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Suez Canal Traffic Dynamics 2008–2025: External Shocks, Structural Change, and Their Relevance to the Suez Canal Authority's 2030 Strategic Agenda

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Abstract

The Suez Canal carries roughly 10–12 percent of world maritime trade, making its traffic fluctuations an important indicator for global supply chains. This study analyzes secondary data from eighteen Suez Canal Authority (SCA) annual reports (2008–2025), covering four data groups: annual transits and net tonnage (with a historical series back to 1975), monthly traffic, fleet composition by ship type, and cargo volume by sailing direction. In addition to longitudinal descriptive analysis, the study applies segmented (interrupted time series) regression to the 1976–2025 series, a counterfactual loss estimate, the Herfindahl–Hirschman Index (HHI) of ship-type composition, and a directional imbalance index. The analysis identifies four external shocks of distinctly different character: the 2009 global financial crisis (cargo −22.6%), the COVID-19 pandemic in 2020 (cargo −2.5%), the 2021 Ever Given grounding, which did not interrupt annual growth, and the 2024 Red Sea security crisis, which cut transits by 50.0% and cargo volume by 65.4% within a single year. The 2024–2025 crisis was highly asymmetric: container ships lost 88.6% of their net tonnage, and their share of total tonnage collapsed from a peak of 60.6% (2015) and 41.9% (2023) to 14% (2024–2025), while tankers proved comparatively resilient and became the backbone of remaining traffic. Segmented regression shows that of the three interventions tested (2009, 2016, 2024), only the Red Sea crisis constitutes a statistically significant discontinuity in the long-run trend (level shift −67.1%; $p < 0.001$), with a counterfactual loss of approximately 1.96 billion net tons over 2024–2025; the ship-type HHI, which had reached its most diversified point in 2023 (2,869), rose back to 3,318 in 2024 as the axis of dominance shifted from containers to tankers. Monthly data for 2025 indicate a gradual recovery in the second half of the year, led by the south–north flow (+20.4%) and the LNG segment (+137% in vessel count). The empirical findings are then mapped against the SCA's five strategic agendas toward 2030 (environmental sustainability, operational efficiency, economic competitiveness, digital transformation, and human capital); the results show that the 2008–2025 traffic data provide quantitative justification primarily for the first three agendas, in particular revenue diversification beyond transit tolls and green incentives to win back the container segment.

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1. Introduction

The Suez Canal is the shortest sea route between Asia and Europe and a principal source of foreign exchange for Egypt. Because of its position as a chokepoint of world trade, handling roughly 10–12 percent of global maritime commerce and about 30 percent of container trade [10], [11] the canal's traffic statistics are widely used as a barometer of global seaborne trade. Recent systemic-risk modelling estimates that trade exposed to disruption at maritime chokepoints amounts to hundreds of billions of US dollars annually, with the Suez Canal among the passages contributing most to expected losses [1]. Simulation studies of chokepoint closures likewise identify the Suez route as one of the closures with the largest global shipping impact [2], and agent-based modelling shows that chokepoint disruption propagates strongly into specific commodity systems such as the global LNG trade [5].

A rapidly growing literature has examined individual disruptions of the canal. For the COVID-19 pandemic, comparative work found that container shipping proved considerably more resilient in 2020 than during the 2008–2009 financial crisis, with demand-side contraction rather than route disruption as the dominant mechanism [7], [8]. The March 2021 grounding of the megaship Ever Given, which closed the canal for six days, has been analyzed extensively from supply chain risk [6] and cost perspectives, generally concluding that its measurable effects, while acute, were short-lived. The Red Sea crisis that began in November 2023 has attracted the largest body of work: network studies document the mass rerouting of container services around the Cape of Good Hope and the associated increases in distance, time, and cost [3], [12]; AIS-based analyses show reduced vessel counts and altered vessel behavior in the Red Sea while the global shipping network as a whole remained resilient [4]; and institutional reports quantify the collapse of Suez transits and the surge of Cape of Good Hope arrivals through 2024 [10], [11]. In parallel, a separate strand of literature has begun to examine the canal's forward-looking positioning, notably its potential role as a green shipping and hydrogen corridor under the SCA's Green Canal 2030 strategy [13].

Three gaps remain. First, most quantitative studies of the Red Sea crisis rely on commercial AIS or high-frequency data over short observation windows; few exploit the SCA's own official statistics, which offer a consistent, audited format across five decades and therefore permit all four recent shocks — financial, pandemic, operational, and security-related — to be compared within a single long-run framework. Second, the existing event studies rarely test formally whether a given shock constitutes a structural discontinuity in the canal's long-run trajectory or merely a transitory deviation. Third, no study to date has systematically confronted the empirical traffic record with the SCA's own strategic agenda toward 2030, even though that agenda — environmental sustainability, operational efficiency,

economic competitiveness, technological transformation, and human capital development [15] — is precisely a response to the risks the traffic record reveals.

This study addresses these gaps using eighteen SCA annual reports (2008–2025) [14] and the SCA's strategic planning document [15]. It asks four questions: (1) what is the long-run trajectory of traffic volume and tonnage through the canal; (2) what are the magnitude and character of each external shock, tested formally through segmented regression; (3) how did the structure of traffic — fleet composition and sailing direction — change during and after the largest shock in 2024; and (4) to what extent do the empirical findings support the challenges and initiatives formulated in the SCA's strategy toward 2030. The contribution is threefold: a consolidated 1975–2025 panel built from official sources; formal statistical evidence distinguishing transitory from structural shocks; and a quantitative cross-mapping between the traffic record and the canal authority's strategic agenda.

2. Data and Methods

This study uses a descriptive quantitative approach applied to secondary data from eighteen SCA annual reports (report years 2008 through 2025) [14]. Each report contains four standard tables: Table 1 (the series of vessel numbers and net tonnage since 1975), Table 2 (monthly traffic for the two most recent years), Table 3 (vessels and net tonnage by ship type), and Table 4 (cargo tonnage by north–south and south–north sailing direction).

Data from all reports were consolidated into three panels: an annual panel (1975–2025), a monthly panel, and a ship-type panel. Cross-validation was performed by comparing figures for the same year across different report editions; for example, the 2008 figures in the 2008 report were checked against the historical series in the 2025 report. The analysis covers annual growth rates, average net tonnage per vessel as a proxy for ship size, ship-type shares of total tonnage, and directional ratios. Two tonnage measures in the SCA reports must be distinguished: net tonnage, which is the basis for transit tolls, and cargo tonnage, which measures actual loads; the two are analyzed separately.

As a second source, the study uses the SCA's strategic planning (inception report) document, which formulates five groups of challenges facing the canal authority — environmental sustainability, operational efficiency, economic competitiveness, technological transformation, and human capital — together with response measures, including a short-term plan for 2026–2027 and a long-term plan for 2028–2030 [15]. The correlational analysis is qualitative: each challenge and initiative in that document is mapped against quantitative evidence from the annual-report panels, to assess which agendas receive the strongest empirical support from actual traffic patterns.

2.1 Advanced analytical techniques

Four quantitative techniques are applied beyond descriptive statistics. First, a segmented (interrupted time series, ITS) regression is estimated on the natural logarithm of annual net tonnage over 1976–2025 with the specification $\ln Y_t = \beta_0 + \beta_1 t + \Sigma_k[\gamma_k D_{kt} + \delta_k D_{kt}(t - T_k)] + \varepsilon_t$, with intervention points $T_k \in \{2009, 2016, 2024\}$ representing, respectively, the global financial crisis, the full operation of the New Suez Canal, and the Red Sea crisis. The coefficient γ_k measures the post-intervention level shift and δ_k the change in trend slope; 1975 is excluded as it was not a full year of operation. As a sensitivity check, data-driven breakpoint detection (dynamic programming

with a quadratic cost function) is run without pre-specifying break locations.

Second, the loss attributable to the Red Sea crisis is estimated counterfactually: a log-linear trend is fitted to 2010–2023, extrapolated to 2024–2025, and the gap between projection and realization is interpreted as tonnage lost relative to a no-crisis scenario. Third, the concentration of traffic composition is measured with the Herfindahl–Hirschman Index (HHI), the sum of squared net-tonnage shares of nine ship types per year (scale 0–10,000), computed for all years 2007–2025. Fourth, directional imbalance is measured with the index (NS − SN)/(NS + SN), where NS and SN denote north–south and south–north cargo respectively; the index equals zero under perfectly balanced flows.

3. Results

3.1 Long-run trends, 1975–2025

The historical series in the 2025 report displays a distinctive pattern: the number of transiting vessels has remained broadly flat within a 13,000–26,000 range for five decades, while net tonnage has multiplied. In 1976, the first full year after the canal's reopening, 16,806 vessels carried 187.8 million net tons, an average of about 11 thousand tons per vessel. In 2023, vessel numbers reached a record 26,434 with net tonnage of 1,568.3 million tons, an average of about 59 thousand tons per vessel. Capacity growth over five decades has thus been driven far more by growth in ship size than by transit frequency.

Within the focal period 2008–2025, the growth path divides into several phases. After the 2009 correction, traffic recovered and moved sideways over 2010–2014 at around 17,000 vessels per year. The opening of the New Suez Canal's parallel channel in August 2015 was followed by an expansion phase in 2016–2019, when net tonnage rose from 974.2 to 1,207.1 million tons and cargo volume passed 1 billion tons (1,031.2 million tons in 2019) for the first time. The historical peak was reached in 2023 with 26,434 vessels, net tonnage of 1,568.3 million tons, and cargo of 1,322.7 million tons.

Table 1. Key indicators of Suez Canal traffic in selected years

Year	Vessels	Net tonnage (million tons)	Cargo (million tons)	Note
2008	21,415	910.1	723.0	Pre-financial-crisis peak
2009	17,228	734.5	559.2	Global financial crisis
2015	17,483	998.7	822.9	New Suez Canal opening
2019	18,880	1,207.1	1,031.2	Cargo first exceeds 1 billion tons
2020	18,830	1,169.0	1,005.1	COVID-19 pandemic
2021	20,694	1,274.8	1,088.9	Ever Given incident
2023	26,434	1,568.3	1,322.7	Historical record
2024	13,213	524.5	457.8	Red Sea crisis
2025	12,758	522.1	464.4	Stabilization and early recovery

Source: compiled from SCA annual reports 2008–2025 [14].

3.2 Comparing four shocks

The four shocks in the study period differ sharply in magnitude and duration. The 2009 financial crisis cut vessel numbers by 19.6% and cargo by 22.6%; recovery to pre-crisis cargo levels took about five years (2013 cargo of 754.5 million tons only then surpassed the 2008 level). The COVID-19 pandemic depressed cargo by only 2.5% in 2020, with the pressure concentrated in the south–north flow (−12.5%), reflecting weak European demand, while the north–south flow actually rose 5.5% — a pattern consistent with the demand-driven, route-preserving character of the pandemic shock documented for container shipping generally [7], [8]. The Ever Given grounding of March 2021, despite closing the canal for nearly a week, is invisible in annual data: 2021 recorded vessel growth of 9.9% and cargo growth of 8.3%, consistent with assessments that its supply chain effects, while acute, were short-lived [6].

The Red Sea crisis produced a correction of a different order of magnitude. Vessel numbers in 2024 fell by exactly 50.0% to 13,213, net tonnage collapsed by 66.6%, and cargo by 65.4%. The much deeper fall in tonnage than in vessel numbers indicates that the largest ships diverted via the Cape of Good Hope in the greatest proportions, consistent with fleet-level evidence that ultra-large container vessels led the diversion [3], [11]; average net tonnage per vessel fell from 59.3 thousand tons (2023) to 39.7 thousand tons (2024).

3.3 Asymmetric impact by ship type

Table 3 of the 2024 report shows that the Red Sea crisis was anything but uniform. Container ships lost 70.1% of transits and 88.6% of net tonnage within a year (from 657.0 million tons in 2023 to 74.8 million tons in 2024). Car carriers fell 88.7%, LNG carriers 85.5%, and passenger ships 82.1%. By contrast, tankers fell only 41.3% and bulk carriers 42.9%, close to the overall average decline.

The composition of traffic consequently changed drastically. The container share of total net tonnage collapsed from 41.9% (2023) to 14% (2024 and 2025), while the tanker share rose from 26.5% to 46–47%. This pattern is consistent with differences in cost and risk structure across segments: liner container networks operating fixed schedules under high insurance premia opted for full rerouting [3], [12], while parts of tramp shipping, such as tankers, proved more tolerant of transit risk.

3.4 Recovery signals in 2025

The 2025 annual figures (12,758 vessels; net tonnage 522.1 million tons) are nearly identical to 2024, but monthly data reveal the dynamics hidden beneath them. The first half of 2025 remained below the same period of 2024, whereas from July the direction reversed: December 2025 recorded 1,138 vessels with net tonnage of 50.4 million tons, up about 30% on December 2024 (38.8 million tons) and the highest-tonnage month since the crisis began.

The recovery is also asymmetric by direction and segment. South–north cargo grew 20.4% to 146.9 million tons, while the north–south flow still fell 5.4%, leaving total 2025 cargo up a modest 1.4% at 464.4 million tons. By ship type, the LNG segment recorded the sharpest rebound (vessel count

+137.0%; net tonnage +132.4%), followed by car carriers (+46.7%) and Ro/Ro (+14.3%). Container ships rose slightly in number (+5.3%) but their net tonnage still fell 3.1%, indicating that what has returned so far are small-to-mid-size container vessels, not the mega-ship fleets of the Asia–Europe trades.

3.5 Segmented regression and counterfactual estimates

The ITS estimates (Table 2) show an underlying net-tonnage growth trend of 3.2% per year ($\beta_1 = 0.0312$; $t = 11.45$) with $R^2 = 0.934$. Of the three interventions tested, only the 2024 Red Sea crisis produces a statistically significant discontinuity: a level shift of −1.112 in log scale ($t = -5.88$; $p < 0.001$), equivalent to a 67.1% decline relative to the trend path. By contrast, the level and slope dummies for 2009 and 2016 are insignificant at the 5% level, meaning that the global financial crisis and the New Suez Canal opening did not alter the long-run trajectory separately from its underlying growth. Data-driven breakpoint detection confirms this picture from another angle: the breaks identified in the level series fall in 1981 and the mid-2000s — the long-run expansion waves — not in the demand-shock years.

Table 2. Segmented regression results, ln (net tonnage), 1976–2025

Variable	Coefficient	Std. error	t-statistic	Interpretation
Constant	5.487	0.051	108.10	—
Trend	0.031	0.003	11.45	Baseline growth 3.2%/year
Level 2009	0.159	0.115	1.39	Not significant
Slope 2009	0.010	0.028	0.37	Not significant
Level 2016	−0.083	0.159	−0.52	Not significant
Slope 2016	0.020	0.036	0.54	Not significant
Level 2024	−1.112	0.189	−5.88	−67.1% decline; $p < 0.001$
R^2	0.934			n = 50

Source: authors' estimates from SCA annual report data [14].

The counterfactual estimate reinforces these magnitudes. The 2010–2023 log-linear trend grows at 4.2% per year and projects net tonnage of 1,472 million tons for 2024 and 1,534 million tons for 2025. Realizations were 525 and 522 million tons respectively, so tonnage lost relative to a no-crisis scenario reaches 948 million tons (2024) and 1,012 million tons (2025) — a cumulative loss of roughly 1.96 billion net tons over two years, or 64–66% below the projected path in each year.

3.6 Traffic concentration and directional imbalance

The HHI computed over nine ship types' net-tonnage shares reveals structural dynamics invisible in aggregate figures. Concentration peaked in 2014–2015 (HHI 4,171–4,216), when container ships alone controlled 60.3–60.6% of net tonnage, then declined almost monotonically to 2,869 in 2023 — the most diversified composition in two decades — as the tanker share rose from

12.5% (2011) to 26.5% (2023). The Red Sea crisis reversed this diversification: the HHI climbed back to 3,318 (2024) and 3,119 (2025), but with the axis of dominance shifting from containers (14% in 2024–2025) to tankers (46–47%). The canal is once again concentrated in a single segment — merely a different one from the previous decade.

The directional imbalance index shows a similar structural shift. Flows were roughly balanced in 2013–2016 (index +2.8% to −2.2%), after which the north–south imbalance strengthened gradually to +13.5% in 2023. The 2024 crisis more than tripled it to +46.7%, as the south–north flow (dominated by Asian exports to Europe, especially containers) collapsed more deeply than its counterpart. In 2025 the index eased to +36.8%, and it is precisely the recovery of the south–north flow (+20.4%) that constitutes the single largest component of that year's improvement in total cargo.

4. Discussion

Three principal findings emerge. First, the canal's sensitivity to shocks is not uniform, and the difference is now statistically confirmed. Segmented regression shows that the global demand shock (2009) and the capacity intervention (2015–2016) produced no significant discontinuity in the long-run trend — their deviations were transitory and reabsorbed by the underlying 3.2% annual growth — whereas the 2024 security shock is the only significant level break (−67.1%; $p < 0.001$), with a counterfactual loss of about 1.96 billion net tons in two years. This asymmetry between demand-side and security-side shocks aligns with the broader chokepoint-risk literature, which attributes the bulk of expected chokepoint losses to geopolitical rather than cyclical hazards [1], [2]. For the canal authority, and for Egypt as recipient of transit revenue, the dominant risk has shifted from cyclical to geopolitical, a risk outside the canal's operational control.

Second, the 2024–2025 crisis restructured the canal's user base, and the HHI analysis places that change in longer context. Before the crisis, traffic composition was actually moving toward diversification: container dependence fell from a 60.6% peak (2015) to 41.9% (2023) and the HHI reached its lowest point. The crisis interrupted that process and re-concentrated traffic around tankers. Because transit tolls are levied on net tonnage and large container ships are the biggest payers per transit, the 66.6% fall in net tonnage likely depressed SCA revenue more deeply than the 50% fall in vessel numbers implies; the new dependence on the tanker segment carries its own concentration risk, given that segment's sensitivity to oil production policy and energy trade sanctions.

Third, the 2025 recovery pattern — led by LNG, the south–north flow, and mid-size vessels — indicates a tiered normalization: segments with the largest time savings and the most flexible risk structures return first, while liner container networks await more durable security guarantees before restoring scheduled services, mirroring rerouting-persistence assessments in the operational literature [3], [12]. The second-half 2025 monthly series can serve as a baseline for monitoring whether full normalization is achieved in 2026–2027.

4.1 Mapping the empirical findings onto the SCA's 2030 strategic agenda

The SCA's strategic planning document identifies five groups of challenges [15]. Mapping them against the 2008–2025 traffic record shows that empirical support for each agenda is uneven, as summarized in Table 3.

Table 3. Mapping SCA strategic challenges onto empirical evidence from the 2008–2025 annual reports

SCA strategic challenge	Key initiatives in the 2026–2030 plan	Empirical evidence from traffic data
Economic competitiveness: global trade fluctuations and alternative routes	Revenue diversification beyond transit tolls; industrial and logistics development in the Canal Economic Zone	Cargo −65.4% and net tonnage −66.6% in 2024 from rerouting; the toll base's dependence on net tonnage caused revenue to collapse more deeply than vessel numbers (−50%)
Operational efficiency: growing ship sizes, deepening and widening needs	Continued Southern Sector expansion; full-length channel duplication; sustained dredging	Average net tonnage per vessel rose from ±11 thousand tons (1976) to ±59 thousand tons (2023); post-2015 expansion phase (net tonnage +24% over 2016–2019)
Environmental sustainability: decarbonization pressure and green fuels	Green Canal 2030; green incentives for low-carbon vessels; conversion of the SCA fleet to gas/hybrid propulsion	The LNG segment led the 2025 recovery (+137% vessels; +132% net tonnage), indicating energy-transition momentum that incentives can capture [13]
Technological transformation: digital navigation and AI adoption	SCA Smart Navigation Platform; AI-based traffic management	High monthly volatility during 2024–2025 (1,000–1,160 vessels per month in 2025) underscores the need for adaptive convoy scheduling; traffic data cannot, however, directly measure digital adoption
Human capital	SCA Academy for Green & Smart Shipping	Not verifiable from traffic data; requires separate workforce indicators

Source: columns 1–2 from the SCA strategic planning document [15]; column 3 compiled from SCA annual reports 2008–2025 [14].

Three substantive points of convergence deserve emphasis. First, the "alternative routes" challenge, stated in general terms in the strategy document, now has a precise empirical measure: diversion via the Cape of Good Hope demonstrably erased two-thirds of the canal's volume within a year. That figure converts the revenue-diversification agenda from a strategic option into a fiscal necessity, and simultaneously sets a benchmark for the Canal Economic Zone: non-transit revenue should ideally be large enough to buffer a shock of the 2024 class.

Second, the full-length channel duplication project and the continued Southern Sector expansion are consistent with the finding that five decades of growth have been driven by ship size, not transit frequency. The 2015 precedent is relevant here: the partial parallel channel was followed by the 2016–2019 tonnage expansion. Yet the 2024–2025 data also counsel caution: physical capacity is not currently the binding constraint — a canal capable of serving 26,434 vessels in 2023 served only 12,758 in 2025. The sequencing of capacity investment should therefore treat the restoration of regional security as a precondition for its returns.

Third, the green-incentive agenda finds its natural target in the 2025 data. The fastest-returning segment is LNG, while the

slowest is the mega-container fleet — precisely the segment whose global networks are investing most aggressively in dual-fuel and methanol vessels. Toll incentives for low-carbon ships could thus serve a dual function: advancing the Green Canal 2030 targets [13] while acting as a marketing instrument to accelerate the return of container liners, the segment that supplied 42% of the canal's net tonnage before the crisis.

5. Limitations

This analysis is confined to the data published in the SCA's standard annual-report tables and therefore excludes transit revenue, waiting times, and commodity-level cargo detail. Document digitization also leaves potential transcription errors; for example, the 2004 row of the historical series in the 2025 report shows 62,127 thousand tons, inconsistent with 621,253 thousand tons in earlier editions, so the earlier figure is used. Net tonnage and cargo tonnage are, moreover, not interchangeable; conclusions about actual loads are drawn only from the directional cargo table. Methodologically, the segmented regression with only two post-2024 observations cannot yet estimate the post-crisis trend slope reliably (the 2024 slope coefficient is insignificant because of the short window, not because recovery is absent), and the counterfactual assumes the 2010–2023 trend would have continued absent the crisis — an assumption that ignores possible global trade-cycle deceleration. Data-driven breakpoint detection also requires a minimum segment length, so shocks at the end of the series are more appropriately tested through intervention variables.

6. Conclusion

The SCA annual-report data for 2008–2025 show that the Suez Canal grew from 910 million net tons (2008) to a peak of 1,568 million tons (2023), driven chiefly by growing ship size, before losing two-thirds of its volume to the Red Sea security crisis in 2024. The crisis impact was highly asymmetric, with container ships the hardest-hit segment and tankers the mainstay of remaining traffic. Recovery signals in the second half of 2025 — particularly in the LNG segment and the south–north flow — indicate the beginning of normalization, but the continued absence of the mega-container fleet shows that full recovery depends on regional security stability rather than economic factors alone.

Mapped against the SCA's 2030 strategic agenda, the traffic data provide the strongest empirical support for three agendas: revenue diversification (evidenced by fiscal vulnerability to rerouting), channel capacity investment (evidenced by the ship-size trend and the 2015 expansion precedent, with a caveat on timing), and green incentives (evidenced by LNG leadership in the 2025 recovery). The digital transformation and human capital agendas remain strategically relevant, but their evaluation requires indicators beyond traffic data and thus constitutes a natural direction for further research.

References

[1] J. Verschuur et al., "Systemic impacts of disruptions at maritime chokepoints," *Nature Communications*, vol. 16, 2025, doi: 10.1038/s41467-025-65403-w.

[2] L. F. Pratson, "Assessing impacts to maritime shipping from marine chokepoint closures,"

Communications in Transportation Research, vol. 3, Art. no. 100083, 2023.

[3] T. Notteboom, H. Haralambides, and K. Cullinane, "The Red Sea crisis: Ramifications for vessel operations, shipping networks, and maritime supply chains," *Maritime Economics & Logistics*, vol. 26, no. 1, pp. 1–20, 2024, doi: 10.1057/s41278-024-00287-z.

[4] Z. Wang, Z. Fang, J. Yu, X. Hu, and J. Gong, "Red Sea crisis impacts on maritime shipping networks," *Heliyon*, vol. 10, no. 22, Art. no. e40384, Nov. 2024.

[5] A. Meza, I. Ari, M. Al Sada, et al., "Disruption of maritime trade chokepoints and the global LNG trade: An agent-based modeling approach," *Maritime Transport Research*, vol. 3, Art. no. 100071, 2022, doi: 10.1016/j.martra.2022.100071.

[6] Ö. Özkanlısoy and E. Akkartal, "The effect of Suez Canal blockage on supply chains," *Dokuz Eylül University Maritime Faculty Journal*, vol. 14, no. 1, pp. 51–79, 2022, doi: 10.18613/deudfd.933816.

[7] T. Notteboom, T. Pallis, and J.-P. Rodrigue, "Disruptions and resilience in global container shipping and ports: The COVID-19 pandemic versus the 2008–2009 financial crisis," *Maritime Economics & Logistics*, vol. 23, no. 2, pp. 179–210, 2021.

[8] K. Cullinane and H. Haralambides, "Global trends in maritime and port economics: The COVID-19 pandemic and beyond," *Maritime Economics & Logistics*, vol. 23, no. 3, pp. 369–380, 2021.

[9] H. K. Lim and S. H. Chiu, "Resilience in maritime chokepoint disruption and its implications," *Continuity & Resilience Review*, 2024.

[10] UNCTAD, *Review of Maritime Transport 2024: Navigating Maritime Chokepoints*. Geneva, Switzerland: United Nations, 2024.

[11] UNCTAD, "Impact to global trade of disruption of shipping routes in the Red Sea, Black Sea and Panama Canal," United Nations, Geneva, Switzerland, Feb. 2024.

[12] International Transport Forum, "The Red Sea crisis: Impacts on global shipping and the case for international co-operation," OECD Publishing, Paris, France, 2024.

[13] T. Zumbraegel and A. Kegel, "Green tides: The Suez Canal as key hub and green corridor for a hydrogen future between the Middle East and Europe," *Frontiers in Energy Research*, vol. 13, Art. no. 1538792, 2025, doi: 10.3389/fenrg.2025.1538792.

[14] Suez Canal Authority, *Navigation Statistics: Annual Reports 2008–2025*. Ismailia, Egypt: SCA, 2008–2025.

[15] Suez Canal Authority, "Suez Canal Authority challenges: Inception

report," internal strategic planning document, Ismailia, Egypt, 2025