**U.S. Port Performance Index**

The U.S. Port Performance Index will provide a comprehensive evaluation of U.S. port operations through time. The index will measure port performance across several dimensions, providing insights into port infrastructure, service, operational efficiency, economic contribution, technological innovation and environmental impact. A data dashboard will provide users with visualizations to interact with and better understand port performance data. The index, and all supporting data will be made publicly available for download.

Measures of port performance:

* Infrastructure: terminals, cranes, rail infrastructure,
  + # of container terminals, # of cranes, capacity of cranes, # of terminals with rail access, capacity of rail access, # of bulk terminals, dock storage capacity, berth depth, berth length ([docks and anchorages](https://geospatial-usace.opendata.arcgis.com/datasets/0f4b16ba76e542e888343907eba91aea_0/explore?location=1.319682%2C12.111796%2C1.22), [complete dock list](https://ndclibrary.sec.usace.army.mil/resource/b625649b-4c33-46a2-fadf-d263f02ebf63), [master dock file](https://ndclibrary.sec.usace.army.mil/resource/9019f037-5c29-4d2b-d726-eb41268ef79c), [roll on roll off facilities](https://geodata.bts.gov/datasets/ff5f787f987c4686b3a79d3dc5b3daa2_0/explore?location=47.271726%2C-122.374461%2C13.02), [intermodal rail facilities](https://data-usdot.opendata.arcgis.com/datasets/e6332597fcd546d3899f60ec9b9157b9_0/explore?location=47.556381%2C-122.309458%2C13.29),)
* Service: throughput, origin-destination markets, hours of operation, costs (terminal fees, container rates)
  + # of vessel calls, # of import countries, # of import regions, # of export countries, # of export regions, pickup/delivery hours of operation, monthly capacity, volume throughput ([AIS](https://hub.marinecadastre.gov/pages/vesseltraffic), [international trade data](https://www.census.gov/data/developers/data-sets/international-trade.html))
* Efficiency: dwell time, capacity utilization, throughput
  + time at dock for each vessel, time at anchor for each vessels, daily # of vessels calls, avg # of vessels at dock at any time, avg # of vessels at anchor at any time, # of vessels awaiting berth, berth turnover time, TEUs/terminal, TEUs/crane, TEUs/labor-hour, TEUs/call ([AIS](https://hub.marinecadastre.gov/pages/vesseltraffic), [international trade data](https://www.census.gov/data/developers/data-sets/international-trade.html))
* Environmental: pollution, emissions
  + Electric shore power, operating time within port waters (not anchored), total time within port waters (including anchored), population weighted pollution, port ([AIS](https://hub.marinecadastre.gov/pages/vesseltraffic), [complete dock list](https://ndclibrary.sec.usace.army.mil/resource/b625649b-4c33-46a2-fadf-d263f02ebf63), [master dock file](https://ndclibrary.sec.usace.army.mil/resource/9019f037-5c29-4d2b-d726-eb41268ef79c))
* Technology/Innovation: automation, smart systems
* Economic Impact: employment, revenue, gdp
  + Port employment, transportation and warehousing employment, contribution to regional gdp, port revenue ([bureau of labor statistics](https://fred.stlouisfed.org/series/SMU53426444340008901A))

Primary data sources:

* [Automated Information System data from Marine Cadastre](https://hub.marinecadastre.gov/pages/vesseltraffic): location and status of vessels at point in time
  + Infrastructure
    - We can infer from the AIS data the types of docks, refueling, bulk, container, repair etc.
      * Unsupervised learning infer dock type by type of ship that most frequently visits the dock…, multi-dimensional clustering algorithm
    - We can also use the USACE dock data, to inform dock type which can be used to derive statistics (e.g., time at berth should be a loading/unloading facility with cranes)
    - Avg size of vessel seen at each dock
  + Efficiency:
    - time at dock for each vessel,
    - time at anchor for each vessel,
    - daily # of vessels processed (vessel calls),
    - max # of vessels at dock at any time,
    - max # of vessels at anchor at any time,
    - avg # of vessels at dock at any time,
    - avg # of vessels at anchor at any time,
    - # of vessels awaiting berth,
      * Identify if a vessel is at the berth that I am headed to while I am within X radius of dock. If yes, then count me as a vessel awaiting berth.
      * Maximum number of vessels awaiting berth at anytime throughout the month, at a point in time.
      * Average number of vessels awaiting berth at anytime throughout the month. For each hour, count the number of vessels awaiting berth at the top of the hour. Average across all hours within the month.
    - time awaiting berth,
      * Identify if a vessel is at the berth that I am headed to while I am at within X radius of dock. If the berth is occupied, count the time that I spend waiting; from when I arrive at anchor or idle in port water, to the time that I head into berth.
    - berth turnover time,
      * time from when a vessel leaves a berth, to the time the next vessel arrives at the berth (probably conditioned on that a vessel was awaiting berth)
    - berth utilization,
      * percent of time berth is occupied
    - time from within X miles of port to anchored or at berth or idle, (needs check)
  + Environmental/health:
    - time from within X miles of port to anchored or at berth or idle (repeat) (eventually calculate population weighted impacts),
    - time at dock for each vessel,
    - time at anchor for each vessel,
  + Reliability:
    - Standard deviation of:
      * berth turnover time,
      * time from entry to U.S. waters to port (anchored or at berth),
      * time at dock for each vessel,
      * time at anchor for each vessel,
      * time awaiting berth,

Radius

Overlapping month

* [International Trade data](https://www.census.gov/data/developers/data-sets/international-trade.html): monthly trade volumes and values by origin-destination by commodity (imports and exports)
  + TEUs (total, import/export, by commodity),
  + bulk volume (total, import/export, by commodity),
  + $ value of throughput (total, import/export, by commodity),
  + Volume across trade lanes
    - Origins and destinations, and some stats about # of origin-destinations, regions, concentration…
* [Docks and Anchorages](https://geospatial-usace.opendata.arcgis.com/datasets/0f4b16ba76e542e888343907eba91aea_0/explore?location=1.319682%2C12.111796%2C1.22): locations and characteristics of docks and anchorages
  + # of terminals, berth depth, berth length, # of cranes, capacity of cranes, dock storage, rail access, rail capacity
* [Complete Dock List](https://ndclibrary.sec.usace.army.mil/resource/b625649b-4c33-46a2-fadf-d263f02ebf63) and [Master Dock File](https://ndclibrary.sec.usace.army.mil/resource/9019f037-5c29-4d2b-d726-eb41268ef79c)
  + # of cranes, capacity of cranes, # of terminals with rail access, # of bulk terminals, dock storage,
* [Roll on Roll off Facilities](https://geodata.bts.gov/datasets/ff5f787f987c4686b3a79d3dc5b3daa2_0/explore?location=47.271726%2C-122.374461%2C13.02) and [Intermodal Rail Facilities](https://data-usdot.opendata.arcgis.com/datasets/e6332597fcd546d3899f60ec9b9157b9_0/explore?location=47.556381%2C-122.309458%2C13.29)
  + # of container terminals, # of terminals with rail access, capacity of rail access, # of bulk terminals

Other data:

* [Port Statistical Areas](https://geospatial-usace.opendata.arcgis.com/datasets/b7fd6cec8d8c43e4a141d24170e6d82f_0/explore?location=37.726825%2C-121.381459%2C9.16): polygon shapes of port waters
* [Principal Ports](https://data-usdot.opendata.arcgis.com/datasets/e3b6065cce144be8a13a59e03c4195fe_0/explore?location=30.935049%2C103.249967%2C1.99): list and rank of marine ports
* [NOAA Port Coastal Chart Raster](https://encdirect.noaa.gov/): coastal navigation shape files

From the AIS data:

**(revisit later)**

**~~1. CPPI (Container Port Performance Index):~~** ~~A global metric evaluating container handling efficiency based on operational factors.~~

* **~~Data to Cover~~**~~:~~
* **~~Arrival Port Limits~~** ~~– The point when the ship enters the port's jurisdiction.~~
* **~~All Lines Fast~~** ~~– The moment when all mooring lines are secured, and the ship is safely docked.~~
* **~~First Lift~~** ~~– The first container or cargo handling operation begins (loading or unloading).~~
* **~~Last Lift~~** ~~– The final container or cargo operation is completed.~~
* **~~All Lines Up~~** ~~– The point when all mooring lines are released, preparing the ship for departure.~~
* **~~Exit Port Limits~~** ~~– The moment when the ship exits the port's jurisdiction.~~
* **~~Data Sources~~**~~: S&P Global’s Port Performance Program~~

**~~2. Cost Efficiency:~~** ~~Evaluates the cost-efficiency of a port in delivering its services, including both operational processes and cargo handling activities.~~

**~~Data to Cover~~**~~:~~

* + **~~Operational costs per TEU/ton~~**~~: The cost incurred per unit of cargo handled at the port (containers or bulk).~~
  + **~~Labor and service costs~~**~~: The costs associated with employing labor and port services per operation.~~
  + **~~Cost comparison~~**~~: Benchmarks comparing the cost of operation against other U.S. or international ports to determine relative efficiency.~~
  + **~~Maintenance and capital expenditure~~**~~: The costs related to port infrastructure upkeep, equipment, and technology.~~
  + **~~Energy and fuel costs~~**~~: The expenses related to energy consumption (e.g., electricity, fuel for port equipment, and ships) to maintain port operations.~~
  + **~~Customs and security fees~~**~~: The fees imposed for customs clearance, security screenings, and other regulatory checks.~~
* **~~Data Sources~~**~~:~~

**~~3. Cargo and Land Dwell Time~~**~~: This metric measures the total time cargo and associated land operations take after unloading, excluding the ship's call time. It includes all the processes that affect the time goods spend in the port before leaving, which are not captured by the CPPI.~~

* **~~Data to Cover~~**~~:~~
  + **~~Total cargo dwell time~~**~~: The complete time cargo (containers, bulk, liquid) remains in the port before and after unloading/uploading, waiting for onward transport.~~
  + **~~Bunkering time~~**~~: The time spent refueling the vessel, which may impact overall cargo movement and port operations.~~
  + **~~Customs clearance time~~**~~: The duration taken for regulatory inspections and customs checks.~~
  + **~~Warehousing/terminal storage time~~**~~: Time spent in the port’s storage facilities, including waiting for trucks, trains, or other transportation.~~
  + **~~Intermodal transfer time~~**~~: The time required to transfer cargo from ships to other transport modes (e.g., trucks, rail), including coordination delays.~~
  + **~~Cargo inspection/security clearance time~~**~~: Time spent on cargo inspection, security checks, or other regulatory requirements not part of CPPI.~~
  + **~~Land-side transportation delays~~**~~: Time taken for trucks or other land-based vehicles to arrive for cargo pickup.~~
  + **~~Administrative or documentation delays~~**~~: Additional time caused by delays in paperwork, documentation, or other non-operational bottlenecks.~~
* **~~Data Sources~~**~~:~~

**~~4~~**~~.~~ **~~Capacity Utilization~~**~~: This metric evaluates how effectively a port utilizes its available capacity, including both storage facilities and physical infrastructure, to handle current and projected volumes of cargo.~~

* **~~Data to Cover~~**~~:~~
  + **~~Berth utilization~~**~~: The percentage of time berths are occupied by vessels versus total available time, reflecting how efficiently the port handles arriving ships.~~
  + **~~Yard and storage utilization~~**~~: The percentage of available yard and terminal space being used for container and bulk cargo storage, indicating how efficiently storage capacity is managed.~~
  + **~~Warehousing capacity~~**~~: The extent to which warehousing facilities are used, including both short-term and long-term storage.~~
  + **~~Infrastructure utilization~~**~~: The degree to which port infrastructure (e.g., cranes, loading/unloading equipment, road/rail connectivity) is used relative to its maximum potential.~~
  + **~~Capacity vs. demand~~**~~: A comparison of current cargo volumes against the port’s designed throughput capacity, highlighting any under- or over-utilization.~~
  + **~~Expansion capacity~~**~~: The port’s ability to scale up operations during periods of peak demand, including any expansion plans or infrastructure developments in the pipeline.~~
* **~~Data Sources~~**~~:~~
  + ~~.~~

**~~5. Digitization~~**~~: This element assesses the level of technology integration and automation in port operations, focusing on how these advancements improve efficiency, safety, and decision-making.~~

* **~~Data to Cover~~**~~:~~
  + **~~Use of automation~~**~~:~~
    - **~~Automated container handling~~**~~: The extent to which cranes, trucks, and other equipment are automated, reducing reliance on manual labor and increasing operational speed.~~
    - **~~Automated stacking systems~~**~~: How efficiently containers are stacked and organized based on priority (e.g., first-in, first-out), ensuring quicker access to containers scheduled for early pickup.~~
    - **~~Automated yard management~~**~~: Systems that automate the movement and storage of containers within the yard, optimizing space and reducing dwell time.~~
    - **~~Automated gate operations~~**~~: Use of automated gates for trucks and vehicles entering and exiting the port, minimizing congestion and wait times.~~
  + **~~Smart port initiatives~~**~~:~~
    - **~~Use of AI and IoT~~**~~: Adoption of artificial intelligence, machine learning, and Internet of Things (IoT) technologies for predictive analytics, real-time monitoring, and improved decision-making.~~
    - **~~Real-time monitoring systems~~**~~: Use of digital dashboards or control centers that offer live data on port operations, allowing for immediate adjustments and optimization.~~
* **~~Data Sources~~**~~:~~

**~~6. Economic Impact~~**~~: evaluates how a port contributes to local, regional, and national economies.~~

* **~~Data to Cover~~**~~:~~
  + **~~Direct employment~~**~~: Number of jobs directly created by the port, including operational, managerial, and logistical roles.~~
  + **~~Indirect and induced employment~~**~~: Jobs created in related sectors like logistics, warehousing, and transportation.~~
  + **~~Revenue contribution~~**~~: The total revenue generated from port operations, tariffs, and related services.~~
  + **~~GDP contribution~~**~~: How much the port contributes to the GDP of its region or the national economy.~~
* **~~Data Sources~~**~~:~~

**~~7. Environmental Impact~~**~~: Measures the port’s effect on the environment, with an emphasis on sustainability and compliance with regulations.~~

* **~~Data to Cover~~**~~:~~
  + **~~Emission levels~~**~~: Measuring CO2, NOx, and other pollutants emitted by port activities.~~
  + **~~Energy consumption~~**~~: Breakdown of renewable versus non-renewable energy usage.~~
  + **~~Sustainability programs~~**~~: Initiatives like electrification of port equipment, waste management, and pollution reduction.~~
  + **~~Water and waste management~~**~~: How the port handles waste disposal and pollution control, including runoff and water usage.~~
  + **~~Compliance with environmental laws~~**~~: The port’s adherence to local, state, and federal environmental regulations.~~
* **~~Data Sources~~**~~:~~