportation performance. *Transportation Research Record*, *2100*(1), 86–93.

Rempel, G., Baumgartner, T., & Montufar, J. (2011). Data collection methodology for container truck traffic in inland port cities. *Transportation Research Record*, *2246*(1), 111–120.

Rhode Island Department of Administration. (2017). *Freight and goods movement plan*. Division of Planning. http://www.planning.ri.gov/documents/trans/freight/freight-plan.pdf

Rohács, J., & Simongati, G. (2007). The role of inland waterway navigation in a sustainable transport system. *Transport*, *22*(3), 148–153.

Seguí, X., Puig, M., Quintieri, E., Wooldridge, C., & Darbra, R. M. (2016). New environmental performance baseline for inland ports: A benchmark for the European inland port sector. *Environmental Science & Policy*, *58*, 29–40.

Sriraj, P. S., Ginsburg, R., & Brown, I. (2015). *Development performance measures for the Illinois maritime freight transportation system*. Report prepared for the Illinois Department of Transportation. https://utc.uic.edu/wp-content/uploads/Full-Report-Maritime-PM-Final-Draft-51915-1.pdf

Texas Department of Transportation. (2018). *Texas freight mobility plan 2017*. https://ftp.dot.state.tx.us/pub/txdot/move-texas-freight/studies/freight-mobility/2017/plan.pdf.

The Tioga Group, Inc. (2010). *Improving marine container terminal productivity: Development of productivity measures, proposed sources of data, and initial collection of data from proposed sources*. Cargo Handling Cooperative Program. http://tiogagroup.com/docs/Tioga_CHCP _Productivity_Report.pdf

Transport for London. (2007). *London freight plan, sustainable freight distribution: A plan for London*. http://www.bestufs.net/download/NewsEvents/articles/London-Freight-Plan_07.pdf

Transportation Research Board. (2004). *The marine transportation system and the federal role:*

Measuring performance, targeting improvement (Special Report 279). The National Academies Press. https://doi.org/10.17226/10890

US Army Corps of Engineers (USACE). (n.d.[a]). *Kaskaskia River lock and dam information sheet.* St. Louis District. Retrieved July 30, 2020. https://www.mvs.usace.army.mil/portals/54/docs/recreation/rivers/navfactsheets/kaskaskia%20river%20lock%20and%20dam.pdf

US Army Corps of Engineers (USACE). (n.d.[b]). *Locks and dams 52 and 53*. Louisville District. Retrieved July 30, 2020. https://www.lrl.usace.army.mil/Missions/Civil-Works/Navigation/Locks-and-Dams/Locks-and-Dams-52-and-53

US Army Corps of Engineers (USACE). (n.d.[c]). *Olmsted locks and dam*. Louisville District. Retrieved July 30, 2020. https://www.lrl.usace.army.mil/Missions/Civil-Works/Navigation/Locks-and-Dams/Olmsted-Locks-and-Dam/

US Army Corps of Engineers (USACE). (n.d.[d]). *Smithland locks and dam*. Louisville District. Retrieved July 30, 2020. https://www.lrl.usace.army.mil/Missions/Civil-Works/Navigation/Locks-and-Dams/Smithland-Locks-and-Dam.

US Army Corps of Engineers (USACE). (2017). *The U.S. waterway system 2016 transportation facts & information.* Navigation and Civil Works Decision Support Center. Retrieved June 18, 2020. https://usace.contentdm.oclc.org/digital/collection/p16021coll2/id/1829

US Army Corps of Engineers (USACE). (2018a). *Illinois waterway locks & dams.* Mississippi Valley Division. Retrieved July 30, 2020. https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll11/id/2968

US Army Corps of Engineers (USACE). (2018b). *Upper Mississippi River locks & dams.* Mississippi Valley Division. Retrieved July 30, 2020. https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll11/id/3033

US Army Corps of Engineers (USACE). (2018c). *Waterborne tonnage for principal U.S. ports and all 50 states and U.S. territories; Waterborne tonnages for domestic, foreign, imports, exports and intra-state waterborne traffic.* Institute for Water Resources, Waterborne Commerce Statistics Center. https://usace.contentdm.oclc.org/digital/collection/p16021coll2/id/1492

US Army Corps of Engineers (USACE). (2019a). *Inland waterway navigation: Value to the nation*. Retrieved July 15, 2019. https://www.mvp.usace.army.mil/Portals/57/docs/Navigation/InlandWaterways-Value.pdf

US Army Corps of Engineers (USACE). (2019b). *Draft environmental assessment for north pier repairs of the Chicago Lock.* Chicago District. Retrieved July 30, 2020. https://www.lrc.usace.army.mil/Portals/36/docs/projects/Chicago%20Harbor%20and%20Lock/EnvironmentalAssessment_ChicagoLockNorthPierRepairs_2019-02-06.pdf

United Nations Conference on Trade and Development. (1976). *Port performance indicators* (TD/B/C.4/131/Supp.1/Rev.1). United Nations Conference on Trade and Development, New York.

US Coast Guard. (2009). *US Coast Guard: America's Maritime Guardian*. US Coast Guard. https://www.hsdl.org/?view&did=36536

US Committee on the Marine Transportation System (US CMTS). (2011). *Strategic Action Plan for Research and Development in the Marine Transportation System*. Retrieved July 15, 2019. https://www.cmts.gov/downloads/CMTS_RD_StrategicActionPlanMTS_%20Jan2011.pdf

US Committee on the Marine Transportation System (US CMTS). (2015). Research and Development Integrated Action Team. *Marine Transportation System Performance Measures: Executive Summary.* Washington, DC.

US Committee on the Marine Transportation System (US CMTS). (2017) *Strategic Action Plan for Research and Development in the Marine Transportation System.* Washington, DC. https://www.hsdl.org/?abstract&did=803190

US Department of Transportation (USDOT). (2017). *America's Marine Highway Program*. Retrieved September 10, 2017. https://www.marad.dot.gov/ships-and-shipping/dot-maritime-administration-americasmarine-highway-program/

Vidan, P., Kasum, J., & Joliæ, N. (2010). A proposal for the models and measures of search and rescue on inland waterways. *Transport*, *25*(2), 178–185.

Washington State Department of Transportation. (2017). *2017 Washington State Freight System Plan*. https://www.wsdot.wa.gov/publications/fulltext/freight/Freight-Plan-2017SystemPlan.pdf

Wilson, W. W. (2006). Vessel, firm, and lock efficiency measures in lock performance. *Transportation Research Record*, *1963*(1), 1–8.

Wisconsin Department of Transportation (WisDOT). (2018). *Wisconsin State Freight Plan*. Wisconsin Department of Transportation. https://wisconsindot.gov/Documents/projects/sfp/plan.pdf

APPENDIX A: LIST OF PERFORMANCE MEASURES

Table 23. Performance Measures with Their Sources

Category	Index	Measures	OR[1]	TX[2]	MD[3]	IA[4]	WA[5]	London[6]	TRB'09[7]	FHWA[8]	PIANC[9]	USACE[10]	CMTS[11]	WH OMB[12]
Safety	1:1	Number of commercial mariner and passenger casualties									✓	✓	✓	
	1:2	Number of commercial vessel accidents										✓	✓	
	1:3	Number of U.S. Coast Guard incident investigations										✓	✓	
	1:4	Number of thefts in freight vehicles						✓			✓			
	1:5	Access control to inland waterway system									✓			
Maintenance and Preservation	2:1	Acres of land available for future maritime industrial use		✓										
	2:2	Number of rail miles abandoned		✓										
	2:3	Dollars spent on freight marketing and education to the general public		✓										
	2:4	Cubic yards of sediment dredged/projected		✓										
	2:5	Age of federally owned and operated navigation locks (Number of federally owned and operated navigation locks opened per decade)										✓	✓	
	2:6	Placement capacity remaining for harbor dredged material			✓									
	2:7	Placement capacity remaining for bay dredged material			✓									
	2:8	Physical condition ratings of critical coastal navigation infrastructure										✓	✓	
	2:9	Availability of container-handling capability (Bulk transfer capability of ports)								✓				
Mobility, Reliability, or Congestion	3:1	TEUs passing through key ports (throughput)	✓	✓			✓			✓				
	3:2	Foreign cargo tonnage			✓									
	3:3	Tons of traffic arriving at key ports by barge in a given time period	✓											
	3:4	Tons of traffic shipping in and out by barge				✓								
	3:5	Total number of navigation lock closures										✓	✓	
	3:6	Hours of navigation lock closures										✓	✓	
	3:7	High tonnage channels with NOAA PORTS instrumentation										✓	✓	
	3:8	Travel time estimates for key waterway segments										✓	✓	
	3:9	Shippers within 50 miles of river port	✓											

Category	Index	Measures	OR[1]	TX[2]	MD[3]	IA[4]	WA[5]	London[6]	TRB'09[7]	FHWA[8]	PIANC[9]	USACE[10]	CMTS[11]	WH OMB[12]
	3:10	Total stops of navigation on a specific waterway section measured in days		✓										
	3:11	Total navigable days per year within a maritime corridor		✓										
	3:12	Frequency of lock closures (for a specific time period)										✓	✓	
Environmental	4:1	Fuel consumption						✓			✓			
	4:2	Discharge of emission (air)						✓			✓			
	4:3	Emission noise									✓			
	4:4	Water quality									✓			
	4:5	Construction and maintenance									✓			
	4:6	Discharge of waste and ballast water by tones		✓										
	4:7	U.S. petroleum-based fuel sales to the maritime industry (diesel fuel, residual fuel)										✓	✓	
	4:8	Vessel pollution incidents (petroleum and other types)										✓	✓	
	4:9	Amount of dredged material reclaimed for beneficial use										✓	✓	
	4:10	Number of reported whale strikes by vessels										✓	✓	
Economic Development	5:1	Regional and local development									✓			
	5:2	Total tonnage of international trade										✓	✓	
	5:3	Total value of international trade										✓	✓	
	5:4	Total tons of freight moving on the waterway		✓										
	5:5	Total value of freight moving on the waterway		✓										
	5:6	Income of Harbor Maintenance Trust Funds										✓	✓	
	5:7	Disbursement of Harbor Maintenance Trust Funds										✓	✓	
	5:8	Income of Inland Waterways Trust Funds										✓	✓	
	5:9	Disbursement of Inland Waterways Trust Funds										✓	✓	
	5:10	Producer Price Index (PPI) for marine transportation industries										✓	✓	
	5:11	Inland waterway shipping barge freight rates (weekly)										✓	✓	
	5:12	Physical condition ratings of critical coastal navigation infrastructure										✓	✓	
	5:13	Age of federally owned and operated navigation locks										✓	✓	

Category	Index	Measures	OR[1]	TX[2]	MD[3]	IA[4]	WA[5]	London[6]	TRB'09[7]	FHWA[8]	PIANC[9]	USACE[10]	CMTS[11]	WH OMB[12]
	5:14	Quantity of direct employment (number of jobs) generated by inland waterway navigation with reference to a certain time period		✓					✓					
	5:15	Quantity of indirect employment (number of jobs) generated by inland waterway navigation with reference to a certain time period		✓					✓					
	5:16	Number of employees in inland navigation in a certain region in a certain time period							✓					
	5:17	Tons of traffic arriving at key ports by barge in a given time period	✓											
Infrastructure	6:1	Availability of locks									✓			
	6:2	Total availability for service of a lock									✓			
	6:3	Total stop of lockage									✓			
	6:4	Lock utilization									✓			
	6:5	Availability of core waterway infrastructure									✓			
	6:6	Capacity of waterway section									✓			
	6:7	Dredging/maintenance of waterway									✓			
	6:8	Handling capacity									✓			
	6:9	Storage capacity utilization									✓			
	6:10	Waiting time for service									✓			
	6:11	Utilization of handling capacity									✓			
	6:12	Maintenance, service, and operating supplies									✓			
	6:13	Capacity									✓			
	6:14	Cargo transport									✓			
	6:15	Passenger traffic									✓			
	6:16	Perceived quality/user satisfaction with cargo and passenger transport									✓			
	6:17	Miles of waterway with unsuitable channel width		✓										
	6:18	Miles of the waterway with unsuitable channel depth		✓										
	6:19	Miles of the waterway with difficult turns and one-way zones		✓										
	6:20	Number of locations to park a barge along the coast line (mooring structures)		✓										
	6:21	Number of lockage		✓										

Category	Index	Measures	OR[1]	TX[2]	MD[3]	IA[4]	WA[5]	London[6]	TRB'09[7]	FHWA[8]	PIANC[9]	USACE[10]	CMTS[11]	WH OMB[12]
	6:22	The amount of operating projects (dams, levees, channels, flood gates, etc.)												✓
	6:23	Port capacity					✓							
Information and Communication Technology	7:1	Frequency of updating electronic fairway charts									✓			
	7:2	Accuracy of electronic fairway charts									✓			
	7:3	Availability of electronic fairway information									✓			
	7:4	Availability of electronic reporting and port information systems									✓			
Customer Service	8:1	Dollars spent on freight marketing and education to the general public		✓										

Note: Grey-shaded cells indicate that these performance metrics are collected from secondary sources or no detail description is found in the source.

Source:

1. McMullen, B.S. & C.M., Monsere. (2010) *Freight Performance Measures: Approach Analysis. Final Report.* Oregon Department of Transportation, Salem, OR. https://www.oregon.gov/ODOT/Programs/ResearchDocuments/Freight_Performance_Measures.pdf Accessed July 15, 2019.
2. Cambridge Systematics, Inc. (2011). *TxDOT waterborne freight corridor study. Task 3: Waterborne freight performance measures*. Texas Department of Transportation. http://ftp.dot.state.tx.us/pub/txdotinfo/library/reports/gov/tpp/spr/waterborne/waterborne_phase2.pdf Accessed July 15, 2019.
3. Maryland Department of Transportation. (2017). *2017 Maryland Strategic Goods Movement Plan,* MD. http://www.mdot.maryland.gov/newMDOT/Freight/Documents/2018/Strategic_Goods_Movement_Plan_2017.pdf Accessed June 19, 2020.
4. Iowa Department of Transportation. (2016). *Iowa State Freight Plan*, IA. https://iowadot.gov/iowainmotion/files/Iowa_State_Freight_Plan_FINAL.pdf Accessed June 19, 2020
5. Washington State Department of Transportation. (2017). *2017 Washington State Freight System Plan*, WA. https://www.wsdot.wa.gov/publications/fulltext/freight/Freight-Plan-2017SystemPlan.pdf Accessed June 19, 2020.
6. Transport for London. (2007). *London Freight Plan, sustainable freight distribution: a plan for London*. http://www.bestufs.net/download/NewsEvents/articles/London-Freight-Plan_07.pdf Accessed July 15, 2019.
7. Posset, M., Pfliegl, R., & Zich, A. (2009). An Integrated Set of Indicators for Assessment of Inland Waterway Transportation Performance. *Transportation research record*, *2100*(1), 86–93.
8. Easley, R., K. Nicole, K. Keith, S. Daniel, & T. Janie. (2017) *Freight Performance Measure Primer* (Report No. FHWA-HOP-16-089). U.S. Department of Transportation, Federal Highway Administration, Washington, D.C. https://ops.fhwa.dot.gov/publications/fhwahop16089/fhwahop16089.pdf Accessed July 15, 2019
9. InCom Working Group 111. (2010). *Performance Indicators for Inland Waterways Transport: User Guideline* (Report No. 111 – 2010). PIANC. https://www.pianc.org/publications/inland-navigation-commission/performance-indicators-for-inland-waterways-transport-user-guideline Accessed on June 18, 2020.
10. Kress, M.M., K.N. Mitchell, P.K. DiJoseph, J.S. Rainey, M. Chambers, J. Hsieh, & W.J. Lillycrop. (2016). *Marine Transportation System Performance Measures Research.* US Army Corps of Engineers, Washington, D.C. https://usace.contentdm.oclc.org/digital/collection/p266001coll1/id/3719/ Accessed July 15, 2019.
11. US Committee on the Marine Transportation System. (2015). Research and Development Integrated Action Team. *Marine Transportation System Performance Measures: Executive Summary.* Washington, D.C., 2015. www.cmts.gov Accessed July 15, 2019.
12. The White House, Office of Management and Budget. ((Cited in Cambridge Systematics, Inc., 2011. TxDOT waterborne freight corridor study)

Table 24. Performance Metric with Their Sources

Category	Index	Metric	OR[1]	FL[2]	TX[3]	MD[4]	IA[5]	NJ[6]	MN[7]	London[8]	TRB'09[9]	The Tioga Group, 2010[10]	FHWA[11]	PIANC[12]	WH OMB[13]
Safety	1:1	Value of cargo lost or damaged in a port per total value of cargo handled in that port in a specific time period	✓										✓		
	1:2	Number of containers lost or damaged in a port per total containers handled in a port in a specific time period	✓										✓		
	1:3	Vessel-to-vessel collisions in a specific channel or port in a specific time period (Expressed as percentage of total collisions)			✓										
	1:4	Vessel-to-fixed object collisions in a specific channel or port in a specific time period (Expressed as percentage of total collisions)			✓										
	1:5	Percentage of port containers inspected annually			✓								✓		
	1:6	Economic Impact of accidents												✓	
	1:7	Port compliance with Maritime Transportation Security Act of 2002				✓									
	1:8	Hazardous spills (Volume/tones) by water modes/hazmat carried by water in a specific time period (Expressed as a percentage of total hazmat carried that is spilled)			✓										
Maintenance and Preservation	2:1	Average maintenance costs of fleet and vehicles per ton – kilometer (tkm) (Expressed in comparison with default value)									✓				
	2:2	Average maintenance cost per lock, per month			✓										
	2:3	Percentage of river tonnage moving through locks with constraints (delays)	✓										✓		
	2:4	Unscheduled lock closure time for maintenance in a given time period (Expressed as percentage of total lock closure time)	✓										✓		
	2:5	Ratio of channel depth of a particular port with the average depth of other competitive ports	✓										✓		

Category	Index	Metric	OR[1]	FL[2]	TX[3]	MD[4]	IA[5]	NJ[6]	MN[7]	London[8]	TRB'09[9]	The Tioga Group, 2010[10]	FHWA[11]	PIANC[12]	WH OMB[13]
	2:6	Percentage of port containers inspected annually			✓										
	2:7	Average age of waterway infrastructure assets			✓										
	2:8	Average age of cranes and other major cargo handling assets			✓										
	2:9	Annual average increase in acreage of developed properties along navigable waterways			✓										
Mobility, congestion and reliability	3:1	Freight mode share by value (for a specific time period)							✓						
	3:2	Freight mode share by weight (for a specific time period)							✓						
	3:3	Average truck turn time (for a specific time period)	✓		✓	✓							✓		
	3:4	Average ship unloading rate (for a specific time period)	✓		✓								✓		
	3:5	Average ship loading rate (for a specific time period)	✓		✓								✓		
	3:6	Average delay per barge tow (for a specific time period)	✓										✓		
	3:7	Average vessel delays at a lock (for a specific time period)			✓										
	3:8	Average container dwell time (for a specific time period)			✓										
	3:9	Average time in transit per barge tow (for a specific time period)			✓										
	3:10	Annual average TEUs per Crane			✓							✓			
	3:11	Average port handling capacity per quay meter			✓										
	3:12	Average port handling capacity per truck loading bay			✓										
	3:13	Percentage of sea ports with active rail access		✓											
	3:14	Average delay of rail movement on port access tracks in a specific time period			✓										
	3:15	Average ship travel time in bottleneck areas (for a specific time period)			✓										
	3:16	Degree of executed transports as contractual agreed compared to previous years									✓				

Category	Index	Metric	OR[1]	FL[2]	TX[3]	MD[4]	IA[5]	NJ[6]	MN[7]	London[8]	TRB'09[9]	The Tioga Group, 2010[10]	FHWA[11]	PIANC[12]	WH OMB[13]
	3:17	Annual average TEU per Slot										✓			
	3:18	Vessel size ratio (Ratio of average vessel size handled by a port in a given time period and the maximum possible vessel size that can be handled by that port)										✓			
	3:19	Annual average TEU per gross terminal or port acre													
	3:20	Annual average TEU per container yard acre										✓			
	3:21	Annual average TEU per Berth										✓			
	3:22	The success of time and mode shift strategies (amount of cargo shifted to off-peak movements and from trucks to alternative rail or barge modes that are sustainable for an extended period)						✓							
	3:23	Congestion/port-related truck volumes on key access routes connecting port facilities and customers						✓							
	3:24	Congestion/port-related volumes on key rail freight routes connecting port facilities and customers						✓							
	3:25	Journey time reliability								✓					
Environmental	4:1	Pounds of greenhouse gas (GHG) emissions per tons moved (in a given time period)	✓		✓										
	4:2	Average evaporative emissions by a ship in transit (for a given time period)			✓										
	4:3	Mitigation Compliance													✓
	4:4	Hazardous spills (Volume/tones) by water modes/hazmat carried by water in a specific time period (Expressed as a percentage of total hazmat carried that is spilled)			✓										
Economic Development	5:1	Economic impact of passenger and cargo transport													
	5:2	Ratio of imports/exports (for a given time period)			✓										
	5:3	Logistics cost as percentage of state GDP			✓										
	5:4	Annual average TEU per berth										✓			

Category	Index	Metric	OR[1]	FL[2]	TX[3]	MD[4]	IA[5]	NJ[6]	MN[7]	London[8]	TRB'09[9]	The Tioga Group, 2010[10]	FHWA[11]	PIANC[12]	WH OMB[13]
	5:5	Total value of key industries income generated			✓										
	5:6	Average cost of freight movement in a specific waterway channel in a time period							✓						
	5:7	Average transit time of freight in key national modal corridors in a time period							✓						
	5:8	Operating expenses per general cargo tonnage (for a given time period)				✓									
	5:9	Ratio of operating expenses to revenue (for a given time period)				✓									
	5:10	Inland waterway transport volume compared to Gross Domestic Product (GDP)												✓	
Infrastructure	6:1	Ratio of channel depth of a particular port with the average depth of other competitive ports	✓												
	6:2	Average maintenance costs of fleet and vehicles per ton – kilometer (tkm) (Expressed in comparison with default value)									✓				
	6:3	Port compliance with Maritime Transportation Security Act of 2002				✓									
Information and communication technology	7:1	The percent of time that high commercial traffic-navigation channels are available to commercial users													✓
	7:2	Waterway length covered with AIS shore side equipment (Expressed as percentage of total navigable channel length)									✓				
Customer service	8:1	Percentages of positive or negative customer reviews											✓		

Note: Grey-shaded cells indicate that these performance metrics are collected from secondary sources or no detail description is found in the source.

Source:

1. McMullen, B.S. & C.M., Monsere. (2010) *Freight Performance Measures: Approach Analysis. Final Report.* Oregon Department of Transportation, Salem, OR. https://www.oregon.gov/ODOT/Programs/ResearchDocuments/Freight_Performance_Measures.pdf Accessed July 15, 2019.
2. Florida Department of Transportation. (2017). *The FDOT Source Book*, Forecasting and Trends Office, FL, 2017. http://www.fdot.gov/planning/FTO/mobility/2017source book.pdf Assessed June 15, 2019

3. Cambridge Systematics, Inc. (2011). *TxDOT waterborne freight corridor study. Task 3: Waterborne freight performance measures*. Texas Department of Transportation. http://ftp.dot.state.tx.us/pub/txdotinfo/library/reports/gov/tpp/spr/waterborne/waterborne_phase2.pdf Accessed July 15, 2019.
4. Maryland Department of Transportation. (2017). *2017 Maryland Strategic Goods Movement Plan,* MD. http://www.mdot.maryland.gov/newMDOT/Freight/Documents/2018/Strategic_Goods_Movement_Plan_2017.pdf Accessed June 19, 2020.
5. Iowa Department of Transportation. (2016). *Iowa State Freight Plan*, IA. https://iowadot.gov/iowainmotion/files/Iowa_State_Freight_Plan_FINAL.pdf Accessed June 19, 2020
6. Parsons Brinckerhoff Quade & Douglas, Inc.(2007). New Jersey comprehensive statewide freight plan. Report prepared for the New Jersey Department of Transportation. https://www.state.nj.us/transportation/freight/plan/pdf/2007statewidefreightplan.pdf Accessed June 22, 2020.
7. Minnesota Department of Transportation. (2018). *Minnesota Go Statewide Freight System and Investment Plan*, MN. https://www.dot.state.mn.us/planning/freightplan/pdf/statewidefreightplanrevised2018.pdf Accessed June 18, 2020.
8. Transport for London. (2007). *London Freight Plan, sustainable freight distribution: a plan for London*. http://www.bestufs.net/download/NewsEvents/articles/London-Freight-Plan_07.pdf Accessed July 15, 2019.
9. Posset, M., Pfliegl, R., & Zich, A. (2009). An Integrated Set of Indicators for Assessment of Inland Waterway Transportation Performance. *Transportation research record*, *2100*(1), 86–93.
10. The Tioga Group, Inc. (2010). *Improving Marine Container Terminal Productivity: Development of Productivity Measures, Proposed Sources of Data, And Initial Collection of Data from Proposed Sources*. Cargo Handling Cooperative Program. http://tiogagroup.com/docs/Tioga_CHCP_Productivity_Report.pdf Accessed July 15, 2019.
11. Easley, R., K. Nicole, K. Keith, S. Daniel, & T. Janie. (2017) *Freight Performance Measure Primer* (Report No. FHWA-HOP-16-089). U.S. Department of Transportation, Federal Highway Administration, Washington, D.C. https://ops.fhwa.dot.gov/publications/fhwahop16089/fhwahop16089.pdf Accessed July 15, 2019
12. InCom Working Group 111. (2010). *Performance Indicators for Inland Waterways Transport: User Guideline* (Report No. 111 – 2010). PIANC. https://www.pianc.org/publications/inland-navigation-commission/performance-indicators-for-inland-waterways-transport-user-guideline Accessed on June 18, 2020.
13. The White House, Office of Management and Budget. ((Cited in Cambridge Systematics, Inc., 2011. TxDOT waterborne freight corridor study)

Table 25. Performance Measures with Their Descriptions

Category	Index	Measures	Definition	Justification	Data Collection	Comment
Safety	1:1	Number of commercial mariner and passenger casualties	Measures the total number of commercial mariner injuries and deaths and commercial passenger injuries and deaths investigated by U.S. Coast Guard in a given year. This also includes unresolved injury and death cases[1].	While it may not be possible to prevent every incident or accident, there is a clear need for continued oversight and emergency response capability across the maritime transportation system. For this, a comprehensive database is essential to find a trend or pattern.	Data source: U.S. Coast Guard, Marine Information for Safety and Law Enforcement (MISLE) files[1].	
	1:2	Number of commercial vessel accidents	Total number of commercial vessel accident in a specific waterway channel for a specific time period.		Data source: U.S. Coast Guard, Marine Information for Safety and Law Enforcement (MISLE) files[1].	
	1:3	Number of U.S. Coast Guard incident investigations	Measures the total number of vessel incidents investigated by U.S. Coast Guard in a given year. Incidents include commercial vessel events, recreational vessel events and unresolved events[1].		Data source: U.S. Coast Guard, Marine Information for Safety and Law Enforcement (MISLE) files[1].	Number of commercial vessel accidents including collisions, allisions and groundings
	1:4	Number of thefts in freight vehicles	This measure addresses the level of theft of (and from) freight vehicles and of theft during the loading/unloading of cash-in-transit operations[2].	Theft is an important safety issue in MTS.		This measure addresses the level of theft of (and from) freight vehicles and of theft during the loading/unloading of cash-in-transit operations.
	1:5	Access control to inland waterway system				Collected from secondary source. No further specification was found.
Maintenance and Preservation	2:1	Acres of land available for future maritime industrial use		Reveals the potential for future expansion of maritime industries.		
	2:2	Number of rail miles abandoned	Total rail miles abandoned due to some short comings	Reveals the necessity of maintenance of rehabilitation of abandoned rail tracks.		

Category	Index	Measures	Definition	Justification	Data Collection	Comment
	2:3	Dollars spent on freight marketing and education to the general public		It is important to make public aware of the importance and contribution of maritime freight transportation system in national economy.		
	2:4	Cubic yards of sediment dredged/projected	Cubic yards of sediments dredged each year.	Indicator of existing maintenance program		
	2:5	Age of federally owned and operated navigation locks (Number of federally owned and operated navigation locks opened per decade)	This indicator measures the number of federally owned and maintained locks opened in each decade[1].	Important to determine the time and type of maintenance and rehabilitation programs.	Data source: Source: U.S. Army Corps of Engineers[1].	
	2:6	Placement capacity remaining for harbor dredged material	This measure monitors the existing capacity remaining at harbor dredged material placement sites	Purpose is to ensure adequate dredged material placement capacity is available to maintain Harbor shipping channels[3].	Data is presented as the capacity remaining in terms of duration[3]. (Maryland Port Authority presented the data for harbor and bay side by side to have a good comparison between them)	Average annual planning volumes of sediment dredged to keep Harbor channels open for business is 1.5 million cubic yards (mcy)[3]. (Maryland has a Dredge Material Management Program, DMMP to explore innovative use, such as environmental restoration, for the millions of cubic yards of dredged material generated each year)

Category	Index	Measures	Definition	Justification	Data Collection	Comment
	2:7	Placement capacity remaining for bay dredged material	This measure monitors the existing capacity remaining at bay dredged material placement sites.	It is necessary to ensure adequate dredged material placement capacity is available to maintain shipping channels and the approach channels[3].	Data is presented as the capacity remaining in terms of duration[3].	This measure corresponds to Maryland Bay shipping channels and the approach channels to the Chesapeake and Delaware Canal. Average annual planning volumes are 2.0 million cubic yards (mcy) for the 50-foot channels and 1.2 mcy for the 35-foot channels[3].
	2:8	Physical condition ratings of critical coastal navigation infrastructure	Physical condition ratings of USACE-owned coastal and great lakes navigation infrastructure. Infrastructure includes piers, groins, jetties, dikes, breakwaters, and revetments of varying size. Total 5 ratings are used, from insignificantly damaged to completely degraded[1].	Important to determine the time and type of maintenance and rehabilitation programs.	Data source: U.S. Army Corps of Engineers, Asset Management Database (beta)[1].	
	2:9	Availability of container-handling capability (Bulk transfer capability of ports)	This is an indicator of bulk transfer capability of a port[4].			This indicator also served as a measure of accessibility and connectivity[4]. No further specification is provided in the report.
Mobility, reliability, or congestion	3:1	TEUs passing through key ports (throughput)	Total number of TEUs passing through a port in a given year. Key ports are the ports within a state those handle the significant amount of cargo in that year. Significant amount can be set by respective authorities.	For ports, mobility is indicated by the amount of traffic passing through the port. For container traffic, TEUs passing through the port would be an indicator of traffic flows.		

Category	Index	Measures	Definition	Justification	Data Collection	Comment
	3:2	Foreign cargo tonnage	This demonstrates the amount of annual foreign cargo tonnage in comparison with general cargo tonnage[3].	A demonstration of higher foreign cargo handling records can account for the reliability of a port to the relevant industry. Relevant industry indicates the companies those are highly dependent on foreign cargo[3].	Data source: U.S. Census Bureau, Foreign Trade Division and U.S. Department of Transportation[1].	
	3:3	Tons of traffic arriving at key ports by barge in a given time period	This indicates the amount of traffic in tons arrived at a key port by barge. This measure can be presented as a comparison of the total throughput of the port.	For ports, mobility is indicated by the amount of traffic passing through the port. Tons of traffic arriving at the port by barge is probably the best indicator of mobility along a river system[5].	While recording the total throughput of a port, by keeping track of modal split, this measure can be estimated.	This performance measure is mainly for river channel system, as majority of river traffic are arrived by barge. (Key port: Port of Baltimore) This
	3:4	Tons of traffic shipping in and out by barge	This can be interpreted as portion of total throughput of a port carried out by barge.	Total throughput by barge is one of the most important performance indicator in case of river system.	While recording the total throughput of a port, by keeping track of modal split, this measure can be estimated.	Shipping in and out of Iowa.
	3:5	Total number of navigation lock closures	Total number of scheduled or unscheduled lock closures in a given year.	Unscheduled maintenance issues can shut down the barge system. Maintenance activities can be scheduled to avoid peak freight times (e.g. harvest) to limit impacts on the freight system.	Data source: U.S. Army Corps of Engineers[1].	
	3:6	Hours of navigation lock closures	Total hours of navigation closures in a given year.		Data source: U.S. Army Corps of Engineers[1].	It keeps tracks of navigation lock closures, hours and number of closures, unscheduled and scheduled.

Category	Index	Measures	Definition	Justification	Data Collection	Comment
	3:7	High tonnage channels with NOAA PORTS instrumentation	It is a measure to keep track of the amount high tonnage port areas (port areas that as a group carry 95% of total tonnage) that have some type of NOAA PORTS (National Oceanic and Atmospheric Administration) instrumentation installed to improve situational awareness for mariners[1]	It is important as the ability to fully utilize on-water navigation capacity is tied to existing landside capacities that may be limited at ports or other intermodal exchanges[1].	Data source: National Oceanic and Atmospheric Administration, U.S. Army Corps of Engineer[1].	
	3:8	Travel time estimates for key waterway segments	It estimates the travel time between origin and destination ports along Ohio river.			
	3:9	Shippers within 50 miles of river port	This is an indicator for the barge accessibility to a river port.	Proximity to a river terminal is a major issue in access to barge transportation. All traffic going out through a maritime port is intermodal in nature, meaning that some connection has been made between modes. Whether the maritime port is considered a viable alternative is dependent on the distance from the shipper to the port, relative to the distance to the nearest alterative export port[5].		For barge accessibility (Port of Baltimore)
	3:10	Total stops of navigation on a specific waterway section measured in days				No further specification is provided in the main report
	3:11	Total navigable days per year within a maritime corridor				No further specification is provided in the source.
	3:12	Frequency of lock closures (for a specific time period)				

Category	Index	Measures	Definition	Justification	Data Collection	Comment
Environmental	4:1	Fuel consumption				These measures include CO2 emissions as well as related particulates and NOX emissions. In this way, freight's contribution to achieving climate change target of a 60 per cent CO2 reduction by 2025 from 1990 base levels will be estimated and reported[2].
	4:2	Discharge of emission (air)				
	4:3	Emission noise				Collected from secondary source. No further specification was found.
	4:4	Water quality				
	4:5	Construction and maintenance				
	4:6	Discharge of waste and ballast water by tones	Total discharge of waste water from water modes.	Important factor for water quality.	Can be collected as tons per year.	
	4:7	U.S. petroleum-based fuel sales to the maritime industry (diesel fuel, residual fuel)	It measures U.S. distillate fuel oil sales to vessel bunkering consumers[1].	Since air quality is impacted by fossil fuel burning, it is important to keep track of how much of it comes from maritime industries[1].	Data source: U.S. Department of Energy.	
	4:8	Vessel pollution incidents (petroleum and other types)	The vast majority of recorded pollution incidents are associated with oil pollution, but records include chemical, other, and unspecified events. Commercial, recreational vessel incidents are reported separately. Unresolved investigations are also reported[1].	Important in maintaining environmental preservation programs.	Data source: U.S. Coast Guard, Marine Information for Safety and Law Enforcement (MISLE) files	

Category	Index	Measures	Definition	Justification	Data Collection	Comment
	4:9	Amount of dredged material reclaimed for beneficial use	It reports the amount of dredged material reclaimed by volume and also placement[1].	It is possible to define what qualifies as beneficial use, if a more refined dataset is available on dredge material placement. More detailed geographical data would be needed to assess the creation of specific habitat types from beneficially reused sediments[1].	Data source: U.S. Army Corps of Engineers[1].	
	4:10	Number of reported whale strikes by vessels	It measures large whale injury and mortality events from vessels[1].		Data source: National Oceanic and Atmospheric Administration.	It measures large whale injury and mortality events from vessels in the U.S. Gulf of Mexico, U.S. Atlantic coast and Canadian maritime provinces.
Economic Development	5:1	Regional and local development				Collected from secondary source. No further specification was found.
	5:2	Total tonnage of international trade	This demonstrates the amount of annual foreign cargo tonnage in comparison with general cargo tonnage[3].	A demonstration of higher foreign cargo handling records can account for the reliability of a port to the relevant industry. Relevant industry indicates the companies those are highly dependent on foreign cargo[3].	Data source: U.S. Census Bureau, Foreign Trade Division and U.S. Department of Transportation[1].	
	5:3	Total value of international trade	Keep records of U.S. export and import value transported by vessel[1].	The value of exports and imports transported via water every year totals hundreds of billions of dollars and forms the cornerstone of U.S. international trade. This is an important measure to keep record of total values of imports and exports via water on a yearly basis[1].	Data source: U.S. Census Bureau, Foreign Trade Division and U.S. Department of Transportation[1].	

Category	Index	Measures	Definition	Justification	Data Collection	Comment
	5:4	Total tons of freight moving on the waterway				No further specification is provided in the source.
	5:5	Total value of freight moving on the waterway				No further specification is provided in the source.
	5:6	Income of Harbor Maintenance Trust Funds	The Harbor Maintenance Tax is a fee collected from users of the maritime transportation system and placed in the Harbor Maintenance trust Fund (HMTF), this serves as a source of revenue for funding the Army Corps of Engineers' operation and maintenance activities[6].	Yearly records of revenue and disbursement shows whether fund is available to reimburse eligible operations and maintenance expenses associated with commercial navigation infrastructure maintenance and channel dredging or not. Since 1988 there has been an approximate eight-fold increase in annual revenues collected by the Harbor Maintenance Trust Fund, indicating an expansion in trade or an increase in the value of goods moving through harbors subject to the tax that funds the HMTF[1].	Data source: U.S. Department of the Treasury[1].	
	5:7	Disbursement of Harbor Maintenance Trust Funds	Disbursement from the Harbor Maintenance Trust Fund (HMTF) is the Congress appropriated funds for harbor dredging[7].		Data source: U.S. Department of the Treasury[1].	

Category	Index	Measures	Definition	Justification	Data Collection	Comment
	5:8	Income of Inland Waterways Trust Funds	The Inland Waterways Trust Fund (IWTF) was created as part of the Inland Waterways Revenue Act of 1978. The IWTF was established to finance construction and major rehabilitation on the nation's inland waterways. Under the IWTF, commercial users of waterways contribute to the trust fund through a modest tax on fuel they use on the waterway system[9].	Yearly records help to keep track of available funds. Revenues from the Inland Waterways Trust Fund have not matched disbursements for most of the past decade, indicating that needs are greater than available funds[1].	Data source: U.S. Department of the Treasury[1].	
	5:9	Disbursement of Inland Waterways Trust Funds	Disbursement includes financing one-half of the construction and rehabilitation costs of specified inland waterway projects[10].		Data source: U.S. Department of the Treasury[1].	
	5:10	Producer Price Index (PPI) for marine transportation industries	PPI measures average change in the selling price of services on a yearly basis[1].	Reveals the change in selling price of services in water transportation compared to other types of modes.	Data source: U.S. Department of Labor, Bureau of Labor Statistics[1].	
	5:11	Inland waterway shipping barge freight rates (weekly)	It shows change in weekly barge spot freight rates[1].	Important to demonstrate seasonal price shifts. Such as, rates are higher during peak agricultural harvest times in the Midwest.	Data is collected as tariff change from the existing benchmark for fright rates over a time period.	Especially developed for southbound shipments originating along the Mississippi River.
	5:12	Physical condition ratings of critical coastal navigation infrastructure				
	5:13	Age of federally owned and operated navigation locks				
	5:14	Quantity of direct employment (number of jobs) generated by inland waterway navigation with reference to a certain time period	Quantity of direct and indirect employment generated by inland waterway navigation within a state, as determined quarterly. Direct	The indicator illustrates the impact of certain amounts of investment. Furthermore, it enables intermodal comparison of the creation of value[5].		The highest added value for single case of fund allocation can be detected and programming decisions can be supported: Σ

Category	Index	Measures	Definition	Justification	Data Collection	Comment
	5:15	Quantity of indirect employment (number of jobs) generated by inland waterway navigation with reference to a certain time period	employment consists of the jobs that provide the products and services generated or initiated by inland waterway services and transportation. The business and associated jobs that result or benefit from the creation of value by inland waterway navigation are considered indirect employmen[5].			(added value of direct and indirect employment[5].
	5:16	Number of employees in inland navigation in a certain region in a certain time period				
	5:17	Tons of traffic arriving at key ports by barge in a given time period	This indicates the amount of traffic in tons arrived at a key port by barge. This measure can be presented as a comparison of the total throughput of the port.	For ports, mobility is indicated by the amount of traffic passing through the port. Tons of traffic arriving at the port by barge is probably the best indicator of mobility along a river system[3].	While recording the total throughput of a port, by keeping track of modal split, this measure can be estimated.	This measure is mainly for river channel system, as majority of river traffic are arrived by barge. (Key port: Port of Baltimore)
Infrastructure	6:1	Availability of locks				Collected from secondary sources. No further specification was found.
	6:2	Total availability for service of a lock				
	6:3	Total stop of lockage				
	6:4	Lock utilization				
	6:5	Availability of core waterway infrastructure				
	6:6	Capacity of waterway section				
	6:7	Dredging/maintenance of waterway				
	6:8	Handling capacity				
	6:9	Storage capacity utilization				
	6:10	Waiting time for service				

Category	Index	Measures	Definition	Justification	Data Collection	Comment
	6:11	Utilization of handling capacity				
	6:12	Maintenance, service, and operating supplies				
	6:13	Capacity				
	6:14	Cargo transport				
	6:15	Passenger traffic				
	6:16	Perceived quality/user satisfaction with cargo and passenger transport				
	6:17	Miles of waterway with unsuitable channel width		Keep records of existing navigable waterway in the whole state.	Measures in every year.	
	6:18	Miles of the waterway with unsuitable channel depth				
	6:19	Miles of the waterway with difficult turns and one-way zones				
	6:20	Number of locations to park a barge along the coast line (mooring structures)	Total number of mooring structures for barge along the coast line.	Measure the accessibility of the navigable waterway.	Records can be kept on yearly basis.	
	6:21	Number of lockage	Total number of locks in a state.			
	6:22	The amount of operating projects (dams, levees, channels, flood gates, etc.)				Collected from secondary sources. No further specification was found.
	6:23	Port capacity	The measure suggests relative maximum throughput of ports, such as channel depth, container terminal berth length, container terminal size, container terminal crane number and size, and rail connectivity[11].			
	7:1	Frequency of updating electronic fairway charts				Collected from secondary sources. No

Category	Index	Measures	Definition	Justification	Data Collection	Comment
Information and Communication Technology	7:2	Accuracy of electronic fairway charts				further specification was found.
	7:3	Availability of electronic fairway information				
	7:4	Availability of electronic reporting and port information systems				
Customer Service	8:1	Dollars spent on freight marketing and education to the general public		It is important to make general public aware of the importance and contribution of maritime freight transportation system in national economy.		

Note: Grey shaded cells indicate that these performance metrics are collected from secondary sources or no detail description is found in the source.

Source:

1. US Committee on the Marine Transportation System. (2015). Research and Development Integrated Action Team. *Marine Transportation System Performance Measures: Executive Summary*. Washington, D.C., 2015. www.cmts.gov Accessed July 15, 2019.
2. Transport for London. (2007). *London Freight Plan, sustainable freight distribution: a plan for London*. http://www.bestufs.net/download/NewsEvents/articles/London-Freight-Plan_07.pdf Accessed July 15, 2019.
3. Maryland Department of Transportation. (2018). *2018 Annual Attainment Report On Transportation System Performance*. MD. http://www.mdot.maryland.gov/newMDOT/Documents/Attainment_Report_Single_2018_LowRes.pdf Accessed on June 22, 2020.
4. Easley, R., K. Nicole, K. Keith, S. Daniel, & T. Janie. (2017) *Freight Performance Measure Primer* (Report No. FHWA-HOP-16-089). U.S. Department of Transportation, Federal Highway Administration, Washington, D.C. https://ops.fhwa.dot.gov/publications/fhwahop16089/fhwahop16089.pdf Accessed July 15, 2019
5. McMullen, B.S. & C.M., Monsere. (2010) *Freight Performance Measures: Approach Analysis. Final Report.* Oregon Department of Transportation, Salem, OR. https://www.oregon.gov/ODOT/Programs/ResearchDocuments/Freight_Performance_Measures.pdf Accessed July 15, 2019.
6. Huynh, N. N. (2005). Methodologies for reducing truck turn time at marine container terminals (Doctoral dissertation).
7. American Great Lakes Ports Association. (2020). Harbor Maintenance Trust Fund. Retrieved June 22, 2020 from https://www.greatlakesports.org/issues/harbor-maintenance-trust-fund/
8. Marlow, P. B., & Casaca, A. C. P. (2003). Measuring lean ports performance. International journal of transport management, 1(4), 189–202.
9. Frittelli, J. (2011). *Harbor Maintenance Trust Fund Expenditures.* Congressional Research Service. https://fas.org/sgp/crs/misc/R41042.pdf Accessed June 22, 2020.
10. *The Inland Waterways Trust Fund*. (2012). Inland Waterways Trust Fund Fact Sheet. https://www.taxpayer.net/wp-content/uploads/ported/images/downloads/IWTF%20-%20TCS%20-%20FINAL%202012-01-18.pdf Accessed June 22, 2020.
11. U.S. Committee on the Marine Transportation System. (2017). *National Strategy for the MTS: Channeling the Maritime Advantage, 2017–2022*. Washington, DC. https://www.cmts.gov/downloads/National_Strategy_for_the_MTS_October_2017.pdf Accessed June 22, 2020.

Table 26. Performance Metrics with Their Description

Category	Index	Metric	Definition	Justification	Data Collection	Comment
Safety	1:1	Value of cargo lost or damaged in a port per total value of cargo handled in that port in a specific time period	This metric gives an estimate of the value of cargo lost or damaged while passing through a port in percentage or ratio of total tons of cargo passing through that port.	In order to define the safety of a port or any river channel system, it is ideal to have a measure of loss and damage per unit of output going through the port or down the river[1].	Two data sets are necessary for this metric: 1) Total amount (in terms of value) of cargo lost or damaged while passing through a port, 2) Total tons passing through the port or arriving at the port from the river.	Oregon DOT has the data for the denominator of this metric. They proposed to collect the data for value of cargo lost or damaged[1].
	1:2	Number of containers lost or damaged in a port per total containers handled in a port in a specific time period	This is a yearly estimate of the rate of container damaged or lost in a port compared to the total number of containers handled in that port.	Container handling is a major task of any port. In order to maintain efficient and reliable port performance, it is very important to ensure the safety and security of container that are handled in that port. This indicator provides a measure of this safety.	Two data sets required for this metric: 1) Number of container damaged or lost while handling per year, 2) Total number of containers handled in that year.	According to ODOT, data availability in this regard either on incidents or dollar values of loss and damage is uncertain. This is largely due to the fact that freight services by barge or ocean going vessel are performed by private companies that are reluctant to share the information on their operations[1].
	1:3	Vessel-to-vessel collisions in a specific channel or port in a specific time period (Expressed as percentage of total collisions)	In a specific waterway channel, this metric reveals the total vessel-to-vessel collisions as a percentage of total collisions.	Reveals whether a certain type of collision is prominent in a cannel.	Two datasets: 1) Total number of vessel-to-vessel collisions, 2) Total number of collisions. Both will be measured for a specific waterway channel, for a specific time period.	
	1:4	Vessel-to-fixed object collisions in a specific channel or port in a specific time period (Expressed as percentage of total collisions)	In a specific waterway channel, this metric reveals the total vessel-to-fixed object collisions as a percentage of total collisions.	Reveals whether a certain type of collision is prominent in a cannel.	Two datasets: 1) Total number of vessel-to-fixed object collisions, 2) Total number of collisions. Both will be measured for a specific waterway channel, for a specific time period.	

Category	Index	Metric	Definition	Justification	Data Collection	Comment
	1:5	Percentage of port containers inspected annually	Port containers are inspected due to safety and maintenance issue. This metric keeps record of how many containers are inspected annually.	Important safety issue.	Dataset: 1) Number of port containers inspected in a year, 2) Total port containers handled in that year.	
	1:6	Economic Impact of accidents				Collected from secondary source. No further specification is found.
	1:7	Port compliance with Maritime Transportation Security Act of 2002	Port authority needs to address the requirements of the act including training, exercises, drills, reports, and record keeping[2].	The Maritime Transportation Security Act of 2002 required owners and operators of international cargo terminals to develop and maintain a Facility Security Assessment and Facility Security Plan, which must be approved by the U.S. Coast Guard[2].	Possible strategies: 1) Fully implement the Transportation Worker Identification Credential at port facilities, 2) Use eModal Trucker Check system, 3) Conduct Vulnerability Assessments and update Facility Security Plans, 4) Coordinate security with other agencies, 5) Complete security capital projects[2].	
	1:8	Hazardous spills (Volume/tones) by water modes/hazmat carried by water in a specific time period (Expressed as a percentage of total hazmat carried that is spilled)	Estimates the hazardous spills on water from any waterborne modes.		Dataset: 1) Hazardous spills from water modes, 2) Hazardous spills that was carried as cargo by a water mode.	

Category	Index	Metric	Definition	Justification	Data Collection	Comment
Maintenance and preservation	2:1	Average maintenance costs of fleet and vehicles per ton – kilometer (tkm) (Expressed in comparison with default value)	Here "default value" includes current value, operator, tons deadweight all told (tdwat)/drive power, days in use/year, crew, repairs, insurance, miscellaneous, amortization/depreciation, interest, overhead shipping company, costs in €/T tdwat per year, differential cost factor, tdwat range[3].			
	2:2	Average maintenance cost per lock, per month	The maintenance cost of a lock in a month.			
	2:3	Percentage of river tonnage moving through locks with constraints (delays)	This metric estimates the percentage of annual cargo that are delayed while moving through locks.	Unlike the railroad or highway systems, there are no alternate routes should one of the locks be unavailable. Yearly delayed cargo is an ideal indicator of lock efficiency[1].	Two datasets required: 1) Amount of cargo delayed at a lock in a year, 2) Total cargo handled by that lock in that year.	
	2:4	Unscheduled lock closure time for maintenance in a given time period (Expressed as percentage of total lock closure time)	Hours of unscheduled lock closure time in a year, presented in comparison with total lock closure time in that year.	Unscheduled maintenance issues can shut down the barge system. Maintenance activities can be scheduled to avoid peak freight times (e.g. harvest) to limit impacts on the freight system.	Two datasets required: 1) Total unscheduled lock closure time in a year, 2) Total lock closure time for maintenance.	
	2:5	Ratio of channel depth of a particular port with the average depth of other competitive ports	For a particular port, this metric indicates whether this port has higher or lower capability than its competitors in terms of serving deep draft container ships.	This is an important indicator as port channel depths and ability to serve deep draft container ships would be relevant maintenance issues[1].	Required data: 1) Channel depth of the relevant port, 2) Channel depths of all other ports in that region those can be considered as competitor of the relevant port.	This metric can have several values based on which competitor port is being considered. A chart can be made showing the comparison among ports.
	2:6	Percentage of port containers inspected annually	Port containers are inspected due to safety and maintenance issue. This metric keeps record of how many containers are inspected annually.	Important maintenance issue.	Dataset: 1) Number of port containers inspected in a year, 2) Total port containers handled in that year.	

Category	Index	Metric	Definition	Justification	Data Collection	Comment
	2:7	Average age of waterway infrastructure assets	Average age of all the available infrastructure assets in a specific waterway system.		Data: Age of all the assets related to waterway infrastructure.	
	2:8	Average age of cranes and other major cargo handling assets	Average age of cranes and other major cargo handling assets of a specific port.		Data: Age of each crane and other major instruments of a port that are used to handle cargo.	
	2:9	Annual average increase in acreage of developed properties along navigable waterways			Data: 1) Total navigable waterway in a given coast line, 2) Yearly dataset of acreage of developed properties along waterways.	
Mobility, congestion and reliability	3:1	Freight mode share by value (for a specific time period)	Percent of total freight in terms of value, carried in/out or within the state by water.	Cargo carried by the trucks tend to have higher value-weight ratios than both rail and water. Therefore, generally, trucks carry a higher percentage of the cargo in terms of value. However, in terms of weight, this percentage may have changed significantly. These two metrics demonstrate the amount of cargo carried by water borne modes in terms of both value and weight compared with other types of freight modes[4].	Dataset: 1) Value of total freight carried in/out in the state, 2) Value of freight carried in/out of state by waterborne modes, in a given year.	These indicators measure the percentage of freight by weight and value carried by different modes in Minnesota
	3:2	Freight mode share by weight (for a specific time period)	Percent of total freight in terms of weight, carried in/out or within the state by water.		Dataset: 1) Weight of total freight carried in/out in the state, 2) weight of freight carried in/out of state by waterborne modes, in a given year.	
	3:3	Average truck turn time (for a specific time period)	Truck turn time is the time it takes a truck to complete a transaction such as picking up an import container. It is calculated as daily/monthly/yearly average. Sometimes, it is also defined as gate reliability[5].	Truck turn time is a key performance indicator which demonstrates efficiency and productivity of a port. Given the fact that containers may arrive at the port both by rail and truck, the focus on container traffic for delays at gate is appropriate[1].		

Category	Index	Metric	Definition	Justification	Data Collection	Comment
	3:4	Average ship unloading rate (for a specific time period)	This indicates the time required for ship unloading per container. This can be daily/monthly/yearly average estimate.	Ship loading/unloading rates are two key performance metrics in terms of port capacity and efficiency.	Data sets required: 1) total number of ships unloaded, 2) number of containers unloaded per ship, 3) time required for unloading per ship, in a specific time period.	
	3:5	Average ship loading rate (for a specific time period)	This indicates the time required for ship loading per container. This can be daily/monthly/yearly average estimate.	Ship loading/unloading rates are two key performance metrics in terms of port capacity and efficiency.	Data sets required: 1) total number of ships loaded, 2) number of containers loaded per ship, 3) time required for loading per ship, in a specific time period.	
	3:6	Average delay per barge tow (for a specific time period)	It defines the average delay of a vessel per barge tow in a specific time period.	For the traffic in the river system, some measure of volume-to-capacity would be helpful in determining whether there are capacity constraints. Considering delay as an indicator of the capacity constraints, average delay can be measured per barge tow[1].		In terms of Columbia/Snake River system, this might become more of an issue in the future if upstream dams are breached as it will affect the lock capacity.
	3:7	Average vessel delays at a lock (for a specific time period)	Average vessel waiting time in a river lock for a specific time period.			
	3:8	Average container dwell time (for a specific time period)	Average container dwell time in a specific port for a specific time period.			
	3:9	Average time in transit per barge tow (for a specific time period)	Average waiting time in transit per barge tow in specific port for a specific time period.			
	3:10	Annual average TEUs per Crane	Average number of TEUs handled in a port per crane in a specific time period.			Annual TEU per crane reflects overall port or terminal performance and balance. It measures the adequacy of the crane infrastructure, and whether excess crane capacity exists.

Category	Index	Metric	Definition	Justification	Data Collection	Comment
	3:11	Average port handling capacity per quay meter		Indicator of ship handling capacity of a port.		No further specification is provided
	3:12	Average port handling capacity per truck loading bay		Indicator of truck handling capacity of a port.		
	3:13	Percentage of sea ports with active rail access	Percentage of seaports with active rail access in the whole state[6].	Seaport rail access accounts for the percentage of seaports served by an active railroad. An active railroad is determined by the presence of trains operating on the facility[6].	2 datasets: 1) number of seaports with active rail access, 2) total number of seaports in the state. Reporting period is "yearly."[6]	
	3:14	Average delay of rail movement on port access tracks in a specific time period	Delay from at-grade rail/street crossings on port access tracks.			
	3:15	Average ship travel time in bottleneck areas (for a specific time period)				No further specification is provided
	3:16	Degree of executed transports as contractual agreed compared to previous years	This metric is estimated from the total number of documented complaints per company in a time period[5].		Number of documented complaints per company[5].	
	3:17	Annual average TEU per Slot	TEU per slot, or annual slot turns, is a productivity measure reflecting the output from the TEU slot[7].			
	3:18	Vessel size ratio (Ratio of average vessel size handled by a port in a given time period and the maximum possible vessel size that can be handled by that port)	It is a comparison between the average vessel sizes being handled to the maximum possible vessel size for the available draft in a time period[7].	It indicates how much of the inherent draft and berth length is being used[7].	Dataset: 1) Sizes of the vessels those are handled in a port in a specific time period.	
	3:19	Annual average TEU per gross terminal or port acre		TEU per gross terminal or port acres is a commonly used but deceptive metric.	Dataset: 1) Annual total TEU throughput of a port.	

Category	Index	Metric	Definition	Justification	Data Collection	Comment
	3:20	Annual average TEU per container yard acre		Many U.S. container terminals devote substantial portions of their footprint to rail yards or ancillary facilities that would not be considered as container yard. Annual TEU per container yard acre is a much more revealing metric, as it compares throughput (annual TEU) with the portion of terminal acres directly used (CY acres)[7].	Dataset: 1) Annual total TEU throughput of a port.	
	3:21	Annual average TEU per Berth		Annual TEU per berth reflects overall port productivity in terms of transfer of containers between land and ship[7].	Dataset: 1) Annual total TEU throughput of a port.	
	3:22	The success of time and mode shift strategies (amount of cargo shifted to off-peak movements and from trucks to alternative rail or barge modes that are sustainable for an extended period)		This metric is designed to improve access to/from any maritime facilities[8].		No further specification is available in the source.
	3:23	Congestion/port-related truck volumes on key access routes connecting port facilities and customers		This metric is designed to improve access to/from any maritime facilities[8].		No further specification is available in the source.
	3:24	Congestion/port-related volumes on key rail freight routes connecting port facilities and customers		This metric is designed to improve access to/from any maritime facilities[8].		No further specification is available in the source.

Category	Index	Metric	Definition	Justification	Data Collection	Comment
	3:25	Journey time reliability	These measures reflect the impact that journey time reliability (JTR) has on operator costs, freight intensity, vehicle loading factors, vehicle time utilization and deviation from schedule[8].			JTR is currently measured for London's general traffic only.
Environmental	4:1	Pounds of greenhouse gas (GHG) emissions per tons moved (in a given time period)	This is a common metric for all types of freight transportation.	Measuring the environmental impact/performance of the various transportation modes is increasingly an important and controversial issue. In the absence of any consistent method for calculating the impact for any mode, let alone across modes, it is suggested that a model be used such as the GreenStep model now being developed by ODOT, to obtain benchmark measure[1].		This metric should also include another parameter: per distance.
	4:2	Average evaporative emissions by a ship in transit (for a given time period)				No further specification is provided
	4:3	Mitigation Compliance				This metrics demonstrates the USACE performance in meeting mitigation requirements that are specified in project authorizations.
	4:4	Hazardous spills (Volume/tones) by water modes/hazmat carried by water in a specific time period (Expressed as a percentage of total hazmat carried that is spilled)	Estimates the hazardous spills on water from any waterborne modes.		Dataset: 1) Hazardous spills from water modes, 2) Hazardous spills that was carried as cargo by a water mode.	

Category	Index	Metric	Definition	Justification	Data Collection	Comment
Economic Development	5:1	Economic impact of passenger and cargo transport				Collected from secondary source. No further specification is found.
	5:2	Ratio of imports/exports (for a given time period)		Important indicator in terms of economy.		No further specification is available in the source.
	5:3	Logistics cost as percentage of state GDP		Important indicator in terms of economy		No further specification is available in the source.
	5:4	Annual average TEU per berth		Annual TEU per berth reflects overall port productivity in terms of transfer of containers between land and ship[7].	Dataset: 1) Annual total TEU throughput of a port.	
	5:5	Total value of key industries income generated				For example, total weight and value of shrimp, oysters and finfish facilitated by the GIWW
	5:6	Average cost of freight movement in a specific waterway channel in a time period	This will track the cost of moving goods and the time of those goods in transit in a number of key gateway corridors. It would consider multiple modes[9].			For Mn/DOT, examples include barge service to/from New Orleans, container rail service to/from Los Angeles, Chicago, and Seattle and trucking service to and from Chicago[9].
	5:7	Average transit time of freight in key national modal corridors in a time period				
	5:8	Operating expenses per general cargo tonnage (for a given time period)	The rate of operating expenses per ton of general cargo in a specific time period[2].	This is used to determine, evaluate and track the port authority's operational and administrative efficiency[2].	2 datasets: 1) Total operating expenses, 2) General cargo tonnage, in a specific time period.	Specifically, for Maryland Port Administration.
	5:9	Ratio of operating expenses to revenue (for a given time period)	Total revenues compared to operating expense of a port in a time period.		2 datasets: 1) Total revenue, 2) Total operating expenses, in a specific time period.	Total revenues compared to operating expense of Maryland Port Administration.
	5:10	Inland waterway transport volume compared to Gross Domestic Product (GDP)				Collected from secondary source. No further specification is found.

Category	Index	Metric	Definition	Justification	Data Collection	Comment
Infrastructure	6:1	Ratio of channel depth of a particular port with the average depth of other competitive ports	For a particular port, this metric indicates whether this port has higher or lower capability than its competitors in terms of serving deep draft container ships.	This is an important indicator as port channel depths and ability to serve deep draft container ships would be relevant maintenance issues[6].	Required data: 1) Channel depth of the relevant port, 2) Channel depths of all other ports in that region those can be considered as competitor of the relevant port.	This matric can have several values based on which competitor port is being considered. A chart can be made showing the comparison among ports.
	6:2	Average maintenance costs of fleet and vehicles per ton – kilometer (tkm) (Expressed in comparison with default value)	Here default value includes current value, operator, tons deadweight all told (tdwat)/drive power, days in use/year, crew, repairs, insurance, miscellaneous, amortization/depreciation, interest, overhead shipping company, costs in €/T tdwat per year, differential cost factor, tdwat range[5].			
	6:3	Port compliance with Maritime Transportation Security Act of 2002	Port authority needs to address the requirements of the act including training, exercises, drills, reports, and record keeping[2].	The Maritime Transportation Security Act of 2002 required owners and operators of international cargo terminals to develop and maintain a Facility Security Assessment and Facility Security Plan, which must be approved by the U.S. Coast Guard[2].	Possible strategies: 1) Fully implement the Transportation Worker Identification Credential at port facilities, 2) Use eModal Trucker Check system, 3) Conduct Vulnerability Assessments and update Facility Security Plans, 4) Coordinate security with other agencies, 5) Complete security capital projects[2].	
Information and communication technology	7:1	The percent of time that high commercial traffic-navigation channels are available to commercial users				Collected from secondary sources. No further specification was found.
	7:2	Waterway length covered with AIS shore side equipment (Expressed as percentage	Percentage of total navigable channel length covered with AIS shore side equipment.	Data about availability of shore side equipment		

Category	Index	Metric	Definition	Justification	Data Collection	Comment
		of total navigable channel length)				
Customer service	8:1	Percentages of positive or negative customer reviews	Customer satisfaction survey.		Percentage of customers rating their satisfaction with the agency's customer service as "good" or "excellent." Rating criteria: overall customer service, timeliness, accuracy, helpfulness, expertise, and availability of information[40].	

Note: Grey shaded cells indicate that these performance metrics are collected from secondary sources or no detail description is found in the source.

Source:

1. McMullen, B.S. & C.M., Monsere. (2010) *Freight Performance Measures: Approach Analysis. Final Report.* Oregon Department of Transportation, Salem, OR. https://www.oregon.gov/ODOT/Programs/ResearchDocuments/Freight_Performance_Measures.pdf Accessed July 15, 2019.
2. Maryland Department of Transportation. (2018). *2018 Annual Attainment Report On Transportation System Performance*. MD. http://www.mdot.maryland.gov/newMDOT/Documents/Attainment_Report_Single_2018_LowRes.pdf Accessed on June 22, 2020.
3. Posset, M., Pfliegl, R., & Zich, A. (2009). An Integrated Set of Indicators for Assessment of Inland Waterway Transportation Performance. *Transportation research record*, *2100*(1), 86–93.
4. Minnesota Department of Transportation. (2009). *Minnesota Statewide Transportation Policy Plan: 2009 – 2028.* MN. https://www.leg.state.mn.us/docs/2009/other/090851.pdf Accessed June 22, 2020.
5. Kress, M.M., K.N. Mitchell, P.K. DiJoseph, J.S. Rainey, M. Chambers, J. Hsieh, & W.J. Lillycrop. (2016). *Marine Transportation System Performance Measures Research.* US Army Corps of Engineers, Washington, D.C. https://usace.contentdm.oclc.org/digital/collection/p266001coll1/id/3719/ Accessed July 15, 2019.
6. Florida Department of Transportation. (2017). *The FDOT Source Book*, Forecasting and Trends Office, FL, 2017. http://www.fdot.gov/planning/FTO/mobility/2017sourcebook.pdf Assessed June 15, 2019
7. The Tioga Group, Inc. (2010). *Improving Marine Container Terminal Productivity: Development of Productivity Measures, Proposed Sources of Data, And Initial Collection of Data from Proposed Sources.* Cargo Handling Cooperative Program. http://tiogagroup.com/docs/Tioga_CHCP_Productivity_Report.pdf Accessed July 15, 2019.
8. Parsons Brinckerhoff Quade & Douglas, Inc.(2007). New Jersey comprehensive statewide freight plan. Report prepared for the New Jersey Department of Transportation. https://www.state.nj.us/transportation/freight/plan/pdf/2007statewidefreightplan.pdf Accessed June 22, 2020.
9. Minnesota Department of Transportation. (2017). *Minnesota Transportation Results Scorecard, 2016.* https://www.dot.state.mn.us/measures/pdf/2017%20scorecarMay%2011.pdf Accessed June 22, 2020.

APPENDIX B: STATE DOT AND STAKEHOLDERS GENERIC TELEPHONE INTERVIEW SCRIPT

Script 1: Telephone interview script for State DOTs

University of Illinois at Chicago – Urban Transportation Center

Project Title: Maritime Freight Data Collection System and Database to Support Performance Measures and Market Analyses

Telephone Interview Script for State DOT

State: **Interviewee:** **Interviewee Title:**	**Interviewer:** **Date:**

Section 1: Consent Process

Hello,

We are doing a research study funded by Illinois Department of Transportation to establish a suite of performance measures and metrics as a part of IDOT's management program for the Illinois Marine Transportation System (IMTS). As a part of the research, we are conducting a review of neighboring Department of Transportation management practices, strategic goals and performance measures as applied to their Inland Ports and Waterways Systems. In this regard, we would like to ask you some questions about the maritime transportation system of your state.

The interview will take approximately 30 to 45 minutes.

First, is it ok for us to record this call so we can have a better record of your answers?

We understand if you prefer not to be recorded and can accommodate that as well.

If you agree to the recording, please say "**I agree**."

If you do not agree to the recording, please say "**I do not agree**."

In case you do not agree to the recording, we will take notes from the conversation for our research purposes and will not record the conversation.

Now, I will read you your rights of confidentiality and privacy which is required by the University to protect you:

You understand that your participation in this study is entirely voluntary and that you can withdraw from the study at any time without penalty. The study team will exclude your name from any reports and will maintain your privacy whether you choose to participate in the study or not.

You understand that your participation in this study will not pose any physical risks to you personally and that you can skip any questions you are not comfortable answering.

You understand that you will not directly benefit from participating in the study, but that the study may be of benefit to governments, organizations, and individuals interested in utilizing maritime freight data to their services or advocacy.

You understand that the research team will make every effort to keep your personal information confidential; however, the research team cannot guarantee absolute confidentiality If you have any questions about this study, feel free to ask them now or anytime throughout the study by contacting:

Dr. P.S. Sriraj, Director
Urban Transportation Center
University of Illinois at Chicago
Phone: (312) 413-7568
e-mail: sriraj@uic.edu

If you have any questions about your rights as a research subject, you may write or call OPRS at the following address:

Office for the Protection of Research Subjects (OPRS)
1737, W. Polk Street, M/C 672
203 Administrative Office Building
Chicago, Illinois – 60612.
Phone: (312) 996 1711 or toll free: 866-789-6215
Email: uicirb@uic.edu

By agreeing to participate in the study and you are acknowledging that you have received an information sheet from UTC before this telephone call and you understand your rights, terms and conditions laid out in that document. You are also giving Dr. Sriraj, and his associates, permission to present this work in written and oral form, without further permission from you.

If you agree, please say "I agree."

If you do not agree, please say "I do not agree."

Any questions before we begin the interview portion?

Section 2: Interview Script

Module A: Strategic Plan

Q1. Can you tell us a little bit about yourself?

Q2. Can you tell us about your maritime freight transportation system?

Q3. How integrated is your Maritime Transportation System planning with the rest of your Statewide Transportation System Plan?

Q4. Is your maritime strategic planning integrated with your Statewide Freight Transportation Plan or do you have a complete freestanding Maritime Strategic Plan?

Q5. What are the strategic goals of your Maritime Transportation Plan?

Q6. Why haven't you established a Strategic plan for your Maritime Transportation System? (If applicable)

Module B: Performance Measurement Program

Q1. Do you have any performance measurement system for your freight transportation system and does this system extend to maritime freight transportation?

Q2. Do you use any performance measures or metrics for your performance measurement system?

Q3. Do you utilize performance measures and associated data specific for Inland Waterways and Ports?

Q4. How did you establish performance measures?

Q5. How frequently are performance measures updated in your state/organization/department?

Q6. What was the motivation for developing the maritime performance measurement program in the first place and the revisions (if any) you have made over the time?

Q7. Which division/section/group in your department in your organization is responsible for developing/revising performance measures?

Q8. What are the performance areas for which you use your performance measures?

Q9. What are the uses of your performance measures?

Module C: Data Collection and Management System

Q1. What methods/tools/technologies do you use in building your freight/maritime freight performance measurement system?

Q2. What do you think are the strengths and shortcomings of these methods/tools/technologies?

Q3. What are the reasons behind department's/organization's involvement in the development of Inland Waterways and Ports database(s):

Q4. From whom do you collect your data, including both publicly available and private data sources?

Q5. Which division/section/group in your department in your organization is responsible for data collection, data storage, data maintenance?

Q6. What is your mechanism for storing and periodically updating databases?

Module D: Conclusion

Q1. In order for us to further understand the maritime freight data collection and performance measurement in your state, can you please tell us the relevant published reports/materials by your organizations?

Q2. Would you be interested to participate in a follow-up interview?

Q3. Can you recommend any other individual(s) or agencies that serve as intermediate stakeholder for your maritime transportation sector?

Q4. Do you think we should contact them to gain further information on your state's maritime freight data collection and performance measurement?

Q5. Could you provide an organization chart and/or position description that better depict the Department's role in marine transportation system activities?

This is the end of the interview. Thank you for your time! If you have any further questions, please do not hesitate to contact P.S. Sriraj at sriraj@uic.edu or 312-413-7568.

Script 2: Telephone interview script for Illinois Port Districts, Maritime Freight Carriers, and USACE

University of Illinois at Chicago – Urban Transportation Center

Project Title: Maritime Freight Data Collection System and Database to Support Performance Measures and Market Analyses

Organization:	**Interviewer:**
Interviewee:	**Date:**
Interviewee Title:	

Section 1: Consent Process

Hello,

We are doing a research study funded by Illinois Department of Transportation to establish a suite of performance measures and metrics as a part of IDOT's management program for the Illinois Marine Transportation System (IMTS). As a part of the research, we are conducting a review of stakeholders in Illinois and their collection, management and usage of performance measures and metrics, specifically related to the inland and waterways systems. In this regard, we would like to ask you some questions about your operations and interactions you have other stakeholders on the Illinois waterways and IDOT

The interview will take approximately 45 to 60 minutes.

First, is it ok for us to record this call so we can have a better record of your answers?

We understand if you prefer not to be recorded and can accommodate that as well.

If you agree to the recording, please say **"I agree**."

If you do not agree to the recording, please say "**I do not agree**."

In case you do not agree to the recording, we will take notes from the conversation for our research purposes and will not record the conversation.

Now, I will read you your rights of confidentiality and privacy which is required by the University to protect you:

You understand that your participation in this study is entirely voluntary and that you can withdraw from the study at any time without penalty. The study team will exclude your name from any reports and will maintain your privacy whether you choose to participate in the study or not.

You understand that your participation in this study will not pose any physical risks to you personally and that you can skip any questions you are not comfortable answering.

You understand that you will not directly benefit from participating in the study, but that the study may be of benefit to governments, organizations, and individuals interested in utilizing maritime freight data to their services or advocacy.

You understand that the research team will make every effort to keep your personal information confidential; however, the research team cannot guarantee absolute confidentiality. If you have any questions about this study, feel free to ask them now or anytime throughout the study by contacting:

Dr. P.S. Sriraj, Director
Urban Transportation Center
University of Illinois at Chicago
Phone: (312) 413-7568
e-mail: sriraj@uic.edu

If you have any questions about your rights as a research subject, you may write or call OPRS at the following address:

Office for the Protection of Research Subjects (OPRS)
1737, W. Polk Street, M/C 672
203 Administrative Office Building
Chicago, Illinois – 60612.
Phone: (312) 996 1711 or toll free: 866-789-6215
Email: uicirb@uic.edu

By agreeing to participate in the study and you are acknowledging that you have received an information sheet from UTC before this telephone call and you understand your rights, terms and conditions laid out in that document. You are also giving Dr. Sriraj, and his associates, permission to present this work in written and oral form, without further permission from you.

If you agree, please say "**I agree**."

If you do not agree, please say "**I do not agree**."

Any questions before we begin the interview?

Section 2: Interview Script

Block 1: Background/Operations

Q7. Can you tell us a little bit about yourself and your organization?

Q8. What are the main priorities of your organization?

Block 2: Stakeholder Relationships

Q2.1. How does your organization engage with local, state, or federal governments?

Q2.2. How does your organization engage with industry professional organizations or advocacy groups?

Block 3: Statewide Planning

Q3.1. Is your organization of any statewide freight activity or planning group? If so, which one(s)?

Q3.2. Would you have interest in participating in a similar group specifically for maritime freight?

Q3.3. How do you or does your company participate in any State Freight Plan or State Maritime Plan strategic planning process?

Block 4: Data Generation/Collection/Management

Q4.1. What kinds of data does your organization **collect**?

Q4.2. What kinds of data does your organization **generate**?

Q4.3. Generally, how do you use the data collected or generated?

Block 5: IDOT

Q5.1. Does your organization have any interaction with IDOT? If so, how?

Q5.2. Do you think it is possible to create a partnership with IDOT if you do not already interact? If so, how?

This is the end of the interview. Thank you for your time! If you have any further questions, please do not hesitate to contact P.S. Sriraj at sriraj@uic.edu or 312-413-7568.

APPENDIX C: FIGURES PERTAINING TO METHODOLOGY

Figure 9. Map. MARAD Marine Highway System.

Figure 10. Map. National Highway Freight Network.

Source:

1. U.S. DOT Maritime Administration. (2020). *America's Marine Highway Program*. https://www.maritime.dot.gov/grants/marine-highways/marine-highway. Accessed on February 5, 2020.
2. U.S. DOT Federal Highway Administration. (2020). National Highway Freight Network Map. https://ops.fhwa.dot.gov/freight/infrastructure/nfn/maps/nhfn_map.htm. Accessed on February 5, 2020.

APPENDIX D: PM EVALUATION ALGORITHM

Name of the PM:

1. Definition:
2. Unit:
3. Source:
4. Citation:
5. Web Link:
6. Utility of PM (*Brief explanation of why this is useful for IL's performance measurement system*):
7. Is this measurement available for the IL IW freight transportation system as a whole, or for a specific location?
8. Component measures if metric (A metric is generated in combination with other measures):
9. Is datapoint publicly available? "Yes or No"

If "Yes" in 8:

i. What is the format of the published data? (xls/pdf/csv, etc)

ii. Can they be collected and populated in our database (please look at the current format of the database)? "Yes or No"

If "Yes" in 8.i:

a. Last available year:

b. First available year:

c. Update cycle:

d. Does every cycle follow the same format for publication? "Yes or No"

If "Yes" in 8.i.d:

1) Please attach a sample (if cycle is annual, then attach latest year's sample)

2) Process this sample to be included in the database

If "No" in 8.i.d:

1) How many formats are there in the available published data?

If "No" in 8.i:

a. Why cannot they be collected and populated?

(issues with this data point – data processing/proprietary/available only upon request/cannot be populated according to the current format of the database or any other issues. Be as detailed as possible, we can use this writeup in the report)

If "No" in 8:

i. Is this data collected by any private entity?

ii. Who is the owner of this data?

iii. Is this data available on request?

iv. Can this data be purchased?

v. Describe the issues with this data as detailed as possible (we can use this writeup in the report).

APPENDIX E: DATABASE USER MANUAL

USER MANUAL FOR

ILLINOIS INLAND MARINE TRANSPORTATION SYSTEM DATABASE

PREPARED BY

URBAN TRANSPORTATION CENTER

UNIVERSITY OF ILLINOIS AT CHICAGO

FOR

ICT R27-192

MARITIME FREIGHT PERFORMANCE MEASURES

SUBMITTED TO

ILLINOIS CENTER FOR TRANSPORTATION

DECEMBER 2020

Urban Transportation Center
University of Illinois at Chicago
412 S. Peoria St., 340 CUPPAH, Chicago, IL 60607-7036
www.utc.uic.edu

INTRODUCTION

The database, developed by a research team of the Urban Transportation Center at the University of Illinois at Chicago, is part of the research project "Maritime Freight Data Collection System and Database to Support Performance Measures and Market Analyses" (ICT-R27-192) sponsored by the Illinois Department of Transportation. The database is designed with the publicly available data sources to track the performance of the Illinois Marine Transportation System. A total of 21 performance measures (PMs) are selected for preliminary inclusion in this database. The PMs included are updated on an annual basis. The database is populated with data for each PM annually from 2010 until the latest period when the data are available. It is possible to periodically update the database when data for future years and/or new PM become available. The home page of the database shown in Figure 1 displays the list of PMs that are included in the database along with some additional functionalities to navigate through the database. This user manual contains a detailed description of these embedded functionalities.

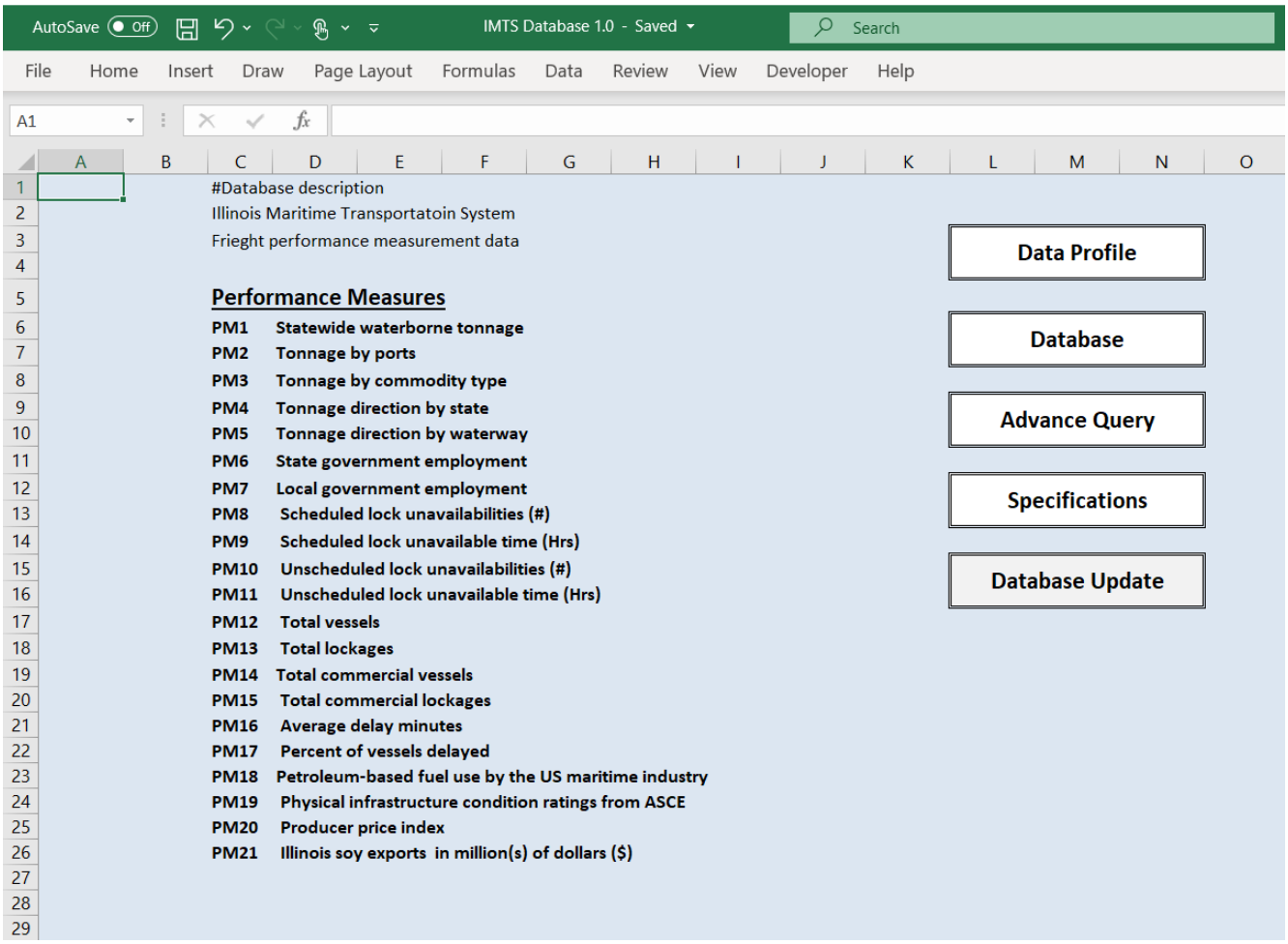


Figure 9. Image. A snapshot of the database home page.

PREREQUISITES

The database is built within **Microsoft Excel 365 MSO (16.0.13001.20266) 32-bit**. In order to experience the full functionality of the database, one must enable the “Macro” and “Visual Basics for Application (VBA)” in Microsoft Excel. These additional functionalities are usually embedded with the standard installation package; they just need to be enabled and do not require any additional purchasing. Users can check whether these are enabled or not by checking the Excel ribbon. If the ribbon contains the "Developer" tool, it means that the “Macro” and “VBA” are enabled. Otherwise, the following steps must be followed to enable them:

Step 1. File>>Options>>Add-ins>>Manage>>Excel Add-ins>>Go

>>Select"Analysis toolpack VBA">>OK

Step 2. File>>Options>>Customize Ribbon

>>Add"Developer"(if not added)

>>Select"Developer">>OK

These steps are also included in the “Database Update” function.

DATA PROFILE

The data profile is an informative summary that contains all of the PMs that have been populated in the database. The data profile provides characteristics for each PM in the database. Table 1 provides a description of the characteristics. A clickable button named “Data profile” is added on the right side of the home page for accessing the data profile.

Table 23. Data Profile Characteristics

Characteristic	Description
PM Name	Name associated with the PM populated into the database
Definition	A statement describing the specific meaning of the PM
Data Unit	Individual component providing a quantitative measurement for PM
Latest Data Year	Last year the data was readily available and collected
Year Collected	Year or range of years the data has been published by the source
Source	Name of source the data was able to be collected from
Citation	Reference for the location source
Weblink	The web address for the source of data
Data Cycle	The data update cycle, i.e., annual, biannual, etc
Utility of PM	A statement describing usefulness, benefit, and/or significance of PM
Component measures	If the PM consists of several individual data points, then a list containing such components

DATA ELEMENT INTERFACE

The “Database” button on the right side of the home page will take one to the actual database where PMs are populated. PMs are populated with annual data. In some cases, data are not available for some years. In such cases, cells are kept empty or populated with a hyphen “-“. The starting year is 2010 for every PM. Depending on the latest year’s data availability: some PMs are populated up until 2017; some until 2018, and the remaining until 2019. Nevertheless, provisions are kept for further population up until the year 2035.

While populating the database, a hierarchical approach is adopted. In this approach, the name of the PM is considered as the first level of the hierarchy. Depending on the PM, up to two additional hierarchical levels are included. The hierarchical levels associated with different PMs are listed in Table 2.

Table 24. Different Hierarchical Levels of PMs

Level 1 (PM name)	Level 2	Level 3
Statewide waterborne tonnage (in thousand tons)	Shipping Receiving Within (Intrastate)	Domestic International
Tonnage by ports (in thousand tons)	Port of Chicago, Port of Kaskaskia, Port of St. Louis.	Import Export Foreign (Import+Export) Domestic Total (Foreign+Domestic)
Tonnage by commodity type (in thousand tons)	Shipping out of IL Receiving in IL	*14 commodity types (USACE defined)*
Tonnage direction by state (in thousand tons)	Shipping out of IL Receiving in IL	*50 states*
Tonnage direction by waterways (in thousand tons)	Shipping Receiving	Illinois Waterway Upper Mississippi River Lower Upper Mississippi River Great Lakes System
State government employment Local government employment	Full-time employment (#) Full-time payroll ($ in one month) Part-time employment (#) Part-time payroll ($ in one month) Part-time hours Full-time equivalent employment (#)	N/A
Scheduled lock unavailabilities (#) Scheduled lock unavailable time (Hr) Unscheduled lock unavailabilities (#) Unscheduled lock unavailable time (Hr) Total vessels (#) Total lockages (#)	Upper Mississippi river Illinois river Ohio river Kaskaskia river Rock Island	27 locks and dams in Illinois and recently closed locks and dams #52 and #53

Level 1 (PM name)	Level 2	Level 3
Total commercial vessels (#) Total commercial lockages (#) Average delay minutes (minutes) Percent of vessels delayed (%)	St. Louis Chicago Rock Island	
Petroleum-based fuel use by maritime industry	Illinois Total Distillate Sales/Deliveries to Vessel Bunkering Consumers (Thousand Gallons) Illinois Residual Fuel Oil Sales/Deliveries to Vessel Bunkering Consumers (Thousand Gallons)	N/A
Illinois soy exports in million(s) of dollars ($)	N/A	N/A
Producer price index	Inland water freight transportation NAICS 483211 (1990 – 2019)	N/A
Physical infrastructure condition ratings from ASCE	Navigable waterways Dams Ports	N/A

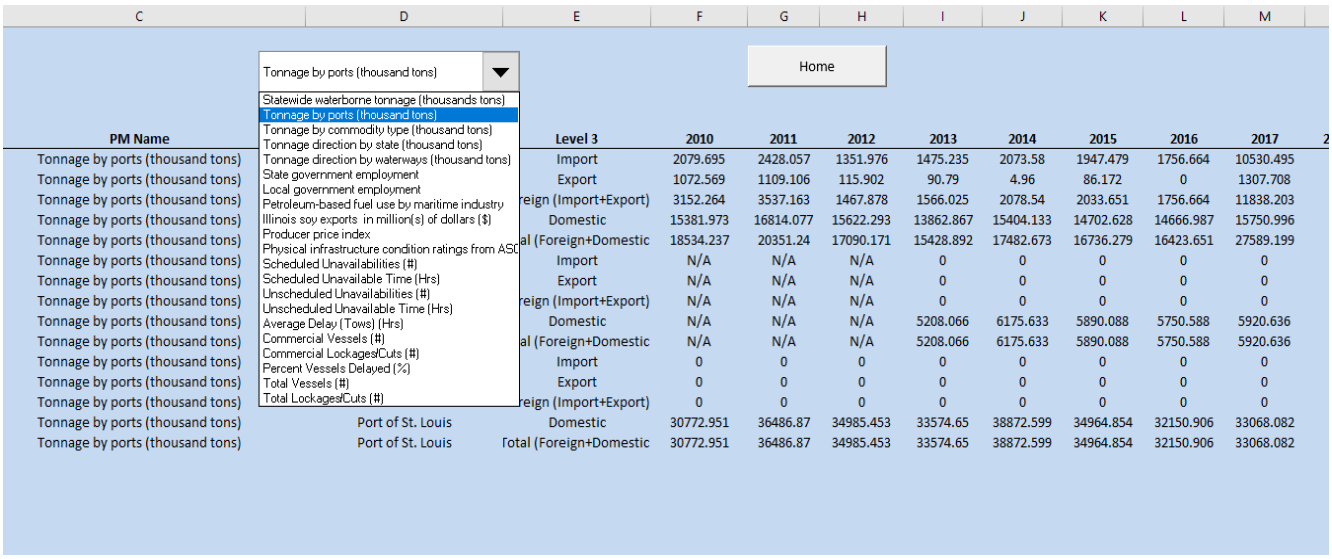
CUSTOMIZED QUERY

In order to navigate through the database conveniently, some built-in customized queries are added in the database. These queries can be accessed by the clickable button “Advance Query” introduced on the home page of the database.

The first two queries are labeled “General Queries.” The first one is to extract data by PM and the second one is to navigate through the entire database following the hierarchical levels. Then, we have three queries by tonnage, three queries by locks and dams, and two queries based on employment data.

Query by PM

This query interface can be reached by clicking on the “Query by PM” link introduced on the “Advance Query” interface. This query interface contains one combo box that lists all the PM available in the database (Figure 2). By clicking on any one of the PM from this combo box, users can extract all available data for that PM.

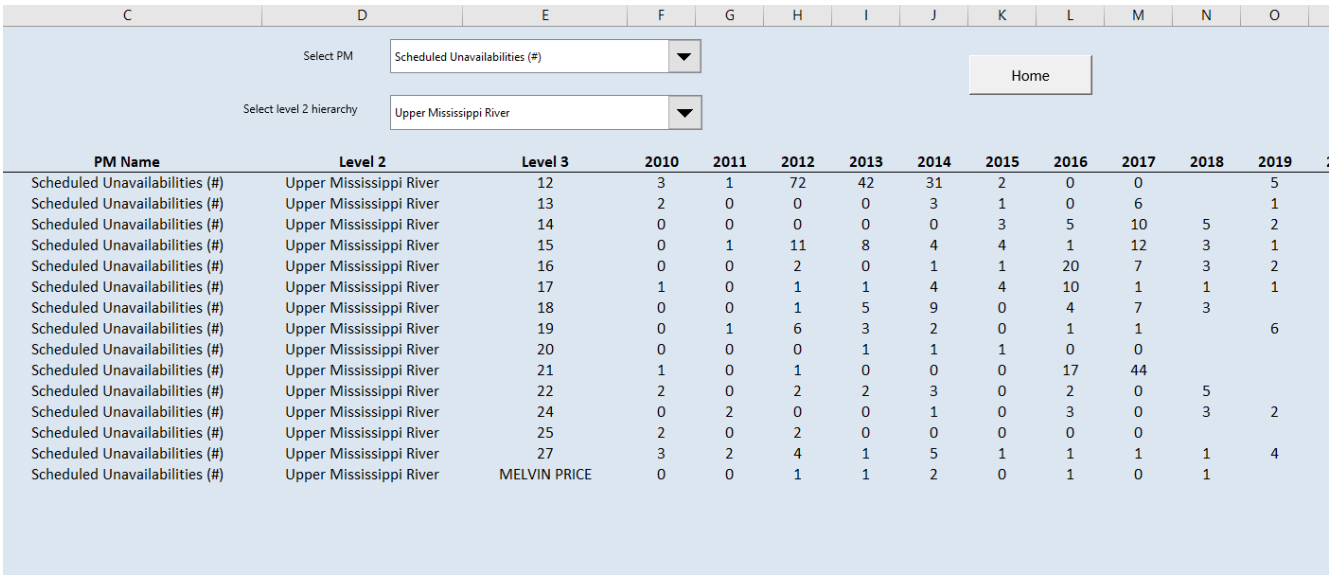


PM Name		Level 3	2010	2011	2012	2013	2014	2015	2016	2017
Tonnage by ports (thousand tons)		Import	2079.695	2428.057	1351.976	1475.235	2073.58	1947.479	1756.664	10530.495
Tonnage by ports (thousand tons)		Export	1072.569	1109.106	115.902	90.79	4.96	86.172	0	1307.708
Tonnage by ports (thousand tons)		reign (Import+Export)	3152.264	3537.163	1467.878	1566.025	2078.54	2033.651	1756.664	11838.203
Tonnage by ports (thousand tons)		Domestic	15381.973	16814.077	15622.293	13862.867	15404.133	14702.628	14666.987	15750.996
Tonnage by ports (thousand tons)		al (Foreign+Domestic	18534.237	20351.24	17090.171	15428.892	17482.673	16736.279	16423.651	27589.199
Tonnage by ports (thousand tons)		Import	N/A	N/A	N/A	0	0	0	0	0
Tonnage by ports (thousand tons)		Export	N/A	N/A	N/A	0	0	0	0	0
Tonnage by ports (thousand tons)		reign (Import+Export)	N/A	N/A	N/A	0	0	0	0	0
Tonnage by ports (thousand tons)		Domestic	N/A	N/A	N/A	5208.066	6175.633	5890.088	5750.588	5920.636
Tonnage by ports (thousand tons)		al (Foreign+Domestic	N/A	N/A	N/A	5208.066	6175.633	5890.088	5750.588	5920.636
Tonnage by ports (thousand tons)		Import	0	0	0	0	0	0	0	0
Tonnage by ports (thousand tons)		Export	0	0	0	0	0	0	0	0
Tonnage by ports (thousand tons)		reign (Import+Export)	0	0	0	0	0	0	0	0
Tonnage by ports (thousand tons)	Port of St. Louis	Domestic	30772.951	36486.87	34985.453	33574.65	38872.599	34964.854	32150.906	33068.082
Tonnage by ports (thousand tons)	Port of St. Louis	Total (Foreign+Domestic	30772.951	36486.87	34985.453	33574.65	38872.599	34964.854	32150.906	33068.082

Figure 10. Image. Query by PM interface.

Hierarchical Query

The “Hierarchical Query” link leads to a customized query to navigate through the entire database following the hierarchical levels. This query interface consists of two combo boxes (Figure 3). The first combo box asks the user to select a PM from a dropdown list that contains all the PMs introduced in the database. The second combo box is a dependent dynamic combo box which, based on the selected PM in the first combo box, will show the available levels for that particular PM. After selecting the desired level, the query will return the filtered data.



PM Name	Level 2	Level 3	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Scheduled Unavailabilities (#)	Upper Mississippi River	12	3	1	72	42	31	2	0	0		5
Scheduled Unavailabilities (#)	Upper Mississippi River	13	2	0	0	0	3	1	0	6		1
Scheduled Unavailabilities (#)	Upper Mississippi River	14	0	0	0	0	0	3	5	10	5	2
Scheduled Unavailabilities (#)	Upper Mississippi River	15	0	1	11	8	4	4	1	12	3	1
Scheduled Unavailabilities (#)	Upper Mississippi River	16	0	0	2	0	1	1	20	7	3	2
Scheduled Unavailabilities (#)	Upper Mississippi River	17	1	0	1	1	4	4	10	1	1	1
Scheduled Unavailabilities (#)	Upper Mississippi River	18	0	0	1	5	9	0	4	7	3	
Scheduled Unavailabilities (#)	Upper Mississippi River	19	0	1	6	3	2	0	1	1		6
Scheduled Unavailabilities (#)	Upper Mississippi River	20	0	0	0	1	1	1	0	0		
Scheduled Unavailabilities (#)	Upper Mississippi River	21	1	0	1	0	0	0	17	44		
Scheduled Unavailabilities (#)	Upper Mississippi River	22	2	0	2	2	3	0	2	0	5	
Scheduled Unavailabilities (#)	Upper Mississippi River	24	0	2	0	0	1	0	3	0	3	2
Scheduled Unavailabilities (#)	Upper Mississippi River	25	2	0	2	0	0	0	0	0		
Scheduled Unavailabilities (#)	Upper Mississippi River	27	3	2	4	1	5	1	1	1	1	4
Scheduled Unavailabilities (#)	Upper Mississippi River	MELVIN PRICE	0	0	1	1	2	0	1	0	1	

Figure 11. Image. General query interface.

Tonnage Queries

The database contains five PMs related to the waterborne freight tonnage. Three customized queries are introduced for navigating through the tonnage data. They are “Query by Ports,” “Query by Domestic,” and “Query by International.”

The “Query by Ports” link added under the Tonnage queries in the “Advance Query” interface will lead to a customized interface to query by ports. In this interface, there are two refresh buttons, which are required to be clicked if any updates have been made in port-related tonnage data. It is advised not to click on refresh buttons if no updates have been made since the refreshing operation may take up to several minutes. There is a built-in user form for this query, which can be accessed by clicking the button “Query.” This user form will take year and name of the port as inputs to return the tonnage values.

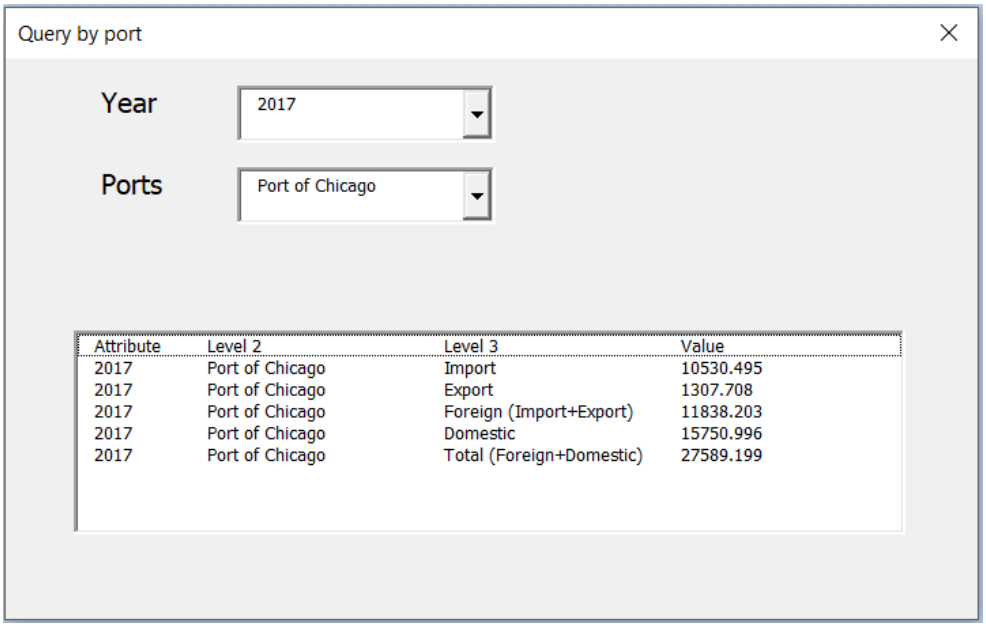


Figure 12. Image. Query by port user form.

The query interface for domestic and international tonnage also contains two clickable refresh buttons. The interface needs to be refreshed if no updates have been made in PM 1—“Statewide Waterborne Tonnage.” Please note that it is advised not to click on the refresh buttons if no updates have been made since the refreshing operation may take up to several minutes. The “Query” button will lead to a user-form that requires two inputs to filter data. The desired year needs to be specified in the first drop-down list; then the user can specify either domestic or international. There are two additional options introduced in the second drop-down list—intrastate and total. The user-form interface is shown in Figure 5.

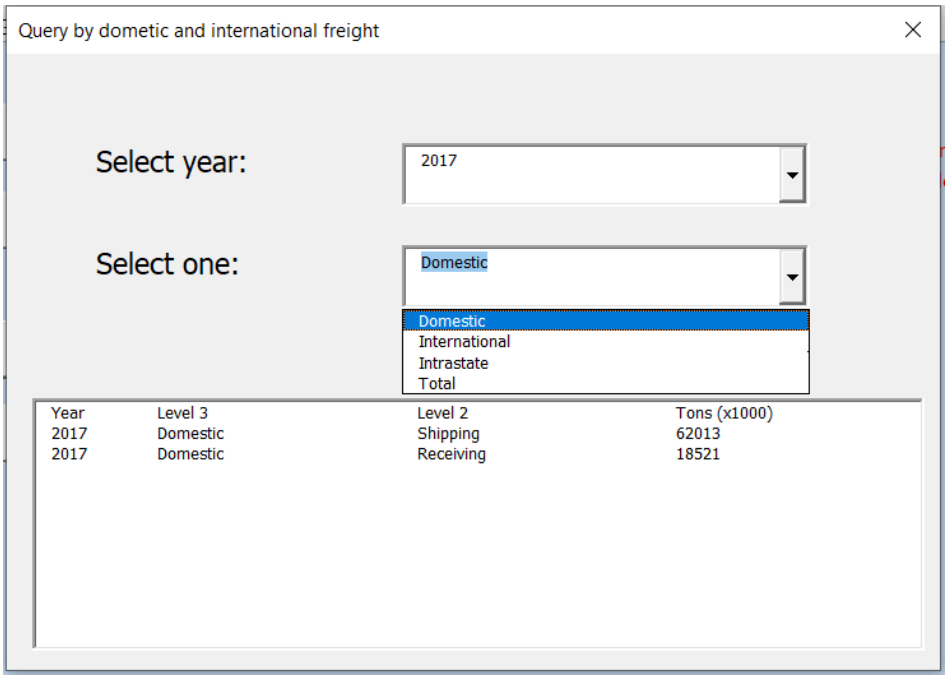
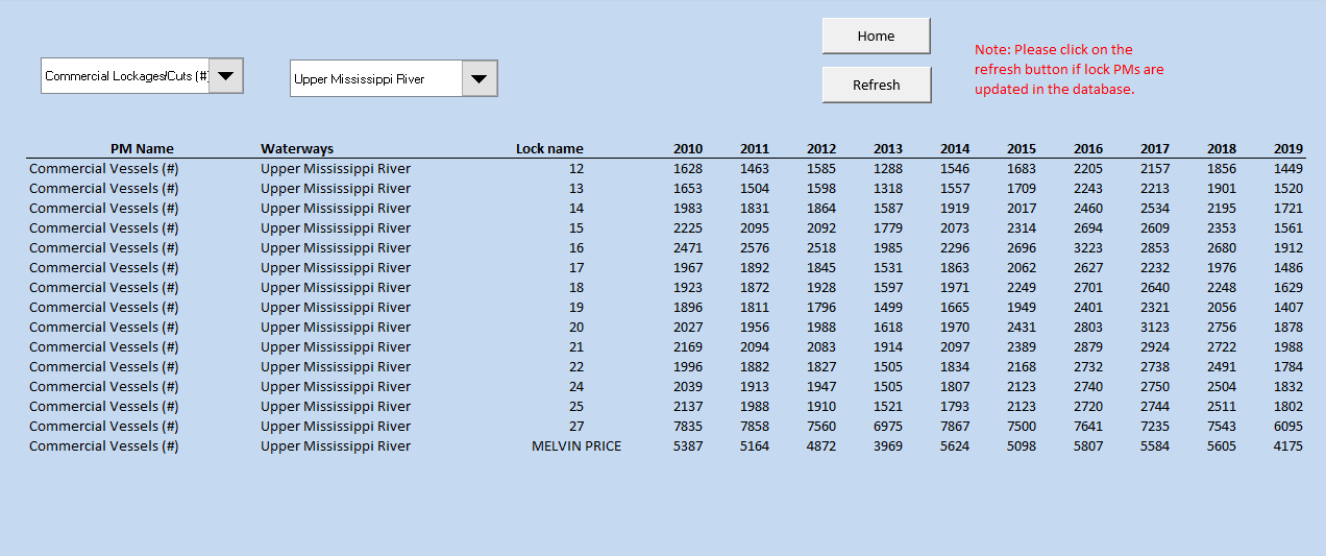


Figure 13. Image. Query by domestic/international freight user form.

Lock and Dam Queries

For accessing lock and dam data, the database contains three queries. The queries are listed in "Advance Query" under the "Lock and Dam Queries" categorization. The first query is "Query by Waterway," which sorts and filters data based on the waterway level. The link "Query by Waterway" will lead to the query interface which consists of two combo boxes. The first combo box will take the input of the PM. The second dependent dynamic combo box will show the available waterway levels for the particular PM. The query interface is also equipped with a "Refresh" button that needs to be clicked if the lock and dam data are updated in the database. The interface is shown in Figure 6. The second query, "Query by Army Corps Districts," has a similar interface and functionalities. The only difference is that the second combo box (dependent and dynamic) will return the available Army Corps of Engineers districts for the PM selected in the first combo box.

The third query, "Query of Lock and Dam Age," will lead to a summary of lock and dam information. Besides the age of locks and dams, this sheet also contains some additional information about a lock or dam, such as the waterway level, the location, the river mile points, the Army Corps district, the phone number, and the year opened.



PM Name	Waterways	Lock name	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Commercial Vessels (#)	Upper Mississippi River	12	1628	1463	1585	1288	1546	1683	2205	2157	1856	1449
Commercial Vessels (#)	Upper Mississippi River	13	1653	1504	1598	1318	1557	1709	2243	2213	1901	1520
Commercial Vessels (#)	Upper Mississippi River	14	1983	1831	1864	1587	1919	2017	2460	2534	2195	1721
Commercial Vessels (#)	Upper Mississippi River	15	2225	2095	2092	1779	2073	2314	2694	2609	2353	1561
Commercial Vessels (#)	Upper Mississippi River	16	2471	2576	2518	1985	2296	2696	3223	2853	2680	1912
Commercial Vessels (#)	Upper Mississippi River	17	1967	1892	1845	1531	1863	2062	2627	2232	1976	1486
Commercial Vessels (#)	Upper Mississippi River	18	1923	1872	1928	1597	1971	2249	2701	2640	2248	1629
Commercial Vessels (#)	Upper Mississippi River	19	1896	1811	1796	1499	1665	1949	2401	2321	2056	1407
Commercial Vessels (#)	Upper Mississippi River	20	2027	1956	1988	1618	1970	2431	2803	3123	2756	1878
Commercial Vessels (#)	Upper Mississippi River	21	2169	2094	2083	1914	2097	2389	2879	2924	2722	1988
Commercial Vessels (#)	Upper Mississippi River	22	1996	1882	1827	1505	1834	2168	2732	2738	2491	1784
Commercial Vessels (#)	Upper Mississippi River	24	2039	1913	1947	1505	1807	2123	2740	2750	2504	1832
Commercial Vessels (#)	Upper Mississippi River	25	2137	1988	1910	1521	1793	2123	2720	2744	2511	1802
Commercial Vessels (#)	Upper Mississippi River	27	7835	7858	7560	6975	7867	7500	7641	7235	7543	6095
Commercial Vessels (#)	Upper Mississippi River	MELVIN PRICE	5387	5164	4872	3969	5624	5098	5807	5584	5605	4175

Figure 14. Image. Query by waterway interface.

Employment Queries

The database contains two types of employment data. One is about state government employment and the other is about local government employment. Both are aggregated to the state level. To filter this data, we introduce two queries under “Employment Queries” in the “Advance Query” interface. The two queries are “Query by State Government” and “Query by Local Government.” By clicking on the associated links, the user will reach the query interface. Like some other customized queries, this interface also comes with two refresh buttons that need to be clicked if the employment data are updated within the main database. The “Query” button opens a user form that takes two inputs—year and employment type in two combo boxes. The user form is shown in Figure 7.

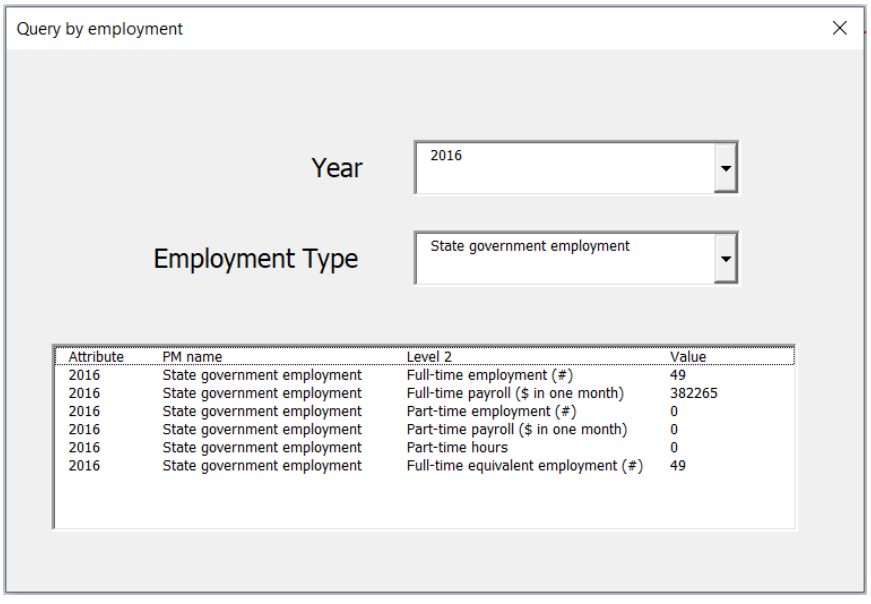


Figure 15. Image. Query by employment user form.

SPECIFICATIONS

In the “Specification” option, we included some additional information, such as 50 state names along with their abbreviations, 14 USACE-defined commodity types along with their ID codes, and 26 USACE-defined waterway regions along with their ID codes.

UPDATE PROTOCOL

The home page of the database has a clickable button named “Database Update.” This option will lead to the protocols for database updating. At the very beginning of this sheet, the steps to enable macro and VBA in Microsoft Excel are described in detail. Then, the necessary protocols for updating each PM are presented step by step. The updating protocol steps are also listed below:

PM1: **Statewide waterborne tonnage**

Step 1: Data acquisition

Download data (excel format) from external source (USACE website)

When in the website, make sure of the **year** — Click here to download

After download is done, open the excel file.

Step 2: Data processing.

The number of sheets in the downloaded excel file can vary

Make sure you are on the sheet that contains state tonnage

The sheet name can be "State_name"

If the sheet name is something else, rename it to "State_Name"

Developer>>Macro>>Select"'IMTS Database 1.0'!PM1_By_state">>Run

Step 3: Populate database

Copy already selected cells (from newly created sheet "PM1_by_state_calc")

Paste data in the database according to the year.

PM2: **Tonnage by ports**

Step 1: Data acquisition

Download data (excel format) from external source (USACE website)

You can use the same spreadsheet downloaded for PM1. — Click here to download

Step 2: Data processing.

Make sure you are on "Port_Name" sheet

Developer>>Macro>>Select"'IMTS Database 1.0'!PM2_By_port">>Run

Step 3: Populate database

Copy already selected cells (from newly created sheet "PM2_by_port_calc")

Paste data in the database according to the year.

PM 3: **Tonnage by commodity type**

Step 1: Data acquisition

Download data (excel format) from external source (USACE website)

When in the website, make sure of the **year** — Click here to download

Step 2: Data processing.

Make sure you are in the sheet with **state to state tonnage flow**

The name of this sheet can be either "$year$ - state" or "state - $year$"

Note that the sheet name can be neither of those exactly;

However, it should be easily distinguishable which sheet contain the state to state tonnage flow.

Developer>>Macro>>Select"'IMTS Database 1.0'!PM3_By_commodity_type">>Run

Step 3: Populate database

Copy already selected cells (from newly created sheet "PM3_By_comm_type_calc")

Paste data in the database according to the year.

PM4: Tonnage direction by states

Step 1: Data acquisition

Download data (excel format) from external source (USACE website)

When in the website, make sure of the **year** Click here to download

Or, you can use the same spreadsheet downloaded for PM3

Step 2: Data processing.

If you use the same spreadsheet that you used for populating PM3, then

1. Make sure you are on the **state** sheet

2. Run the the macro named "PM4_state_to_state"

Developer>>Macro>>Select"'IMTS Database 1.0'!PM3_state_to_state">>Run

If you download the spreadsheet again for PM4

Make sure you are in the sheet with **state to state tonnage flow**

The name of this sheet can be either "$year$ - state" or "state - $year$"

Note that the sheet name can be neither of those exactly;

However, it should be easily distinguishable which sheet contain the state to state tonnage flow.

Developer>>Macro>>Select"'IMTS Database 1.0'!PM3_state_to_state">>Run

Step 3: Populate database

Copy already selected cells (from newly created sheet "PM4_state_to_state_calc")

Paste data in the database according to the year.

PM 5: Tonnage direction by waterway

Step 1: Data acquisition

Download data (excel format) from external source (USACE website)

When in the website, make sure of the **year** Click here to download

Or, you can use the same spreadsheet downloaded for PM3

Step 2: Data processing.

If you use the same spreadsheet that you used for populating PM3, then

1. Make sure you are on the **region** sheet

2. Run the the macro named "PM5_direc_waterway"

Developer>>Macro>>Select"'IMTS Database 1.0'!PM5_direc_waterway">>Run

Make sure you are in the sheet with **region to region tonnage flow**

The name of this sheet can be either "$year$ - region" or "region - $year$"

Note that the sheet name can be neither of those exactly;

However, it should be easily distinguishable which sheet contain the region to region tonnage flow.

Developer>>Macro>>Select"'IMTS Database 1.0'!PM5_direc_waterway">>Run

Step 3: Populate database

Copy already selected cells (from newly created sheet "PM5_direc_waterway_calc")

Paste data in the database according to the year.

PM6: State government employment

Step 1: Data acquisition

Download data (excel format) from the external source (Census Bureau website)

When in the website, make sure of the **year** Click here to download

State and local governmnet data are in sepreate excel spreadsheet

Be sure to download to **state government** data

Step 2: Data processing.

Open the downloaded excel file

Run the macro named "PM6_state_gov_employ"

Developer>>Macro>>Select"'IMTS Database 1.0'!PM6_state_gov_employ">>Run

Step 3: Populate database

Copy already selected cells (from newly created sheet "PM6_Calculation")

Paste data in the database according to the year

PM7: Local government employment

Step 1: Data acquisition

Download data (excel format) from the external source (Census Bureau website)

When in the website, make sure of the **year** Click here to download

State and local governmnet data are in sepreate excel spreadsheet

Be sure to download to **local government** data

Step 2: Data processing.

Open the downloaded excel file

Run the macro named "PM7_local_gov_employ_v2"

Developer>>Macro>>Select"'IMTS Database 1.0'!PM7_local_gov_employv2">>Run

Step 3: Populate database

Find the desired data points

Paste data in the database according to the year

PM8: Scheduled lock unavailabilities (#)

PM9: Scheduled lock unavailable time (Hrs)

PM10: Unscheduled lock unavailabilities (#)

PM11: Unscheduled lock unavailable time (Hrs)

These PMs can be generialized as lock unavailabilities PMs.

We update these four PMs together;

First, we update them based on the waterway level; then we update for army corps districts.

1. Updating lock unavailabilities by waterway

Step 1: Data acquisition

Download data (excel format) from external source (USACE website)

When in the website, make sure of the **year** Click here to download

Note: If no dataset is shown in the webpage, search by "Lock Unavailibility"

Step 2: Data processing

Open the downloaded spreadsheet

Run the macro named "Lock_unavailities_by_waterway_update"

Developer>>Macro>>Select"Lock_unavailities_by_waterway_update">>Run

Step 3: Populate database

Copy selected cells

Select row #183 in "database" and column "$year$"

Paste selected data

2. Updating lock unavailabilities by army corp district

Step 1: Data acquisition

Use same dataset you have been using for lock usage by waterway

Step 2: Data processing

Open the downloaded spreadsheet

Run the macro named "Lock_unavailibilities_by_corps_district"

Developer>>Macro>>Select"Lock_unavailibilities_by_corps_district">>Run

Step 3: Populate database

Copy selected cells

Select row #647 in "database" and column "$year$"

Paste selected data

PM12: Total vessels

PM13: Total lockages

PM14: Total commercial vessels

PM15: Total commercial lockages

PM16: Average delay minutes

PM17: Percent of vessels delayed

These PMs can be generalized as lock usage PMs

We update these four PMs together;

First, we update them based on the waterway level; then we update for army corps districts.

1. Updating lock usages by waterway

Step 1: Data acquisition

Download data (excel format) from external source (USACE website)

When in the website, make sure of the **year** Click here to download

Note: If no dataset is shown in the webpage, search by "Lock Unavailibility"

Step 2: Data processing

Open the downloaded spreadsheet

Run the macro named "Lock_usage_by_waterway_update"

Developer>>Macro>>Select"'Lock_usage_by_waterway_update">>Run

Step 3: Populate database

Copy selected cells

Select row #298 in "database" and column "$year$"

Paste selected data

2. Updating lock usages by army corp district

Step 1: Data acquisition

Use same dataset you have been using for lock usage by waterway

Step 2: Data processing

Open the downloaded spreadsheet

Run the macro named "Lock_usage_by_corps_district"

Developer>>Macro>>Select"'Lock_usage_by_corps_district">>Run

Step 3: Populate database

Copy selected cells

Select row #473 in "database" and column "$year$"

Paste selected data

PM18 Petroleum-based fuel use by the US maritime industry

Step 1: Data acquisition

Download data from external web page. Click here to download

When in the website, make sure of the **state-Illinois**

Step 2: Data processing and populating

The downloaded data is adequetly processed

Go to the sheet name "Data 9" - vessel bunkering

Copy the latest year's data and paste it in the database

PM19 Physical infrastructure condition ratings from ASCE

Step 1: Data acquisition

Follow the attahced web link Click here

Ratings are availble in this webpage

Step 2: Populate database

Find the ratings for "Navigable waters", "Dams" and "Ports"

Update these ratings in the database (rows #760, #761, #762)

PM20: Producer price index

Step 1: Data acquisition

Download data from external web page. Click here to download

Download the entire dataset

A link should be embedded at the bottom of the demonstrative table

Step 2: Data processing

Data is adequately processed

To filter out the data, run macro "M20_Producer_price_index"

Developer>>Macro>>Select"'IMTS Database 1.0'!M20_Producer_price_index">>Run

Step 3: Database populating

Find the latest year's data from the filtered data

Populate according to the year

PM21 **Illinois soy exports in million(s) of dollars ($)**

Step 1: Data acquisition

Follow the attached web link Click here

Select Illinois in the map (shown in website)

Select latest year

Select commodity

Step 2: Populate database

Select export value in million dollars

Copy the value and paste in the database according to the year

CODE BASE

The code for this database is written in Microsoft Visual Basic for Application 7.1.


Illinois Department
of Transportation


ILLINOIS