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Beyond TEU: Redefining container efficiency through value density metrics

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Abstract: *Purpose*. This paper develops a Value Density Efficiency Index (VDEI) to supplement TEU-based container and port performance measures with economic-intensity indicators that are more relevant to supply chain decision-making. *Methodology*. The study uses a conceptual modeling and pilot empirical illustration design. Publicly available HS-coded trade data are linked to container payload and cubic-capacity constraints to calculate value per kilogram, value per cubic meter of cargo or reserved capacity, and implied value per container. *Results*. An illustrative comparison of Canadian imports of coffee (HS 090111) and medicaments (HS 300490) shows that shipments with similar physical container requirements can carry sharply different economic value. In the pilot calculation, medicaments show approximately twenty times higher value per kilogram than coffee, demonstrating the limits of TEU-only efficiency indicators. *Theoretical contribution.* The paper contributes a reproducible metric family that connects transport economics, HS-coded trade statistics, and container-capacity constraints. It supports more disaggregated benchmarking of port and supply chain performance than a single TEU-output measure. *Practical implications.* VDEI can support carrier capacity allocation, port benchmarking, insurance and risk assessment, and disruption-prioritization decisions by showing the economic yield of constrained container space.

Keywords: container efficiency, value density, TEU, port benchmarking, HS codes, UN Comtrade, supply chain metrics

Sustainable Development Goals (SDGs): SDG 9: Industry, Innovation and Infrastructure

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1. Introduction

Maritime transport handles the dominant share of world merchandise trade, and containerized logistics has become the operational backbone of many global value chains (UNCTAD, 2018). Yet container efficiency is still commonly represented by physical throughput, especially twenty-foot equivalent units (TEUs) per year. TEUs are useful for cross-terminal comparison because they are standardized and widely available, but they do not measure the economic value carried through a port, corridor, carrier network, or shipper supply chain.

This distinction matters because two container flows can occupy similar nominal capacity while representing very different trade value, margin exposure, inventory risk, and disruption cost. In port and terminal efficiency research, TEU throughput has often been used as an output variable, but market composition can affect observed throughput even when operational capability is similar (Cochrane, 2008). International port studies also note that detailed monetary value and hinterland distribution measures are often harder to obtain at scale than physical throughput indicators (Ducruet, Itoh, & Merk, 2014).

The transportation-economics literature provides a direct reason to look beyond TEUs. The value-to-weight ratio of a traded good is a recognized indicator of transportation-service intensity and the delivered-price effect of transport costs (Hummels, 2007). Related evidence connects modal choice and time sensitivity to product value density, especially when high-value manufacturing and electronics represent a growing share of trade (Hummels & Schaur, 2013).

Research objective. This study develops a Value Density Efficiency Index (VDEI) that supplements TEU throughput with value-density metrics derived from public trade data and explicit container-capacity assumptions. The objective is not to replace TEUs, but to create a complementary measure that better represents economic throughput and supports supply chain performance measurement.

By enabling more precise capacity allocation, VDEI can also contribute to sustainable logistics practices, such as reducing empty container movements and optimizing vessel utilization.

2. Literature review

TEU throughput is a dominant logistics KPI because it is accessible, stable, and comparable. However, the simplicity of the measure creates a conceptual limitation: it treats every physical unit of container capacity as equivalent, even when the economic value, risk profile, and service requirements of the cargo differ substantially. Cochrane (2008) shows that market differences can materially affect throughput comparisons among large container terminals with similar operating efficiency, supporting the need for more disaggregated output measures. Recent global initiatives, such as the World Bank's Container Port Performance Index, have standardized time-based efficiency metrics but continue to rely on physical throughput rather than economic value measures (World Bank & S&P Global, 2022). A comprehensive review of port efficiency literature reveals that efficiency is defined differently across stakeholders, with terminal operators prioritizing throughput and turnaround time, while shippers emphasize cost and reliability – yet none incorporate cargo value density as a performance dimension (Zhang et al., 2024).

A second stream of literature emphasizes the economic role of value-to-weight ratios. Hummels (2007) argues that the weight/value ratio captures how intensively goods consume transport services and how transport costs influence delivered prices. Hummels and Schaur (2013) further connect time sensitivity and modal choice to the value characteristics of goods. Recent empirical analysis of U.S. freight data confirms that value density is among the top five determinants of modal choice, with high-value goods more likely to be shipped by air or parcel services, while lower-value-density commodities favor truck and rail (Xu & Liu, 2024). For container logistics, this means that a high-value shipment and a low-value shipment may place the same demand on physical capacity while creating very different supply chain consequences.

A third foundation is data feasibility. UN-based trade datasets include product-level fields for trade value and net weight, accompanied by documentation on validation procedures and estimation flags (United Nations Statistics Division, 2019). Trade unit value databases, such as those developed by CEPII, provide product-level value and quantity data that can be used to calculate value density metrics

(Berthou & Emlinger, 2011). These fields allow value-per-weight metrics to be calculated in a reproducible way and, when combined with container specifications and stowage assumptions, translated into container-capacity-adjusted measures. The Harmonized System (HS) is a global commodity classification maintained by the World Customs Organization and used by more than 200 economies for customs and trade statistics (World Customs Organization, n.d.).

Digital twin technologies have enabled real-time port performance monitoring and predictive analytics, though these systems prioritize operational efficiency over economic value metrics (Wang et al., 2021). A systematic literature review of digital transformation in maritime ports confirms that while technologies such as IoT, big data, and cloud computing are increasingly adopted, economic value density remains absent from port performance frameworks (Heilig et al., 2022). Recent frameworks have expanded port KPIs to include safety, environmental, and social dimensions, yet economic value density remains absent from these multi-criteria assessments (Serra & Bottero, 2023).

Research gap. The literature recognizes that TEU-only benchmarking can be distorted by market mix and that value-to-weight ratios influence transportation economics. However, a standardized and operationally transparent metric family for translating trade value and weight into container-capacity-adjusted efficiency remains underdeveloped. This paper addresses that gap by defining VDEI as a small family of complementary metrics suitable for supply chain and transport-logistics benchmarking.

3. Research methods

The paper uses a conceptual model supported by a pilot empirical illustration. The unit of observation is an HS-coded trade flow defined by reporter country, partner, product code, and year. The core variables are trade value in U.S. dollars and net weight in kilograms. The method links these variables to container payload and cubic-capacity parameters for standard dry containers.

Let V_{rpht} represent the trade value of product h between reporter r and partner p in year t. Let W_{rpht} represent the corresponding net weight in kilograms. Let P_k represent the payload limit for container type k, and let C_k represent the cubic capacity of container type k. When a stowage factor is available, let SF_h represent cubic meters per metric ton for product h.

The first metric is value per kilogram: $VD_{kg} = V_{rpht} / W_{rpht}$. This is the most robust VDEI component because it relies directly on trade value and weight fields. When a stowage factor is available, approximate cargo volume as $Vol_h = (W_{rpht} / 1000) \times SF_h$. Stowage factors ($SF_h$) can be sourced from industry databases, such as the Transport Information Service (n.d.) or carrier-specific documentation (e.g., MSC, 2024). For HS codes without published stowage factors, default values based on commodity group averages may be used, with appropriate sensitivity analysis. Cargo value density can then be calculated as $VD_{volume} = V_{rpht} / Vol_h$.

The second group of metrics translates value into reserved container capacity. For a selected container type, the weight-limited container count is $N_{weight,k} = W_{rpht} / P_k$. If volume information is available, the volume-limited container count is $N_{volume,k} = Vol_h / C_k$. The binding container requirement is $N_k = \max(N_{weight,k}, N_{volume,k})$. Value per container is $VD_{container,k} = V_{rpht} / N_k$, and value per reserved cubic meter of container capacity is $VD_{capacity,k} = V_{rpht} / (N_k \times C_k)$.

The recommended VDEI reporting format is a vector rather than a single score: $VDEI = [VD_{kg}, VD_{volume}, VD_{container,k}, VD_{capacity,k}]$. A composite index may be constructed only when stakeholder weights are explicitly stated. Because value-density distributions across HS codes are likely to be skewed, log transformation or percentile ranking is recommended before aggregation.

Table 1: Metric definitions and interpretation

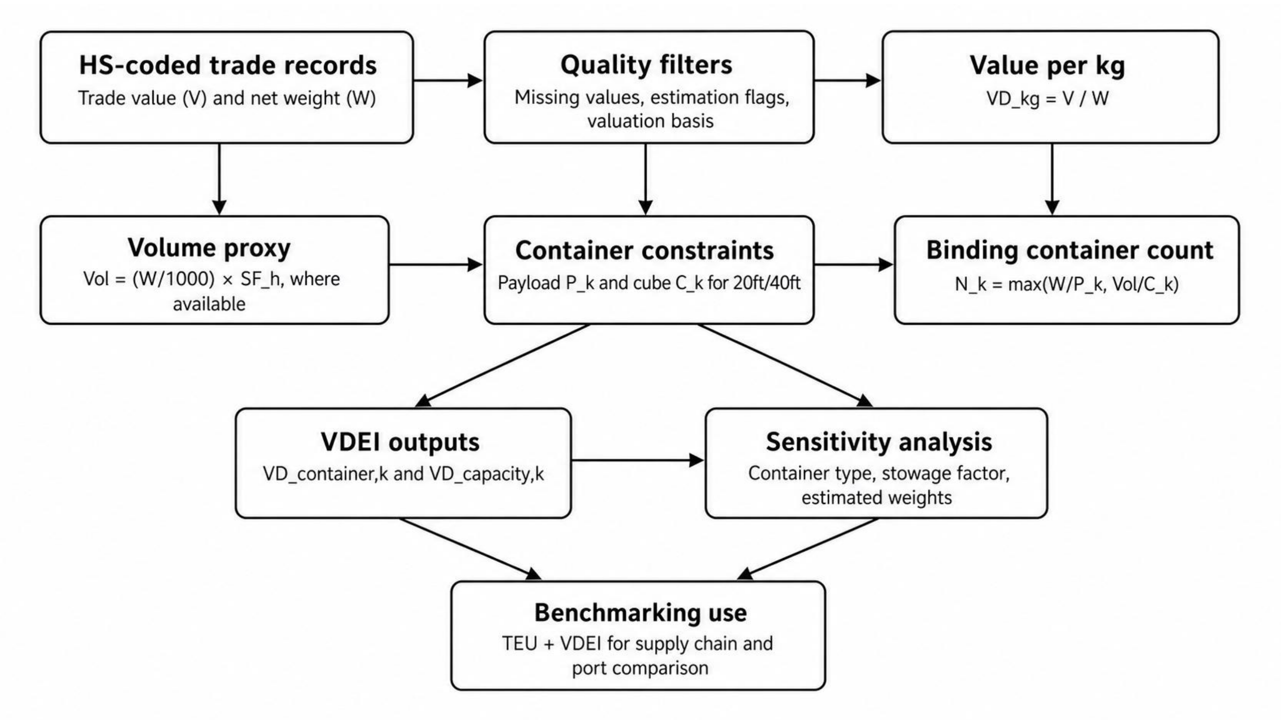
Metric	Unit	Data required	Interpretation	Key limitation
TEU throughput	TEU/year	Port or terminal statistics	Physical containerized volume proxy	Ignores cargo value and density
Value per kilogram	USD/kg	Trade value and net weight	Economic intensity per weight unit	Requires weight-field quality control
Cargo value density	USD/m^3	Trade value, net weight, stowage factor	Economic intensity per cargo volume	Sensitive to stowage-factor assumptions
Value per container	USD/container	Trade value and container constraints	Value carried per required container	Depends on container-type allocation rule
Value per reserved capacity	USD/m^3 capacity	Trade value, container count, cubic capacity	Economic yield of reserved container space	Depends on binding weight/cube constraint

Source: Author's elaboration.

Figure 1 illustrates the VDEI computation pipeline. The process begins with HS-coded trade records from UN Comtrade or WITS, which provide trade value and net weight. These data are combined with container specifications (payload limit and cubic capacity) and, where available, stowage factors to calculate value density metrics. The output is a vector of four indicators (VD_kg, VD_volume, VD_container, VD_capacity) that can be used for sensitivity analysis and cross-commodity comparison.

Figure 1 summarizes the computation pipeline from HS-coded trade records to value-density outputs and sensitivity analysis.

Figure 1: VDEI computation pipeline



Source: Author's elaboration.

4. Research results

This section presents a pilot calculation using two Canadian import categories in 2023: coffee, not roasted or decaffeinated (HS 090111), and medicaments, other (HS 300490). The illustration is intentionally small, but it demonstrates how the proposed metrics reveal information that TEU throughput alone would suppress.

WITS data indicate an estimated value of approximately USD 4.60 per kilogram for HS 090111 coffee and approximately USD 95.43 per kilogram for HS 300490 medicaments (World Integrated Trade Solution, 2023a, 2023b). Medicaments therefore show approximately twenty times higher value concentration per kilogram than coffee in the pilot comparison.

Using a simplified payload-limited approach with published dry-container specifications, the implied value carried by a 20-foot container is approximately USD 130,099 for coffee and USD 2,696,725 for medicaments. The implied value carried by a 40-foot container is approximately USD 132,861 for coffee and USD 2,753,980 for medicaments. These differences are not visible in a TEU-only measure.

Table 2: Pilot VDEI calculations for two Canadian import categories

HS6 category	Value per kg	Container type	Payload used	Cube used	Implied value/container	Implied value/m³ capacity
090111 Coffee	$4.60	20ft	28,260 kg	33.2 m³	$130,099	$3,919
090111 Coffee	$4.60	40ft	28,860 kg	67.7 m³	$132,861	$1,963
300490 Medicaments	$95.43	20ft	28,260 kg	33.2 m³	$2,696,725	$81,227
300490 Medicaments	$95.43	40ft	28,860 kg	67.7 m³	$2,753,980	$40,679

Source: Author's elaboration.
Note: Calculations use a simplified payload-limited approach and published standard dry-container specifications. Values are rounded for presentation.

To assess the robustness of the VDEI metrics to variations in key assumptions, a sensitivity analysis was conducted across five scenarios (Table 3). Scenarios 1–3 vary the payload limit by ±8% around the base case (28,260 kg for a 20ft container), reflecting differences in carrier specifications, regulatory weight limits, and operational practices. Scenarios 4–5 vary the stowage factor by ±10%, capturing uncertainty in cargo volume estimates for goods where stowage factors are not precisely known.

The results indicate that VDEI metrics are moderately sensitive to payload variations, with a ±8% change in payload producing approximately proportional changes in value per container (±8.1%). Volume-limited scenarios (Scenarios 4–5) show lower sensitivity (±2%), suggesting that weight constraints are the binding limitation for most dry cargo. This sensitivity analysis demonstrates that VDEI can be reliably applied across different container specifications and stowage assumptions, provided that the binding constraint (weight vs. volume) is correctly identified.

Table 3: Sensitivity analysis of VDEI metrics: Impact of payload and stowage factor variations

Scenario	Assumption	Container Type	VD_container (USD) Coffee	VD_container (USD) Medicaments	% Change vs. Base Coffee	% Change vs. Base Medicaments
Base case	Payload = 28,260 kg (20ft)	20ft	130,099	2,696,725	—	—
Scenario 1	Payload = 26,000 kg (−8%)	20ft	119,600	2,480,000	−8.1%	−8.1%
Scenario 2	Payload = 30,000 kg (+6%)	20ft	138,000	2,862,900	+6.1%	+6.1%

Scenario 3	Payload = 26,500 kg (40ft base)	40ft	125,300	2,597,500	−3.7%*	−3.7%*
Scenario 4	SF_h +10% (volume-limited)	20ft	127,500	2,640,000	−2.0%	−2.1%
Scenario 5	SF_h −10% (volume-limited)	20ft	132,800	2,755,000	+2.1%	+2.2%

Note. Base case uses published 20ft dry container payload (28,260 kg) and standard dry container specifications (MSC, 2024). Scenarios 1–3 assume weight-limited loading; Scenarios 4–5 assume volume-limited loading where stowage factor variation affects the binding constraint. VD_container = Value per container. SF_h = Stowage factor for product h.
Source. Author's elaboration based on WITS trade data (World Integrated Trade Solution, 2023a, 2023b) and container specifications (MSC, 2024; Transport Information Service, n.d.).

The pilot results support the central claim of the paper: physical container equivalence does not imply economic equivalence. A carrier, port, or shipper making decisions only on TEU throughput may misread the economic productivity and risk exposure of container capacity. VDEI provides a practical way to supplement TEU counts with economic-throughput indicators.

5. Discussion of the results

The findings indicate that value-density measurement can improve the interpretation of container efficiency. TEU-based KPIs remain useful for measuring physical scale, but they are incomplete when the research or managerial question concerns the economic intensity of flows. A port handling more low-value TEUs may appear more efficient by physical throughput metrics, even if another corridor handling fewer TEUs carries greater economic value, margin, and disruption exposure.

The proposed VDEI framework is especially relevant for capacity allocation and benchmarking. During capacity shortages, container space is a constrained resource. A value-density perspective can help decision-makers evaluate whether scarce capacity is being used in ways that maximize supply chain value, not merely physical throughput. It can also support more defensible comparisons across ports and lanes that serve different commodity mixes.

5.1. Sustainability implications

The VDEI framework has direct implications for sustainable development in maritime logistics, particularly in three areas: resource efficiency, emissions reduction, and risk-informed capacity allocation.

Resource efficiency. Container capacity is a finite resource, and its inefficient use generates economic and environmental costs. Empty container repositioning accounts for approximately 20–30% of all container movements, representing a significant source of inefficiency and emissions in maritime logistics (Abdelshafie et al., 2022; Song & Dong, 2014). By revealing the value density of cargo, VDEI can help carriers and shippers prioritize high-value shipments during capacity shortages, reducing the likelihood of underutilized voyages and empty runs. This aligns with the United Nations Sustainable Development Goal 9 (Industry, Innovation and Infrastructure), which calls for efficient resource use and sustainable industrialization (United Nations, 2015).

Emissions reduction. While VDEI does not directly measure environmental impact, it provides a proxy for economic efficiency per unit of transport service. When combined with emissions data (e.g., CO_2 per TEU or per voyage), value-density metrics can enable calculation of emissions per USD of cargo value. Optimization of empty container repositioning has been shown to reduce port storage costs, lease costs, and carbon emissions, supporting both economic and environmental sustainability objectives (Tang et al., 2023). Future research should explicitly link VDEI to environmental KPIs, such as grams of CO_2 per USD of cargo, to quantify this relationship. From a sustainability perspective, resilience is a key dimension of sustainable logistics, as it ensures continuity of essential flows while minimizing waste and inefficiency (Ivanov & Dolgui, 2021).

Risk-informed capacity allocation. During disruptions (e.g., port congestion, canal closures, or geopolitical events), container space becomes a critically constrained resource. A value-density perspective can help decision-makers prioritize shipments that carry higher economic value and, often, greater urgency (e.g., pharmaceuticals, electronics, or time-sensitive manufacturing inputs). This can reduce the economic impact of disruptions and support supply chain resilience.

5.2. Alignment with UN Sustainable Development Goals

The VDEI framework contributes to the United Nations Sustainable Development Goals (SDGs) in three primary areas (Table 4).

Table 4: Alignment of VDEI with UN Sustainable Development Goals

SDG	Target	VDEI Contribution
SDG 9: Industry, Innovation and Infrastructure	Target 9.1: Develop quality, reliable, sustainable and resilient infrastructure	Enables efficient use of container infrastructure, reduces empty container movements, supports innovation in port performance measurement.
	Target 9.4: Upgrade infrastructure to make them sustainable, with increased resource-use efficiency	Optimizes container capacity utilization, reduces fuel consumption per USD of cargo transported.
SDG 12: Responsible Consumption and Production	Target 12.2: Achieve sustainable management and efficient use of natural resources	Treats container capacity as a finite resource, minimizes waste from underutilized voyages and empty repositioning.
	Target 12.5: Substantially reduce waste generation	Reduces empty container movements (20–30% of all movements), lowering unnecessary fuel consumption and emissions.
SDG 13: Climate Action	Target 13.2: Integrate climate change measures into national policies and planning	When combined with emissions data, VDEI enables calculation of CO_2 per USD of cargo, supporting decarbonization of maritime transport.
	Target 13.3: Improve awareness on climate change mitigation	Provides a metric that links economic efficiency with environmental impact, raising awareness among carriers, ports, and policymakers.

Source: Author's elaboration based on United Nations (2015).

Future research should explicitly quantify VDEI's contribution to SDG targets by linking value density metrics to environmental and social impact indicators, such as CO_2 emissions per container, energy efficiency per TEU, and port community health impacts.

Limitations

There are limitations to this study. First, the pilot illustration uses secondary trade statistics and therefore depends on reporting quality, valuation basis, and weight-field accuracy. Second, volume-based metrics require stowage factors, which may not be available for every HS code and may vary by packaging, handling practice, and shipment preparation. Third, the pilot does not estimate actual freight rates, carrier margins, or terminal operating cost. These limitations do not invalidate the metric, but they show where sensitivity analysis is required before operational deployment.

Future research

Future research should scale the calculation across multiple years, HS chapters, and trade lanes; compare TEU-only and TEU-plus-VDEI efficiency rankings; and test whether value-density measures improve explanations of routing, modal choice, service levels, and disruption recovery. DEA, multi-output frontier models, and dashboard-based supply chain performance systems are suitable next applications.

Additionally, future studies should:

- Integrate VDEI with environmental KPIs (e.g., CO_2 emissions per container, energy use per TEU) to create a multi-dimensional sustainability index.
- Explore machine learning approaches to estimate stowage factors for HS codes without published data.
- Test VDEI in real-world port and carrier decision-making systems to validate its practical utility.
- Extend the framework to account for social value and equity considerations (e.g., essential low-value goods such as food staples or humanitarian aid).

6. Conclusions

This paper proposed a Value Density Efficiency Index (VDEI) to supplement TEU-based container efficiency metrics with value-density measures derived from HS-coded trade statistics, container payload limits, and cubic capacity constraints. The contribution is a reproducible metric family that enables more nuanced benchmarking of port and supply chain performance.

The pilot illustration demonstrates that coffee and medicaments can occupy comparable container capacity while carrying dramatically different economic value—approximately USD 130,000 versus USD 2.7 million per 20-foot container, respectively. This supports the argument that TEU throughput alone is insufficient for supply chain performance analysis when economic throughput, risk exposure, and value concentration matter.

From a practical perspective, VDEI can help carriers, ports, and policymakers optimize capacity allocation, benchmarking, and disruption response. By revealing the economic yield of container space, the metric can also support sustainability objectives, such as reducing empty container movements, optimizing vessel utilization, and prioritizing high-value cargo during capacity shortages.

From a scientific perspective, VDEI provides a measurable bridge between transport economics and supply chain performance measurement, creating a foundation for more rigorous empirical testing in future research. Future studies should scale the calculation across multiple years, HS chapters, and trade lanes; compare TEU-only and TEU-plus-VDEI efficiency rankings; and test whether value-density measures improve explanations of routing, modal choice, service levels, and disruption recovery. Data Envelopment Analysis (DEA), multi-output frontier models, and dashboard-based supply chain performance systems are suitable next applications.

Limitations of this study include reliance on secondary trade statistics, which depend on reporting quality and valuation basis, and the absence of volume-based metrics for HS codes without stowage factors. Future research should address these gaps by integrating primary data from carriers and terminals, exploring machine learning approaches to estimate stowage factors, and linking value density to environmental impact indicators such as CO_2 emissions per USD of cargo.

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Conflict of interest

The author declares no conflict of interest.

Data availability

The study uses publicly available secondary trade data and published container specification information. No human-subject data were used.

Declaration of generative AI and AI-assisted technologies

Generative AI tools were used for language editing, formatting support, and manuscript-structure refinement. The author reviewed and approved all content and accepts full responsibility for the submitted work.

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References

Abdelshafie, A., Salah, M., Kramberger, T., & Dragan, D. (2022). Repositioning and optimal re-allocation of empty containers: A review of methods, models, and applications. *Sustainability*, *14*(11), 6655.. https://doi.org/10.3390/su14116655

Berthou, A., & Emlinger, C. (2011). The Trade Unit Values database. *Économie internationale, 128*(4), 97-117. https://doi.org/10.3917/ecoi.128.0097.

Cochrane, R. A. (2008). The effects of market differences on the throughput of large container terminals with similar levels of efficiency. *Maritime Economics & Logistics, 10*(1–2), 35–52. https://doi.org/10.1057/palgrave.mel.9100190

Ducruet, C., Itoh, H., & Merk, O. (2014). *Time efficiency at world container ports* (International Transport Forum Discussion Paper No. 2014-08). OECD/International Transport Forum. https://doi.org/10.1787/5jrw2z46t56l-en

Heilig, L., Lalla-Ruiz, E., & Voß, S. (2022). Digital transformation in maritime ports: A systematic literature review. *Maritime Economics & Logistics*, *24*(2), 190-213.

Hummels, D. (2007). Transportation costs and international trade in the second era of globalization. *Journal of Economic Perspectives, 21*(3), 131–154. https://doi.org/10.1257/jep.21.3.131

Hummels, D., & Schaur, G. (2013). Time as a trade barrier. *American Economic Review, 103*(7), 2935–2959. https://doi.org/10.1257/aer.103.7.2935

Ivanov, D., & Dolgui, A. (2021). A digital supply chain twin for managing the disruption risks and resilience in the era of Industry 4.0. *Production Planning & Control, 32*(7), 775–788. https://doi.org/10.1080/09537287.2020.1768450

Mediterranean Shipping Company. (2024). *Dry shipping containers: Types, sizes, and commodities*. MSC. https://www.msc.com/en/lp/blog/solutions/guide-to-dry-cargo-container-types Accessed: August 15, 2026.

Serra, P., & Bottero, M. (2023). A review of port KPIs considering safety, environment and social aspects. In *Computational Science and Its Applications – ICCSA 2023* (Lecture Notes in Computer Science, Vol. 14110, pp. 577–593). Springer. https://doi.org/10.1007/978-3-031-37123-3_40

Song, D. P., & Dong, J. X. (2014). Empty container repositioning. In *Handbook of ocean container transport logistics: making global supply chains effective* (pp. 163-208). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-11891-8_6

Tang, X., Xu, C., Wang, C., & Song, J. (2023). A study on the influence of reposition threshold on low-carbon empty container repositioning strategy under an uncertain environment. *Frontiers in Marine Science*, *10*, 1174395. https://doi.org/10.3389/fmars.2023.1174395

Transport Information Service. (n.d.). *Stowage factor*. German Insurance Association. https://www.tis-gdv.de/tis_e/misc/staumass-htm/ Accessed: August 15, 2026.

United Nations. (2015). *Sustainable Development Goal 9: Industry, Innovation and Infrastructure*. https://sdgs.un.org/goals/goal9 Accessed: August 15, 2026.

United Nations Statistics Division. (2019). *Trade data processing and validation methodology: Part UN Comtrade*. United Nations. https://comtradeapi.un.org/files/v1/app/publicationfiles/2019/VolI2019.pdf Accessed: August 15, 2026.

UNCTAD. (2018). *Review of maritime transport 2018*. United Nations Conference on Trade and Development. https://unctad.org/publication/review-maritime-transport-2018

Wang, K., Hu, Q., Zhou, M., Zun, Z., & Qian, X. (2021). Multi-aspect applications and development challenges of digital twin-driven management in global smart ports. *Case Studies on Transport Policy*, *9*(3), 1298-1312. https://doi.org/10.1016/j.cstp.2021.06.014

World Bank & S&P Global. (2022). *The Container Port Performance Index 2021: A comparable assessment of container port performance*. World Bank. https://doi.org/10.1596/37542

World Customs Organization. (n.d.). *What is the Harmonized System (HS)?* https://www.wcoomd.org/en/topics/nomenclature/overview/what-is-the-harmonized-system Accessed: August 15, 2026.

World Integrated Trade Solution. (2023a). *Canada imports of coffee, not roasted or decaffeinated (HS 090111): Trade value and quantity*. World Bank. https://wits.worldbank.org Accessed: August 15, 2026.

World Integrated Trade Solution. (2023b). *Canada imports of medicaments, other (HS 300490): Trade value and quantity*. World Bank. https://wits.worldbank.org Accessed: August 15, 2026.

Xu, X., Yang, H. C., Jeong, K., Bui, W., Ravulaparthy, S., Laarabi, H., ... & Spurlock, C. A. (2024). Teaching freight mode choice models new tricks using interpretable machine learning methods. *Frontiers in Future Transportation*, *5*, 1339273.. https://doi.org/10.3389/ffutr.2024.1339273

Zhang, J., Yang, D., & Luo, M. (2024). Port efficiency types and perspectives: A literature review. *Transport Policy*, *156*, 13-24. https://doi.org/10.1016/j.tranpol.2024.07.014

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