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High-seas transhipment in the Western and Central Pacific Ocean: fleet structure, vessel economics, and the impracticability assessment

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High-seas transhipment in the Western and Central Pacific Ocean: fleet structure, vessel economics, and the impracticability assessment

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Executive summary

At-sea transhipment moves catch from fishing vessel to carrier beyond the reach of port-based monitoring. Within the Western and Central Pacific Ocean (WCPO), the Western and Central Pacific Fisheries Commission (WCPFC) Conservation and Management Measure (CMM) 2009-06 prohibits at-sea transhipment for non-purse seine vessels unless in-port transhipment is impracticable. Impracticability rests on a two-part test: that in-port transhipment would impose significant economic hardship, and that in-port transhipment would force a significant and substantial change to the vessel's historical mode of operation. The test was developed to accommodate vessels fishing in areas genuinely remote from any suitable port. It has since become the standard justification for most high-seas transhipment in the WCPO, applied broadly and rarely examined.

This report analyses the economic hardship argument quantitatively against vessel behaviour. It applies the framework of Lehmann et al. (2024) to 1,644 transhipment events recorded between May 2020 and March 2026, covering six carrier vessels and 486 fishing vessels. The six carriers were selected based on event volume and for coverage of the flag states that account for the large majority of high-seas transhipment in the WCPFC Convention Area: Chinese Taipei, China, South Korea, and Panama, with beneficial ownership in Japan and Chinese Taipei. This report shows that the economic hardship argument for at-sea transhipment is not supported by vessel behaviour or operational patterns. The conclusions of this report are based on six years of data and build upon the methodology and findings of Lehmann et al. (2024).

This report is a source data analysis. It quantifies patterns of transhipment activity and tests the spatial and economic assumptions behind the impracticability argument at fleet scale. It does not assess the compliance of individual vessels, adjudicate specific claims of economic hardship, or make determinations about licensing or authorisation.

The distance test

For each high-seas transhipment event we calculated an impracticability ratio: the distance from the geographic centre of the vessel's fishing activity (the fishing centroid) to the transhipment location, divided by the distance to a suitable port. That port distance is measured two ways: from the fishing centroid to the nearest suitable port, and as the vessel's closest approach to any suitable port within two weeks of the event. We use whichever produces the higher ratio, so that any port opportunity available to the vessel, whether from the fishing grounds or along its route, counts against the impracticability claim. A ratio above one means a port was at least as accessible as the location the vessel chose.

Of the 1,277 events for which the ratio could be calculated, 53% fall clearly within the exemption (i.e. transhipment in port is impracticable) and 5% are marginal. The remaining 41% do not. Within that group, 242 events (19% of the total) have a ratio above three, meaning the journey to the carrier was more than three times the journey to a suitable port. The result holds for all six carriers, and it is almost identical for transhipments of five hours or longer (42%) and shorter encounters (40%). It is not produced by one operator, one flag state, or one operating area.

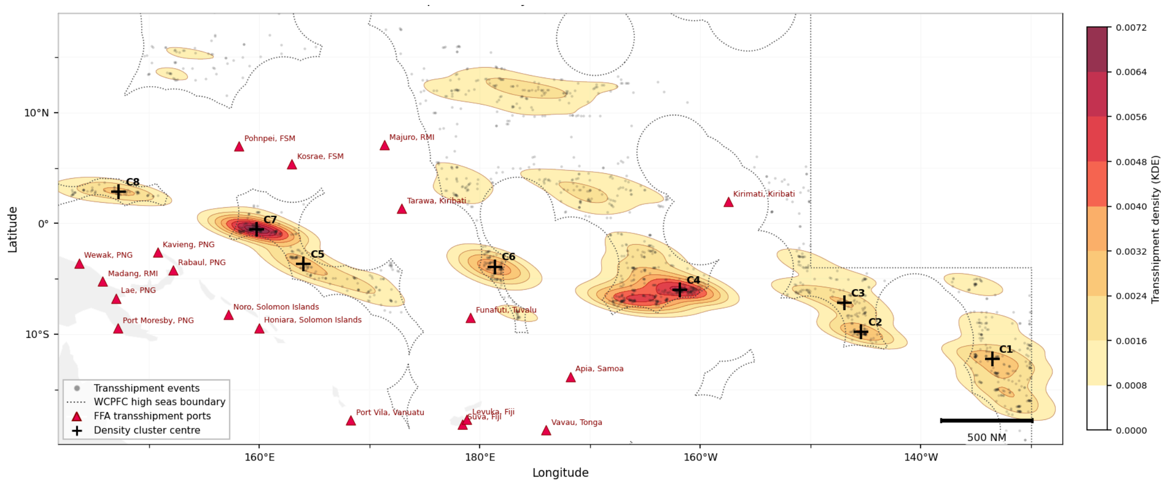
Summary of impracticability tier classification for all transhipment events and shorter encounters

	Transhipments (≥5 h)	Encounters (<5 h)	All events
Total events	745	532	1,277
Clearly impracticable (ratio < 0.75)	395 (53%)	286 (54%)	681 (53%)
Marginal (ratio 0.75–1.0)	35 (5%)	35 (7%)	70 (5%)
Not impracticable (ratio ≥ 1.0)	315 (42%)	211 (40%)	526 (41%)
Strongly not impracticable	161 (22%)	81 (15%)	242 (19%)

Direct measurements of track lengths make the same point in physical terms. Six fishing vessels were tracked across 17 fishing trips of between 2,152 and 22,155 NM. In the week before transshipping, nine of those trips brought the vessel within a distance of a suitable port equal to less than 10% of the trip's total track length, and five within less than 5%. This shows that the ports were not out of reach, but they were passed.

Across the six years of the study, the ratio shows no temporal trend, i.e., fleet behaviour has not moved toward port use. The requirement of Article 29(1) of the WCPF Convention requiring members to encourage in-port transhipment and reduce reliance on the exemption, is not supported by the study's data.

High-seas transhipment events cluster in eight areas. The three eastern clusters sit between 837 and 1,600 NM from the nearest port able to host a longline transhipment, distances at which the exemption is defensible on its face. The other five lie within 550 NM of Funafuti, Kavieng, Kosrae, Honiara, or Kiritimati. Those are the ports carrying the cost of the practice, in forgone charges, in services never bought, and in the monitoring and catch verification that a port call would have delivered to the region.



Hotspots of high-seas transhipment events recorded by six carrier vessels in the Convention Area, May 2020–March 2026 within 20°N/S (n = 1,644 events). Eight local density maxima (C1–C8) are identified and labelled. Red triangles indicate suitable regional transhipment ports.

Economic hardship

The economic hardship argument is tested assuming that distance travelled for transhipment is directly related to fuel expenditure. If that logic governed behaviour, vessels would transship closer to their fishing grounds when fuel is expensive. We did not find evidence for that. The correlation between monthly Singapore marine gas oil (MGO) prices and the median impracticability is not significant. The result is robust to several time lags and different averaging windows.

Part of the reason may be that the fuel price we use does not describe what these fleets actually pay. Most fishing vessels bunker at sea rather than in port. The flag states involved provide substantial fuel subsidies to their distant-water fleets, and China is a documented buyer of discounted Russian crude. Fuel bought at sea, subsidised, and outside the tax base does not track the Singapore spot price. This may explain why fuel prices leave no signature in the data, and it means the cost gap between meeting a carrier at sea and calling at a port is narrower than a market-rate calculation implies.

A track analysis of a carrier voyage representative of the fleet extends the economic assessment beyond the fishing vessel to the carrier effort and cost that high-seas transhipment requires. In this case, the carrier vessel travelled 3,590 NM under main engine power during positioning and transhipment activity. That steaming represents fuel cost that port-based transshipment would eliminate, yet the impracticability test does not consider it, since the test applies only to the longline vessel. Where carrier and fishing operations are vertically integrated, however, a complete economic assessment of high-seas transhipment requires accounting for both.

Fleet structure

Carrier and fishing vessel relationships follow national and commercial lines rather than geographic ones. Three of the six carrier vessels transhipped overwhelmingly with the same flag state: DONG HRONG 899 transshipped with Chinese Taipei-flagged vessels in 130 of 136 partnerships, PINGTAIRONGLENG2 with Chinese vessels in 91 of 98, and MV

Badaro with South Korean vessels in all 32. Ownership records show two ways of organising the same activity. Some operators own both ends of the transfer. Pingtairong Ocean Fishery owns PINGTAIRONGLENG2 and 11 of the fishing vessels that regularly tranship with it, and Dongwon Industries owns MV Badaro and six of its partner vessels. In each case an owner directs catch from its own fishing vessels to its own carrier on the high seas. Other groups work the opposite way. Sajo Industries and Silla spread their vessels across several carriers, and SEISHIN takes vessels from Korean, Chinese, and Chinese Taipei owners without belonging to any of them. What the two patterns have in common is that neither is set by geography.

The same structure limits the efficacy of carrier-based monitoring. 176 fishing vessels, 36% of those in the network, transshipped with more than one carrier. Catch from a single vessel can enter several separate carrier logistics chains, none of which observes the others.

Implications for policy development

The use of the impracticability exemption is currently the default justification for high-seas transhipment in the Convention Area. Based on our distance logic it does not apply to 41% of the events analysed in this report. Its economic rationale leaves no trace in six years of vessel behaviour and is weakened further by how these fleets buy fuel. Behaviour has not shifted in six years, so the framework will not correct itself.

The fleet structure data speak to the test's second limb, which asks whether requiring port use would force a significant and substantial change to the vessel's historical mode of operation. Korean operators, including Sajo Industries, Dongwon Industries, and Silla, distribute their fleets across multiple carriers; SEISHIN serves vessels from Korean, Chinese, and Chinese Taipei ownership groups without belonging to any of them. This suggests that transhipment logistics are actively managed commercial decisions, rather than driven by historical modes of operation.

Under CMM 2009-06, paragraph 34 permits high-seas transhipment only where a member has determined it is impracticable for the vessels it is responsible for; paragraph 35 requires those vessels to be named. CMM 2009-06 does not define what evidence must support that determination or how impracticability is to be assessed. The guidelines paragraph 37 required the Commission to adopt by 2012 have never been adopted, leaving the interim two-limb test as the sole operative standard after 16 years. Determinations are made by the flag state itself against no evidentiary standard, allowing the exemption to function as a routine pathway. The Commission recognised the problem in 2019 and tasked an intersessional working group to review CMM 2009-06. This working group was disestablished in 2024 with little progress and no amendment to the impracticability test. Requiring each impracticability determination to be supported by evidence remains the minimum step consistent with the Commission's own mandate. The metrics in this report already show which vessels would be most directly affected by a more rigorous evidentiary standard.

We suggest further measures based on our findings.

a) Require disclosure of actual fuel costs and government fuel support when hardship is claimed, and assess hardship at the level of the supply chain, including the carrier's costs, where the same owner controls both vessels.

b) Establish an independent high-seas transhipment observer programme, as recommended in 2024. Carrier-level coverage cannot follow vessels that move between carriers, and 176 (36%) of them do.
c) Consider scaled fisheries transhipment charges as a complementary incentive for port use, recognising that port charges are largely fixed and fall hardest on smaller longline vessels. Incentives alone have not changed fleet behaviour over six years, and unilateral changes to port charges risk costing Pacific island nations more than they recover.

Introduction

At-sea transhipment between fishing vessels and carrier vessels is among the least monitored and verified activities in the Western and Central Pacific Ocean (WCPO). When catch is transferred on the high seas rather than landed in port, it passes outside the oversight mechanisms that most fisheries monitoring and control activities are designed to provide. The result is an elevated risk of mis- and under-reporting that undermines stock assessments and compliance monitoring across the Western and Central Pacific Ocean Fisheries Commission (WCPFC) Convention Area (Convention Area). Conservation and Management Measure (CMM) 2009-06 addresses this by prohibiting high-seas transhipment for non-purse seine vessels unless in-port transhipment is demonstrably impracticable. The impracticability determination requires a two-part test. First, in-port transhipment must impose significant economic hardship, assessed against the cost of landing or transshipping at a permitted location other than on the high seas. Second, the vessel must alter its historical mode of operation in a way that is significant and substantial in order to comply. This test was conceived to acknowledge fishing in areas genuinely remote from any suitable port. In practice, the impracticability exemption has become the default justification for the large majority of high-seas transhipments conducted in the Convention Area, applied broadly and with limited scrutiny.

Lehmann et al. (2024) was the first systematic investigation of whether the impracticability argument is supported by the observed behaviour, using vessel tracking data from the Automated Identification System (AIS). Between May 2020 and November 2023, it recorded 4,666 carrier-fishing vessel encounters in the high seas between 20°N and 20°S, of which 1,048 lasted five hours or longer and were classified as likely transhipments. Manual characterisation of 50 events identified three recurring journey patterns:

1. Vessels fishing primarily within the exclusive economic zones (EEZs) of WCPFC members before transshipping on the high seas;
2. Vessels fishing predominantly on the high seas but transiting member state EEZs and passing suitable ports; and
3. Vessels operating in genuinely remote high seas areas rarely entering EEZs.

The central finding of the study was that a substantial number of transhipments could not be justified under the impracticability test. Eleven carrier vessels, including three central carriers, regularly received fish that could have been offloaded in port with equal or lower travel-related cost, and 27 fishing vessels made repeated journeys in which the distance to the chosen transhipment location exceeded the distance to a suitable port by a factor of two or more.

This report was commissioned by Sharks Pacific and the Marshall Islands Marine Resources Authority (MIMRA). It applies the same methodology as Lehmann et al. (2024) to a dataset extended to March 2026, providing nearly three additional years of evidence to corroborate and strengthen the original findings. Rather than analysing all carrier vessels active in the Convention Area, the study concentrates on six carriers most central to high-seas transhipment activity in the WCPO. The selection was based on transhipment event frequency, continuity with the carriers identified as most active in the 2024 study, and coverage of the principal flag states involved: Chinese Taipei, China, South Korea, and Panama (with beneficial ownership in Japan and Chinese Taipei). Together, the six vessels account for 1,644 events across the study period and collectively represent the operational and commercial structures through which the large majority of high-seas transhipments in the Convention Area are conducted. This focus allows for deeper analysis of carrier-level behaviour and network relationships than would be possible across a broader, more diffuse vessel set. In addition to extending the core impracticability analysis, this report introduces new analytical components not included in the 2024 study:

- Stratification of events by duration to separate transhipments from shorter encounters;
- A network analysis of carrier-fishing vessel relationships including beneficial ownership linkages derived from S&P Global's Maritime Intelligence Risk Suite;
- An assessment of the relationship between carrier vessel size and transhipment event duration;
- An examination of whether fuel prices are reflected in transhipment location decisions; and
- Actual track lengths were analysed for selected journeys by a carrier vessel and six fishing vessels to ground the centroid-based impracticability metric in the actual distances involved.

This report is a source data analysis. It quantifies patterns of transhipment activity and tests the spatial and temporal assumptions underlying the impracticability argument at fleet scale. It does not assess the compliance of individual vessels, adjudicate specific claims of economic hardship, or make determinations about licensing or authorisation. The distance metrics and network analysis presented here are designed to be reproducible and applicable to new data as it becomes available, providing a framework that can inform and strengthen the evaluation of impracticability claims under CMM 2009-06.

Data source and overview

Ship tracks and vessel identification for this study are derived from ship's transmissions of the Automatic Identification System (AIS). The operation of AIS transponders is compulsory for all passenger vessels and all large vessels over 500 gross tons, or 300 gross tons on international voyages (SOLAS 2002, IMO 2015). AIS transmissions are received by a network of receivers on shore-based stations, low-Earth orbit satellites, and some commercial vessels, providing practically continuous, global receiver coverage. The study period spans May 2020 to March 2026.

Ship tracks and ship track-derived events such as transhipments and port calls for this study were provided by Starboard Maritime Intelligence. Vessel ownership and company information were provided by C4ADS from various sources, including S&P Global Market Intelligence.

Operational definition of a likely transhipment event

Starboard analyses vessel track data to detect encounters between vessels. An encounter is recorded when two vessels come within 50 metres of each other for at least 10 minutes, or within 200 metres for at least 30 minutes. In some cases, two vessels encounter multiple times successively over a few hours or days. The reason for this may be temporary detachment of the vessels to accommodate crew breaks at night or during bad weather. Starboard merges successive encounters if the gap between them is less than 12 hours.

Encounters between FVs and CVs are defined as likely transhipment events. The term *likely* emphasizes that a transhipment activity is assumed, but not proven. Furthermore, as per Lehmann et al. (2024), it is useful to distinguish transhipment events that are long enough for significant fish transfers from shorter encounters serving other purposes, such as crew transfer or provisioning. In this dataset, approximately half of all events are shorter than five hours (see section *Event duration*). Instead of omitting these encounters, as in the 2024 study, we consider all events and stratify many analyses by duration class. Stratified analyses are indicated explicitly; otherwise the terms transhipments, encounter, and events refer to all events combined.

The analysis is restricted to the high seas within the WCPFC Convention Area. Further clipping to within 20° of the equator was done to focus on the tropical tuna fishery, consistent with the 2024 study. Geographic filtering used the official WCPFC high seas boundary polygon.

Carrier vessels

Six carrier vessels were selected from the broader pool of carriers active in the Convention Area. Five of the six were among the eight central carriers identified in Lehmann et al. (2024). Selection was guided by three criteria: transhipment event volume, coverage of the principal flag states and ownership structures present in the fleet, and the range of impracticability distance ratios recorded in 2024. TAIHO MARU and FULL KUO SHIN were included as the two highest-volume carriers in the dataset. DONG HRONG 899 and PINGTAIRONGLENG2 were selected to represent the Chinese Taipei and Chinese fleets, each with distinct operational areas and fishing vessel networks. SEISHIN was included as the carrier with the highest median distance ratio (2.06) in the 2024 study, making it the strongest single-vessel case against the impracticability argument. MV BADARO, though recording fewer events than the other carriers, was selected for its elevated distance ratio (1.56) and its role as the primary carrier serving the South Korean longline fleet in the eastern Pacific. Together the six vessels cover the four flag states accounting for the large majority of high-seas transhipments in the Convention Area, and span the full range of impracticability ratios observed in 2024. Note that FULL KUO SHIN was removed from the WCPFC record of fishing vessels in April 2025 and events after that date are not included in its analysis. Table 1 summarises key characteristics of their activity. The locations of high-seas transhipment events by the six carrier vessels considered in this study are mapped in Figure 1

Table 1. Carrier vessels considered in this study and characteristics of their transhipment activity after geographic filtering and 24-hour event merging.

CV Name	Flag	Transhipments*	Unique FVs	Median duration (h)
DONG HRONG 899	Chinese Taipei	401	136	4.2
SEISHIN	S. Korea	213	112	7.4
PINGTAIRONGLENG2	China	179	98	5.6
FULL KUO SHIN	Panama	378	166	3.7
MV BADARO	S. Korea	49	32	8.9
TAIHO MARU	Panama	424	140	6.4
All CVs combined	—	1,644	486	5.3

*Includes events of <5 and >=5 h duration

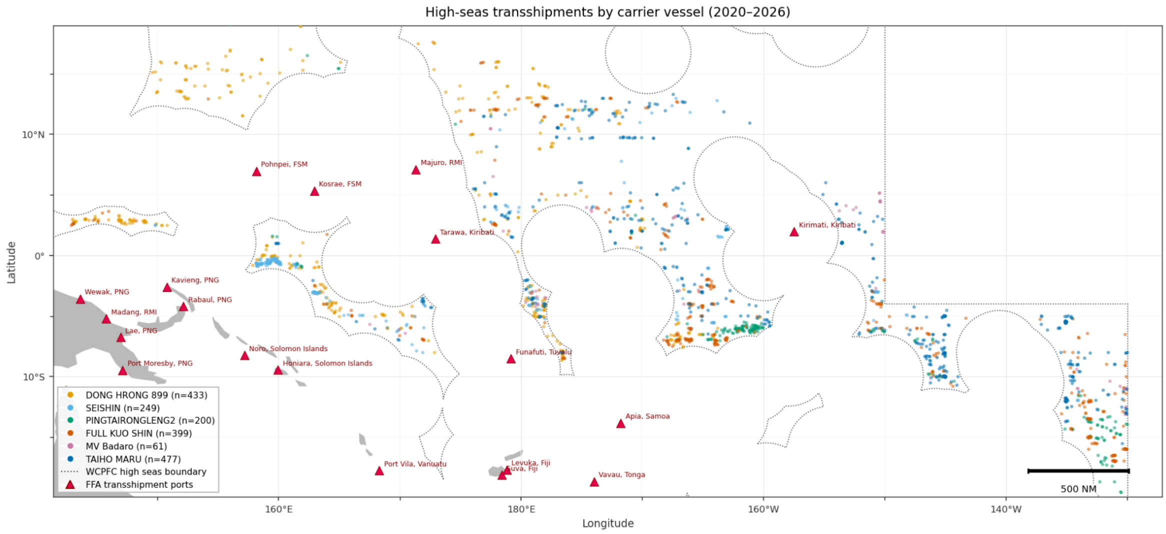


Figure 1. Locations of high-seas transhipment events recorded by six carrier vessels in the Convention Area, May 2020–March 2026. Points represent individual likely transhipment or encounter events; events outside the WCPFC high-seas area or beyond 20°N/S are excluded (n = 1,644). Colours distinguish carrier vessels. Red triangles indicate FFA members' ports able to host longline transhipments. The dashed line shows the WCPFC high-seas boundary.

Transhipment hotspots

A two-dimensional Gaussian kernel density estimate (KDE) was fitted to all transhipment coordinates. Bandwidth was set to 0.1 (Scott's rule factor) to resolve sub-regional clusters. The eight most prominent density peaks were identified as cluster centres using a local maximum filter, ranked by density and labelled C1–C8. Distances from cluster centres to FFA-listed transhipment ports were computed using the Haversine formula in nautical miles (NM).

Transhipment events are concentrated across the equatorial Pacific (Figure 2), forming two broad zones: a western cluster centred around 155–175°E (near the Solomon Islands, The Federated States of Micronesia, and Papua New Guinea), and an eastern cluster spanning 160–135°W (near Kiribati and the Cook Islands). A spatial density analysis identifies eight distinct hotspots (C1–C8; Table 2).

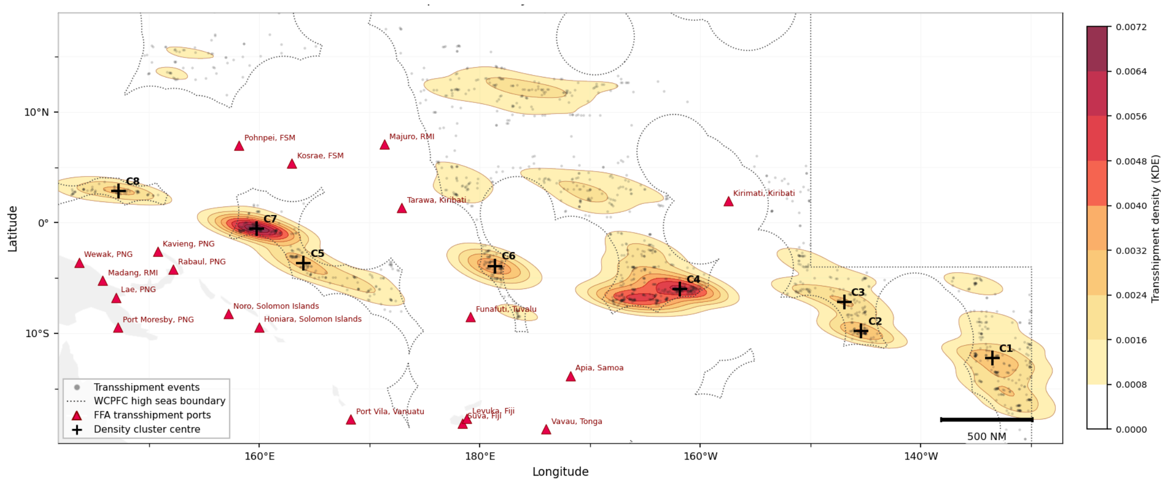


Figure 2. Spatial density of high-seas transhipment events recorded by six carrier vessels in the Convention Area, May 2020–March 2026 within 20°N/S (n = 1,644 events). Eight local density maxima (C1–C8) are identified and labelled. Red triangles indicate suitable regional transhipment ports.

Table 2. KDE cluster centres (C1–C8) and distances to the two nearest FFA transhipment ports. Clusters C1–C3 in the eastern Pacific are the most remote, over 800 NM from any suitable port. Clusters C5–C8 in the western Pacific are within 500 NM of ports.

Cluster	Longitude	Latitude	Nearest port	Dist (NM)	2nd nearest	Dist (NM)
C1	133.5°W	12.2°S	Avarua, Cook Islands	1,600	Kirimati, Kiribati	1,664
C2	145.4°W	9.8°S	Kirimati, Kiribati	1,009	Avarua, Cook Islands	1,077
C3	146.9°W	7.2°S	Kirimati, Kiribati	837	Avarua, Cook Islands	1,125
C4	161.9°W	6.0°S	Kirimati, Kiribati	546	Apia, Samoa	751
C5	164.0°E	3.7°S	Honiara, Solomon Islands	423	Noro, Solomon Islands	491
C6	178.6°W	3.9°S	Funafuti, Tuvalu	305	Tarawa, Kiribati	598
C7	159.8°E	0.5°S	Kosrae, FSM	402	Pohnpei, FSM	460
C8	147.3°E	2.9°N	Kavieng, PNG	389	Wewak, PNG	442

Event duration

Transhipment durations across all six CVs range from under one hour to over 30 hours, with a combined median of 5.3 hours. The distribution is right-skewed, with most events lasting 1–8 hours. Duration histograms (1-hour bins) are provided for the combined dataset (Figure 3) and for each CV (Figure 4).

The six CVs differ substantially in the breadth and intensity of their transhipment activity (Table 4). FULL KUO SHIN engaged the largest number of distinct fishing vessels (165 FV partners, 377 events), yet its median event duration was the shortest at 3.6 hours, suggesting frequent, shorter interactions. In contrast, MV Badaro had the smallest network footprint (32 FV partners, 49 events) but the longest median event duration at 10.4 hours — nearly three times the fleet median — pointing to longer, more deliberate transhipments with a tightly defined group of vessels. TAIHO MARU and DONG HRONG 899 sit in the middle on FV partner count (137 and 135, respectively) but account for the largest cumulative transhipment durations (3,061 h and 2,250 h), reflecting their central role in the overall network.

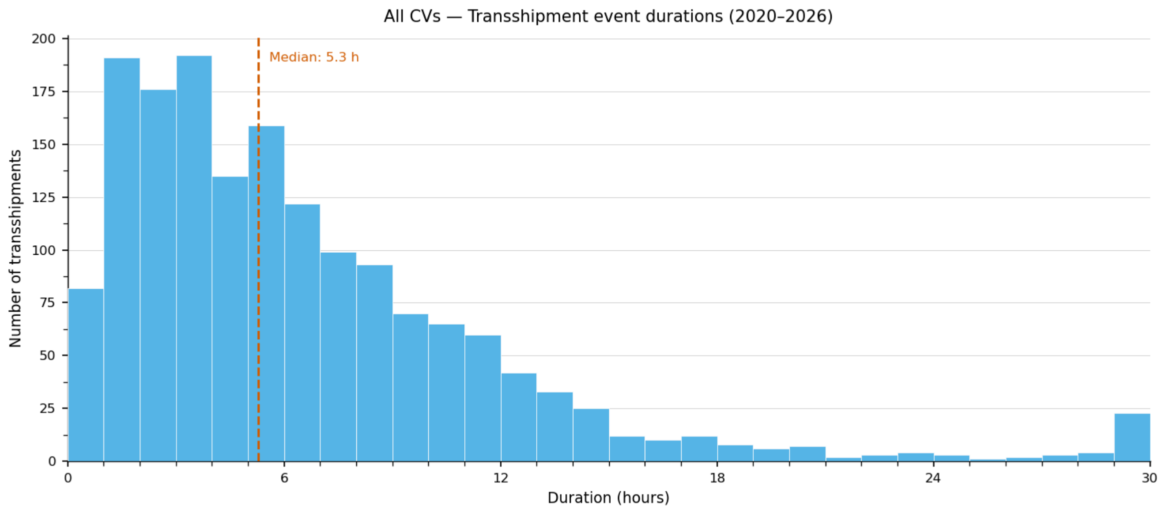


Figure 3. Distribution of high-seas transhipment event durations across all six carrier vessels considered in this study (n = 1,644 events; 1-hour bins, clipped at 98th percentile). The median event duration was 5.3 hours (dashed line).

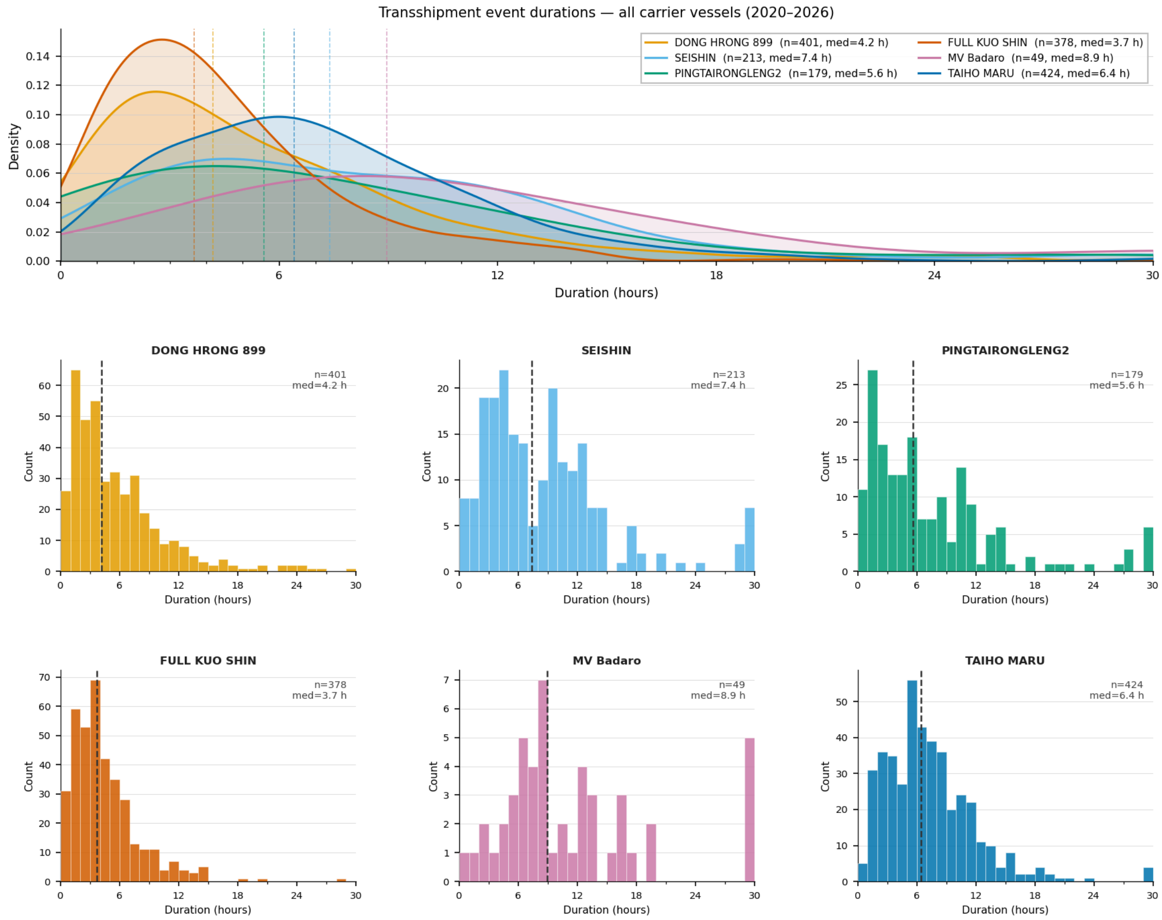


Figure 4. Duration of high-seas transhipment events recorded by six carrier vessels considered in this study. Top: Kernel density estimates (Gaussian, Scott's rule) of event duration for each carrier vessel, normalised to unit area to allow shape comparison independent of sample size. Dashed vertical lines indicate per-vessel medians. Bottom: Individual event counts by duration (1-hour bins, clipped at 98th percentile). Median duration ranged from 3.7 h (FULL KUO SHIN) to 8.9 h (MV Badaro); the overall median across all vessels was 5.3 h.

Carrier size effects

Fish carriers in the tuna transhipment trade fall into two physical classes. Large vessels with capacities from 2,000 t to 15,000 t generally serve the purse seine fleet. Smaller vessels with capacities from about 1,000 t to 2,000 t generally serve the longline sector. Both classes handle cannery-grade fish. Some, though not all, of the smaller vessels carry refrigeration capable of sashimi-grade tuna, down to -55 or -60˚C.

Carriers that regularly deliver cargo to Asian ports backload supplies for the return leg. Those supplies include food, spare parts, and bait for the donor vessels, and, equally important, crew joining or leaving those vessels. Crew movement by sea matters where nationality makes air travel impractical or impossible because of visa restrictions or other constraints. Carriers can also act as a proxy bunker, carrying additional fuel for delivery to fishing vessels.

At-sea transhipment between a longliner and a carrier vessel is operationally demanding (see details in Lehmann et al., 2024). In summary, Yokohama fenders are deployed and the vessels are secured alongside each other with lines. Crews position cranes, rig cargo nets, chutes, and pallets on deck. This preparatory phase can take 40 to 60 minutes in favourable conditions. Once alongside, the carrier holds its heading with respect to wind and waves under engine power to maintain a stable working position for crane operations. The crane operating window on the longliner side typically measures 6 by 4 to 6 metres, leaving no margin for error: any destabilisation of either vessel halts operations immediately.

Even small changes in sea conditions can alter the smaller vessel's heaving, swaying, and surging, forcing separation until conditions improve. Vessel size directly determines how often separation occurs. Vessel size determines how often that threshold is reached: greater displacement resists motion across a wider range of sea states, allowing alongside operations to continue where a smaller carrier would have to stand off. An examination of transhipment event durations (Figure 4) and carrier vessel characteristics (Table 3) shows a clear relationship between estimated gross tonnage (GT) and median event length: larger carriers record longer transhipments, consistent with their greater operational stability.

Table 3. Gross tonnage comparison of CVs considered in this study. GRT converted to GT via the London Convention 1969 formula using calibrated volumetric (Cv) coefficient. Data source: WCPFC Record of Fishing Vessels, accessed May 2026

Vessel Name	Year Built	Length (m)	Beam (m)	Moulded depth (m)	Volume L×B×D (m³)	GT (range)	GT / GRT ratio	Median transhipment duration (h)
BADARO	1997	120.1	16.8	10.0	20,180	4,643	1.00	8.9
PINGTAIRONGLENG1	2017	107.9	16.6	9.2	16,478	4,571	1.00	5,6
TAIHO MARU	2008	89.6	16.8	9.9	14,894	3,858* (3,393 - 4,907)	1.07	6,4
SEI SHIN	1988	86.3	14.5	8.3	10,327	2,837* (2,326 - 3,364)	2.90	7.4
FULL KUO SHIN	1986	88.4	14.0	7.8	9,657	2,647* (2,171 - 3,139)	1.05	3.7
DONG HRONG NO.899	1987	51.3	8.2	3.9	1,625	499	1.00	4.2

Table notes:

- Asterisk in GT column indicates that the value was estimated from dimensions
- $GT = K_1 \times V$ where $K_1 = 0.2 + 0.02 \times \log_{10}(V)$ (London Convention on Tonnage Measurement of Ships, 1969)
- Cv back-solved from three vessels with known GT: PINGTAIRONGLENG1 (Cv = 0.976), DONG HORNG NO.899 (Cv = 1.157), BADARO (Cv = 0.809)
- Range: Low/High range uses Cv = 0.809 and Cv = 1.157 (observed min/max across calibration vessels)

- SEI SHIN's reported GRT 978 is anomalously low for its dimensions. The FULL KUO SHIN, a CV of similar size, has GRT 2,525. GRT of Korean vessels from this era were often measured under national rules applying large space exemptions. The dimension-based GT estimate (~2,837) is considered more reliable for cross-vessel comparison.
- Full Kuo Shin was deleted from the WCPFC register in 2025

Size effects on transhipment duration

Larger carriers, by virtue of their greater displacement, waterplane area, and structural mass, resist rolling, pitching, and surging more effectively than smaller vessels. The operational difference is measurable.

BADARO with GT 4,643 is the largest carrier considered here. It records the longest median transhipment duration in the dataset (8.9 hours). The smallest carrier, Dong Horng No. 899 (GT ~499), records 4.2 hours. Taiho Maru (GT ~3,858) and Sei Shin (GT ~2,837) post medians of 6.4 and 7.4 hours respectively, both substantially exceeding the durations recorded by smaller vessels.

The duration distributions in Figure 4 reinforce this pattern. Smaller carriers produce sharply right-skewed histograms, consistent with operations frequently cut short before transfer is complete. Larger vessels produce broader, flatter distributions, indicating operations are more likely to run to their conclusion, i.e., the full transfer of the fishing vessel's catch.

A complete load transfer from a typical longliner requires many hours of continuous crane operations. Only a sufficiently stable carrier can sustain that continuity across the range of conditions encountered in the high-seas environment of the WCPO.

Operational interruptions

Transhipment events are routinely interrupted by weather, sea state, carrier's crew rest requirements[1], and the need to move fish between hatches within the longliner. These interruptions occur regardless of carrier size. On a larger, more stable vessel, however, operations resume more readily after each pause: re-securing alongside remains safe even as sea conditions shift.

Concurrent transfers of cargo (bait, provisions, and machine parts, etc) and occasionally crew add to the total time alongside and are only practicable under near-calm conditions. Vessels transhipping in port do not face the same challenges caused by weather and sea state.

GT and its underlying dimensional parameters are meaningful predictors of transhipment event duration. Larger carriers sustain safe, continuous operations across a broader envelope of conditions. Nonetheless, it is reasonable to assume that any carrier's per-unit operating costs on the high seas are structurally higher than in-port or at berth. Continuous underway operation compounds mechanical wear and shortens maintenance intervals. It also elevates crew fatigue and injury-related costs, with their associated liability exposure,

[1] Unlike fishing vessels, carrier's crew are covered by ILO's Maritime Labour Convention determining crew rest requirements
https://www.ilo.org/international-labour-standards/maritime-labour-convention-2006

and exposes transshipment windows to weather-related delay or abandonment. None of these apply to a vessel alongside in a sheltered port with shore-based support.

Fuel costs of at-sea transhipment

The stability advantages of larger carrier vessels carry a significant and underappreciated fuel cost implication. From the moment the fishing vessel approaches the carrier to the separation at the end of transhipment operations, the carrier's main propulsion engine runs continuously for positional control against prevailing wind and swell. Fuel consumption during this period scales broadly with conditions. Simultaneously, all auxiliary systems, crane hydraulics, deck machinery, generators, and refrigeration compressors, must remain powered to sustain cargo handling and protect the integrity of the frozen catch already aboard. As an approximation, about 50% of fuel use during transhipment is used for position control by the main engine, while the other half is used for auxiliary needs.

For larger vessels, whose main engines are considerably more powerful than those of smaller carriers, hourly fuel burn in this idling-under-load configuration is substantially greater. The BADARO provides the highest estimate of the carriers considered in this study. Its main engine power is 5,600 hp (4,175 kW). Assuming half-loaded holds of 2,000 t of tuna and steaming into average wind and sea at around 3 knots, BADARO is expected to burn about 4 t of fuel a day[2]. Refrigeration and hydraulics use during transhipment can increase this to 6 t to 8 t a day, depending on open hatches and volume on board.

Fuel use of 6 to 8 t equates to US$5,000 to US$6,800 per day. This calculation assumes VLSFO[3] as the most likely grade for a 1997-built carrier operating outside ECAs[4] and prices on 6 August 2026. Running HFO[5] on the main engine and MGO[6] on the generators, which is common on older Korean and Japanese vessels, the fuel-only cost is around US$4,500 to US$6,000 a day.

Therefore, the need for positional control during high-seas transhipments, in addition to auxiliary power, represents a considerable operational cost that has no direct equivalent at an in-port transhipment.

[2] Figure calculated from the following sources: Sustainable Ships, Specific fuel consumption [g/kWh] for marine engines; FAO, Freezing and refrigerated storage in fisheries; and IMO, Fourth IMO Greenhouse Gas Study 2020.
[3] VLSFO: very low sulphur fuel oil, a residual marine fuel with a sulphur content at or below 0.50% m/m, the global cap set under MARPOL Annex VI.
[4] ECA: emission control area, a sea area designated under MARPOL Annex VI in which a 0.10% m/m sulphur limit applies. No ECA has been designated in the WCPO.
[5] HFO: heavy fuel oil, a high-viscosity residual fuel that must be heated before use and typically carries a sulphur content above the global cap unless abated by exhaust gas cleaning.
[6] MGO: marine gas oil, a distillate fuel used in auxiliary engines and generators. It costs more per tonne than residual grades but needs no heating.

Network analysis

The 2024 study identified eight carrier vessels accounting for over 73% of all high-seas transhipments in the Convention Area, with activity concentrated around a small number of central carriers rather than distributed across the broader fleet. Network analysis of those carriers revealed distinct clustering by flag state: Chinese Taipei-controlled carriers formed one group, South Korean carriers another, and Chinese-controlled vessels a third, with relatively few fishing vessels crossing between them. These patterns suggested that carrier-fishing vessel relationships are organised along national and commercial lines rather than determined by proximity or availability.

To examine these relationships formally, this study constructed five networks. The overall network includes all observed events regardless of duration. The duration-stratified networks separate transhipments (five hours or longer) from shorter encounters (fewer than five hours), allowing direct comparison of the two encounter types. An ownership network links vessels under common ownership, and a co-carrier network connects any two fishing vessels that shared a common carrier.

Methods

The transhipment network was constructed as a bipartite graph in which CVs and FVs form two distinct sets of nodes, connected by edges representing transhipment relationships. Edges were weighted by three metrics: the number of events between a given pair, their cumulative duration in hours, and the median duration per event. Node size in the visualisation scales with total transhipment duration.

Fishing vessels appearing in the event records of more than one carrier were identified as shared FVs and analysed separately, as they represent indirect structural links between otherwise distinct carrier clusters.

The network was built directly with the pandas Python library for data manipulation such as grouping, aggregating edges, and filtering shared FVs. The NetworkX library was used to compute node positions for the static visualisation, with the six carrier vessels fixed in a circle and fishing vessels arranged around them by the Fruchterman-Reingold force-directed algorithm. Dynamic network visualisation was produced using the vis.js physics-based layout engine, implemented in Python via the pyvis library.

Results

All encounters

The CV–FV transhipment network comprises six carrier vessels, 491 fishing vessels, and 687 directed edges (unique FV–CV pairs), representing 1,644 individual transhipment events totalling approximately 10,915 hours between May 2020 and March 2026 (Figure 5). The network is sparse in the sense that most fishing vessels transshipped with only one carrier and did so infrequently: the median FV–CV pair produced only two events, and 46%

of pairs recorded a single encounter. A small core of repeat relationships dominates activity — just 11% of pairs (77 edges) account for five or more events, while the remaining 89% transshipped with a given carrier four times or fewer. This is consistent with existing CV-FV relationships alongside a broader pool of opportunistic vessels.

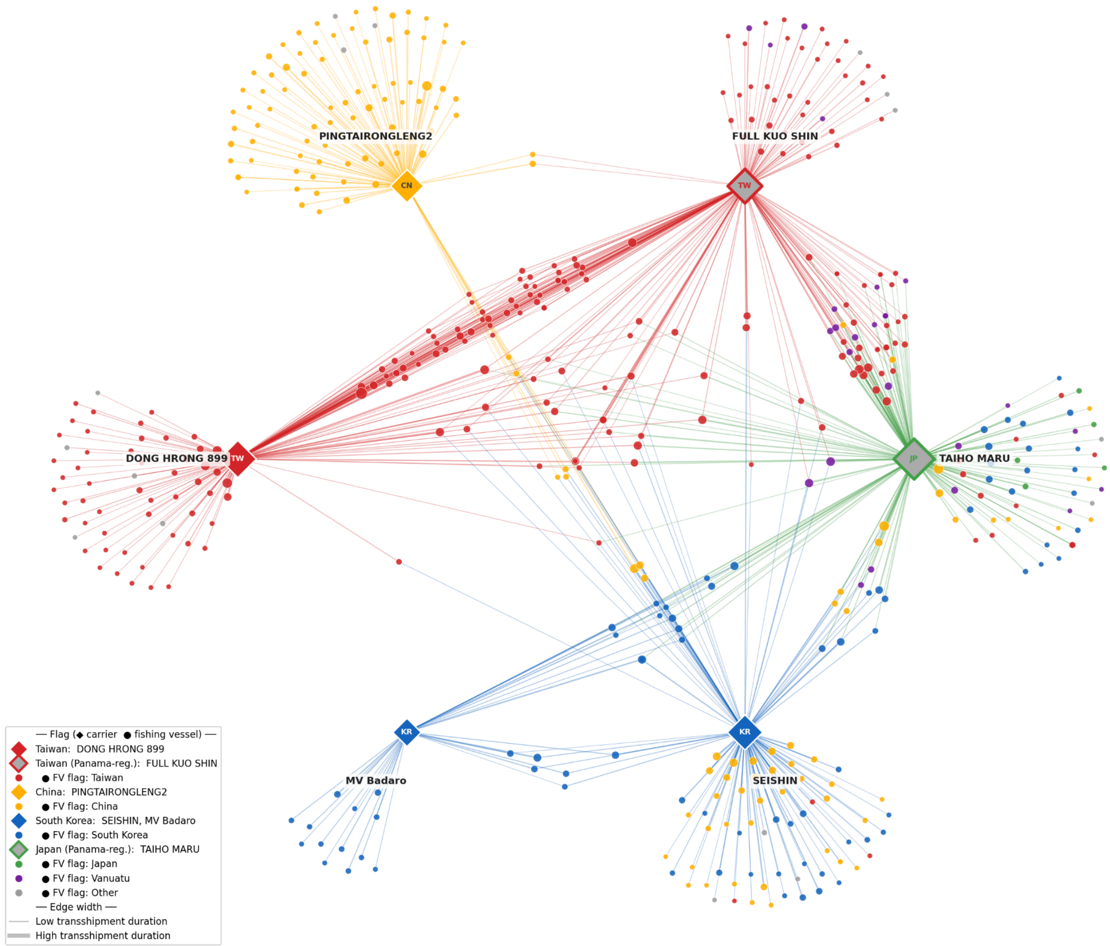


Figure 5. High-seas transhipment network in the WCPFC Convention Area (May 2020 – March 2026), showing carrier vessels (diamonds) and fishing vessels (circles). Node size is proportional to total cumulative transhipment duration. Edge width is proportional to cumulative transhipment duration per carrier–fishing vessel pair, and colour identifies the flag state.

Fleet specialisation by flag

A striking feature of the transhipment network is that each carrier operates within a near-distinct flag-defined fishing fleet. DONG HRONG 899 transshipped almost exclusively with Chinese Taipei-flagged vessels (130 of 136 FV partners). PINGTAIRONGLENG2 almost entirely serves a Chinese-flagged fleet (91 of 98 FV partners). MV Badaro transshipped exclusively with South Korean-flagged vessels (32 of 32). FULL KUO SHIN transhipped with predominantly Chinese Taipei-flagged vessels (142 of 165). SEISHIN and TAIHO MARU are the most fleet-diverse, with SEISHIN split across Chinese, South Korean, and Chinese Taipei vessels, and TAIHO MARU serving the widest mix including Vanuatu- and Japan-flagged vessels. This flag clustering suggests that carrier–fleet relationships are organised along national or ownership lines rather than purely geographic ones.

Fishing vessels transshipping to multiple carriers

176 fishing vessels (35.8% of all FVs in the network) transshipped with more than one carrier, representing a notable structural feature of the network. Of these, 134 transhipped with two carriers, 28 with three, and two vessels — SING MAN YI NO3 and NIAN SHENG NO168 (both Chinese Taipei-flagged) — transshipped with four of the six carriers.

Shared FVs are the indirect links between otherwise separate carrier clusters and are policy-relevant: a vessel that tranships with multiple carriers is harder to monitor through carrier-level observer programmes, and its catch may be commingled across different carrier logistic chains.

Relationship intensity

The strongest individual relationship by event count is DONG HRONG 899 with JIN DE MAN NO1 (Chinese Taipei), with 18 events and 158.8 cumulative hours — the most intensive bilateral pair in the dataset. Three other pairs exceed 100 cumulative hours: TAIHO MARU–XINSHIJI7HAO (123.1 h, 13 events), DONG HRONG 899–HAI CHIEN HSING NO2 (111.4 h, 11 events), and TAIHO MARU–XIN SHI JI 17 HAO (109.0 h, 12 events). A notable outlier is the PINGTAIRONGLENG2 and PINGTAIRONG89 pair, which produced two events totalling 107.4 cumulative hours. One was a routine 2.7-hour encounter; the other, recorded in December 2024, lasted 104.7 hours, the longest individual transhipment in the dataset and potentially indicative of an atypical activity warranting further scrutiny.

Ownership

Beneficial ownership was taken from S&P Global's Maritime Intelligence Risk Suite (MIRS), which provides company-of-control linkages derived from vessel registration, corporate filings, and beneficial ownership disclosures. MIRS records were matched to vessels in the transhipment network by MMSI, yielding ownership attribution for 69% of the 483 fishing vessels identified. The matched records point to 203 distinct beneficial owners, of which 21 control three or more vessels and are shown in Figure 6.

Two companies own both a carrier vessel and fishing vessels indicating vertical integration. Pingtairong Ocean Fishery controls PINGTAIRONGLENG2 and 11 of its regular fishing vessel partners, forming the most tightly integrated operation in the dataset. Dongwon Industries controls MV Badaro and 6 associated fishing vessels. The remaining four carrier vessels are owned by companies with no other vessels in this network.

Twelve of the 21 major owners send fishing vessels to more than one carrier, indicating lack of captive fleet arrangements. This pattern is concentrated among Korean companies: Sajo Industries (14 FVs, 2 carriers), Dong Won Fisheries (9 FVs, 3 carriers), Silla (8 FVs, 3 carriers), and KHD Korea (3 FVs, 3 carriers) all distribute their fleets across multiple carriers, including non-Korean ones such as TAIHO MARU.

Chinese companies are almost exclusively single-carrier, each tied to either PINGTAIRONGLENG2 or SEISHIN. Korean companies operate the most fluid cross-carrier arrangements. SEISHIN appears in the portfolios of more companies than any other carrier, functioning as a shared regional hub rather than a dedicated fleet vessel.

DONG HRONG 899 and FULL KUO SHIN have very few identifiable major company owners in the dataset, reflecting either atomised individual ownership of Chinese Taipei fishing vessels or gaps in the ownership data for this flag state.

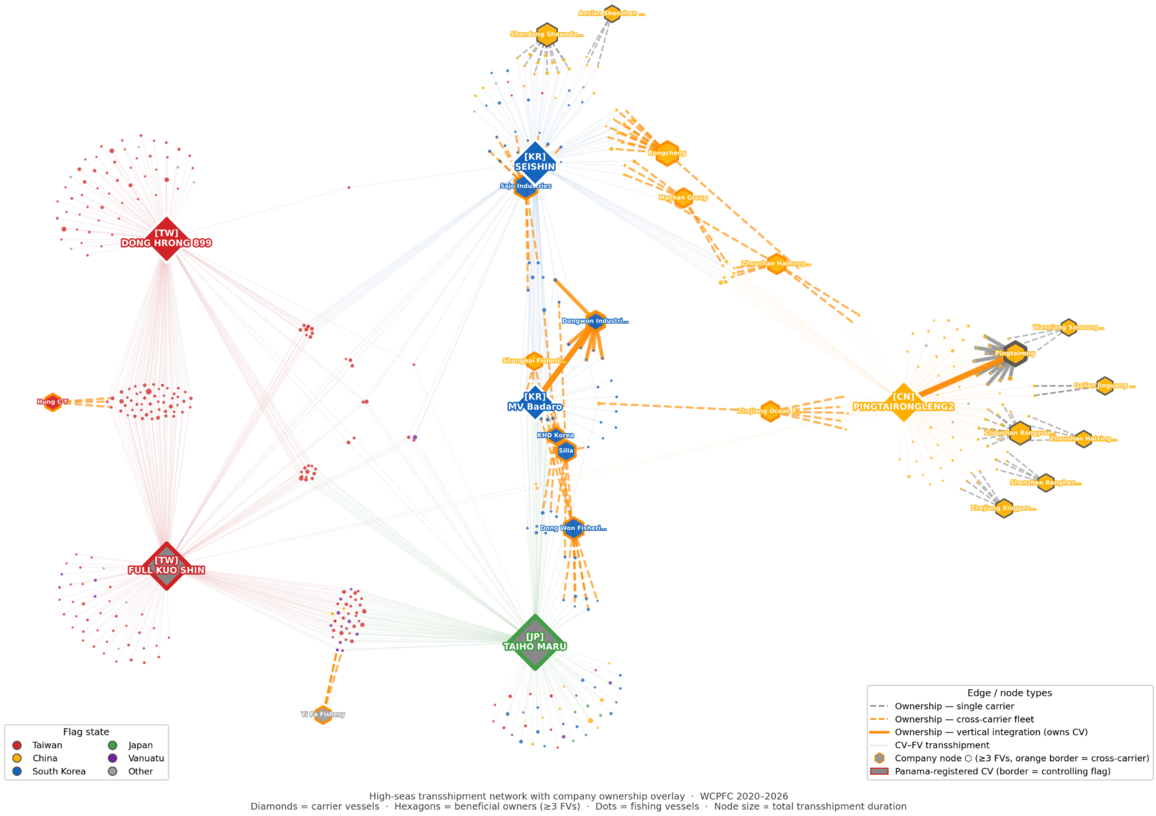


Figure 6: Beneficial ownership overlay on the high-seas transhipment network. Diamonds represent carrier vessels, sized by cumulative transhipment duration and coloured by controlling flag state; grey fill indicates Panama registration with a flag-coloured border. Hexagons represent beneficial owners controlling three or more fishing vessels in the network, sized by fleet count and coloured by country of control (S&P Global MIRS). Dots represent fishing vessels, coloured by flag state. Dashed grey lines denote ownership links where a company's fleet operates with a single carrier; dashed orange lines denote cross-carrier fleets. Solid orange lines denote vertical integration, where the beneficial owner also controls the carrier vessel.

Networks stratified by event duration

Not all CV-FV encounters result in fish transfers. Shorter encounters may reflect crew transfers, provisioning, bunkering, or vessel-to-vessel communication, and including them alongside longer transhipments could obscure the structure of catch-related relationships. Separating encounters by duration allows us to investigate whether network differences exist between the fishing supply chain and the broader set of at-sea interactions.

Following Lehmann et al. (2024), the network analysis was carried out for events lasting less than five hours and five hours or more, respectively. The resulting networks are presented side by side to highlight differences in carrier-fishing vessel relationships across the two duration classes (Figure 7).

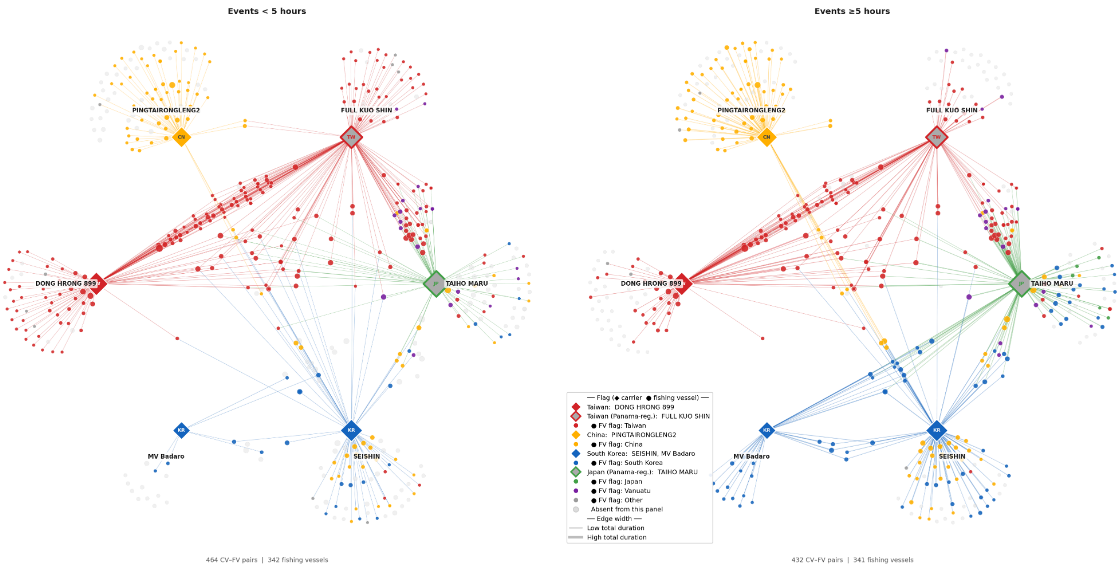


Figure 7. CV–FV transhipment network stratified by event duration. Left panel: encounters lasting fewer than five hours (464 CV–FV pairs, 342 fishing vessels). Right panel: transhipments of five hours or longer (432 CV–FV pairs, 341 fishing vessels). Faded nodes indicate fishing vessels absent from that duration band. Node size is proportional to total duration; edge width is proportional to cumulative duration per pair.

The two networks are nearly identical in size: 464 edges connecting 342 fishing vessels in the sub-five-hour group, and 432 edges connecting 341 fishing vessels in the long-duration group. Most vessels appear in both: 209 of the 350 vessels with at least one short encounter (60%) also recorded at least one long-duration event, suggesting a pattern of repeated short interactions alongside occasional transhipments.

The threshold does not divide the fleet into two separate populations, but the groups diverge in flag composition. Short encounters are concentrated among Chinese-Taipei-flagged vessels (198 of 350), with FULL KUO SHIN and DONG HRONG 899 accounting for the majority of these connections (Table 4). Both carriers record the lowest median event durations in the fleet. The long-duration event network draws from a broader fleet, with Chinese-Taipei (141 vessels), China (103), and South Korea (69) all contributing substantially (Table 5).

MV BADARO illustrates this contrast directly. It appears in the short-encounter records of only six fishing vessels but connects to 30 in the transhipment network, consistent with its median event duration of 10.4 hours. Virtually all of its interactions exceed the five-hour threshold.

Taken together, the stratified analysis confirms the five-hour threshold captures a real difference in encounter type. Short encounters are concentrated among the smallest carriers and Chinese Taipei-flagged fishing vessels, consistent with the carrier-size finding that shorter durations are associated with vessels less suited to large-volume fish transfer. Most fishing vessels appear on both sides of the threshold, though with only six carriers included this overlap is likely an undercount, as some fishing vessels will have additional encounters or transhipments with carriers outside this study.

Table 4. Fishing vessels most active in short-duration encounters.

Vessel	Flag	Events	CVs	Total (h)	Median (h)	Max (h)
MAN FU TSAI NO.88	Chinese Taipei	13	DONG HRONG 899, FULL KUO SHIN, SEISHIN	32.6	3.0	4.2
MAN YU CAI NO6	Chinese Taipei	11	DONG HRONG 899, FULL KUO SHIN	26.0	2.5	3.8
SHENGLIAN SHIANG NO1	Chinese Taipei	10	DONG HRONG 899	24.3	2.2	4.5
DE CHAN NO.44	Chinese Taipei	8	DONG HRONG 899, FULL KUO SHIN, SEISHIN	24.0	3.0	4.3
NIAN SHENG NO168	Chinese Taipei	7	DONG HRONG 899, FULL KUO SHIN, SEISHIN, TAIHO MARU	22.3	2.7	4.8
BOADA NO.5	Vanuatu	8	FULL KUO SHIN, SEISHIN, TAIHO MARU	22.2	2.7	4.7
SING MAN YI NO3	Chinese Taipei	7	DONG HRONG 899, TAIHO MARU	21.2	3.1	3.8
FV MAN FU TSAI NO 9	Chinese Taipei	7	DONG HRONG 899, FULL KUO SHIN, SEISHIN	21.2	3.4	4.7
CHAO YI NO.188	Chinese Taipei	7	DONG HRONG 899, FULL KUO SHIN	20.0	3.5	4.9
CHIN YUNG WEN	Chinese Taipei	7	FULL KUO SHIN, TAIHO MARU	19.6	2.2	4.3

Table 5. Summary of FV most active with transhipments (≥5 hours)

Vessel	Flag	Events	CVs	Total (h)	Median (h)	Max (h)
JIN DE MAN NO1	Chinese Taipei	14	DONG HRONG 899, FULL KUO SHIN	153.5	9.6	23.6
XINSHIJI7HAO	China	12	TAIHO MARU	120.8	10.5	15.8
XIN SHI JI 17 HAO	China	13	SEISHIN, TAIHO MARU	115.4	8.3	13.7
PINGTAIRONG89	China	1	PINGTAIRONGLENG2	104.7	104.7	104.7
HAI CHIEN HSING NO2	Chinese Taipei	7	DONG HRONG 899	98.2	10.4	24.3
LIAOYUANYU101	China	6	PINGTAIRONGLENG2, SEISHIN	92.2	11.4	29.4
SHIN SHIE YI	Chinese Taipei	6	DONG HRONG 899	81.8	11.2	22.9

NO.101 HAE CHEON	South Korea	4	MV Badaro, SEISHIN, TAIHO MARU	81.7	20.6	29.1
CHIN YOU WEN	Chinese Taipei	9	FULL KUO SHIN, TAIHO MARU	78.3	7.5	17.2
SHENGLIAN SHIANG NO1	Chinese Taipei	6	DONG HRONG 899	75.4	10.2	26.2

Relationships between fishing vessels

The CV–FV transhipment network identifies which fishing vessels directly interacted with each carrier vessel, but it captures only part of the on-water relationships. Fishing vessels operating in the high seas regularly encounter one another independently of any carrier. The FV–FV encounter network (Figure 8) maps these vessel-to-vessel events to reveal the broader operational community around each carrier.

The inner ring of each figure shows confirmed transhipment partners; the outer ring shows fishing vessels present in the same operational sphere, but without a recorded direct transfer.

Together the two layers expose fleet cohesion and cross-vessel relationships that a purely carrier-centric view would miss, and provide a basis for identifying vessels that warrant closer scrutiny even where a direct transhipment with the carrier was not detected.

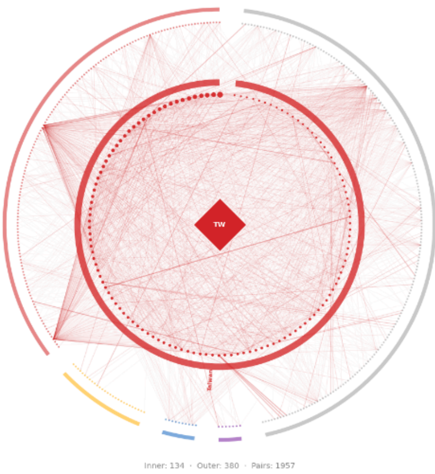
Observations

Six CVs are linked to 468 unique primary FVs (direct transhipment recorded) via 676 CV-FV edges. Among those primary FVs, approximately 770 unique co-encounter pairs are recorded (Figure 8).

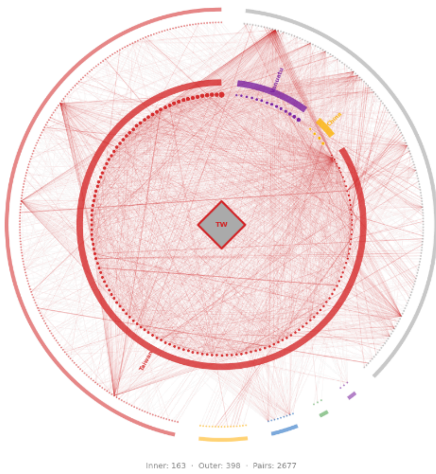
The on-water FV-FV relationships correspond to the CV-FV flag relationships. Around 70% of FV-FV encounters occur within the same flag state as the respective CV. DONG HRONG 899 and FULL KUO SHIN operate almost exclusively with Chinese Taipei-flagged FVs; PINGTAIRONGLENG2 almost exclusively with Chinese FVs; MV Badaro with South Korean FVs. SEISHIN and TAIHO MARU are more mixed.

FULL KUO SHIN has the densest sub-network with 489 unique FV-FV pairs, roughly double DONG HRONG 899 (286) and six times the next three carriers. MV Badaro's fleet is extremely sparse (7 pairs), consistent with its much smaller primary fleet.

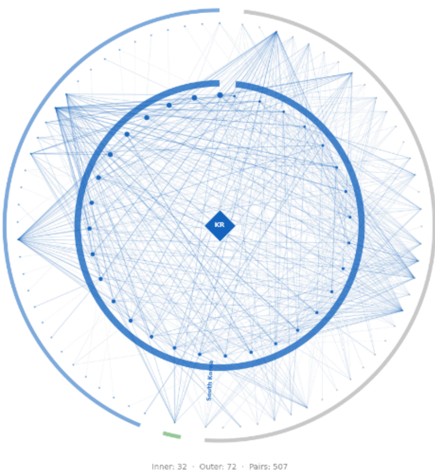
DONG HRONG 899 [TW]



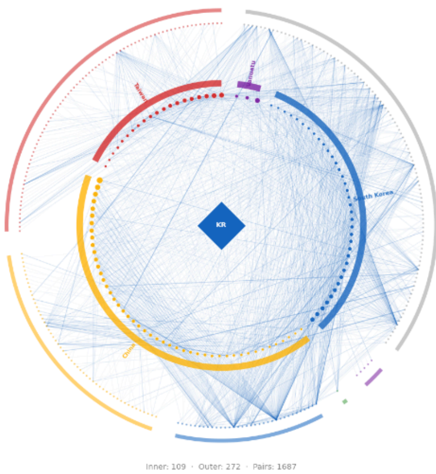
FULL KUO SHIN* [TW]



MV Badaro [KR]

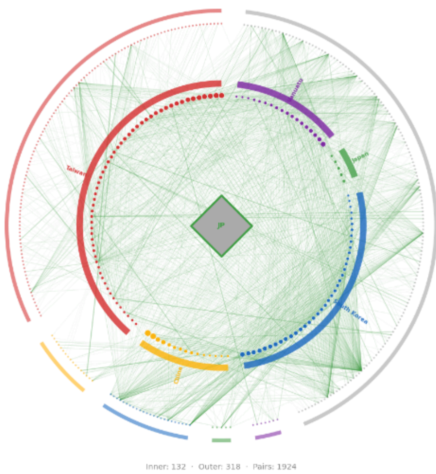


SEISHIN [KR]



PINGTAIRONGLENG2 [CN]

TAIHO MARU* [JP]



Taiwan · South Korea · Vanuatu · Co-encountered FV (outer ring) · Panama-registered CV (*)
China · Japan · Other · FV-FV co-encounter (chord)

Figure 8. Encounter network for each carrier vessel (centre diamond, labelled by controlling flag state) and its associated fishing vessel community. The inner ring contains fishing vessels with a recorded transhipment event with that carrier; the outer ring contains additional fishing vessels co-encountered by inner-ring fleet members but without a direct recorded transfer. Chord lines connect fishing vessel pairs with documented co-encounters, with line weight and opacity proportional to the log of cumulative encounter duration. Node and arc colours indicate vessel flag state.

Impracticability

Methods

For each transhipment event, the geographic centre of all fishing activity recorded since the vessel's previous transhipment or port visit was calculated as a weighted mean position (the fishing centroid). The distance from this centroid to the transhipment location and to the nearest suitable port were then computed using the Haversine formula. The ratio of fishing centroid-to-transhipment distance divided by fishing centroid-to-port distance provides a measure of the relative proximity of the transhipment location compared to the nearest port. A ratio below 1 indicates that the transhipment occurred closer to the fishing grounds than the nearest port, while a ratio above 1 indicates that a port was closer.

A second distance measure was calculated as the minimum distance from any point along the vessel's track to the nearest suitable port within two weeks either side of the transhipment event. We refer to this as the 'track distance' and the impracticability ratio is referred to as track-based impracticability. The argument is that if a fishing vessel comes close to a transhipment port within a two-week time window of the high seas transhipment, then it should have used that port for offloading to a carrier.

One complication exists for track distances. They approach zero where a vessel enters a port within the two-week window surrounding the transhipment event. This produces numerically unstable ratios that distort the distribution of the ratio. To address this, a minimum track distance of 12 nautical miles was applied before computing the track-based ratio, consistent with the international standard for territorial waters. This floor affects 37 events (2.9% of all events), all of which had track distances below 1.3 NM. All subsequent analyses use the floored ratio.

Both, centroid- and track-based ratios are reported in the appended data file. The following results and discussion use the impracticability ratio that uses the greater of the two ratios for each event.

Events were stratified by duration into transhipments (≥5 hours) and shorter encounters (<5 hours) for comparison. The analysis follows the framework established in Lehmann et al. (2024).

Results

An in-port transhipment is considered to be impractical if a fishing vessel's travel to a port is greater than the journey to meet a carrier vessel on the high seas. Our impracticability ratio is defined as the greater of two distance ratios: the fishing centroid to transhipment location relative to the nearest suitable port, and the fishing centroid to transhipment location relative to the vessel's closest approach to any suitable port within two weeks of the transhipment event. A ratio greater than one indicates that in-port transhipment is not impractical. Using the maximum of the centroid- and the track-based ratios ensures that any practical port access opportunity, whether from the fishing grounds or along the vessel's transit route, is accounted for when assessing whether in-port transhipment was impracticable.

Across all 1,277 events, 53% have an impracticability ratio below 0.75, meaning the transhipment location was substantially closer to the fishing grounds than the nearest suitable port (Figure 9, Table 6). A further 5% fall in the marginal zone (ratio 0.75–1.0), where the port and transhipment location were approximately equidistant. The remaining 42% have a ratio of 1.0 or above, indicating that a suitable port was at least as accessible as the chosen transhipment location. Of these, 242 events (19%) have a ratio above 3, meaning the journey to the high seas transhipment location was more than three times greater than that to a suitable port; these strongly not impracticable events represent the cases where the economic hardship argument is least supportable.

The pattern is consistent across both duration bands. Among transhipments (≥5 hours), 53% are clearly impracticable, 5% marginal, and 42% not impracticable. Among shorter encounters (<5 hours), the proportions are nearly identical at 54%, 7%, and 40% respectively.

The impracticability ratio distribution is strongly right-skewed (skewness = 8.5 across all events), so all subsequent trend and seasonality analyses were conducted on the natural log-transformed impracticability ratio. Log transformation reduces skewness to near zero (0.07), producing a roughly symmetric distribution appropriate for regression and non-parametric testing. The transformation also provides a natural reference frame: $\log(1) = 0$ marks the equidistant threshold, values below zero indicate that the transhipment location was closer to the fishing grounds than the nearest port, and the tier boundary at ratio = 0.75 corresponds to $\log(0.75) = -0.29$.

Table 6. Summary of impracticability tier classification for all transhipment events and shorter encounters, based on the conservative ratio (the greater of the centroid-based and vessel-track-based port distance ratios). Clearly impracticable events have a ratio below 0.75, indicating the transhipment location was substantially closer to the fishing grounds than the nearest suitable port. Marginal events (ratio 0.75–1.0) fall within a zone of approximate equidistance where best-practice port use could reasonably be expected. Events with a ratio of 1.0 or above are classified as not impracticable, as a suitable port was at least as accessible as the transhipment location. Events with a conservative ratio above 3, where the transhipment location was more than three times further from the fishing grounds than the nearest suitable port, are classified as strongly not impracticable.

	Transhipments (≥5 h)	Encounters (<5 h)	All events
Total events	745	532	1,277
Clearly impracticable (ratio < 0.75)	395 (53%)	286 (54%)	681 (53%)
Marginal (ratio 0.75–1.0)	35 (5%)	35 (7%)	70 (5%)
Not impracticable (ratio ≥ 1.0)	315 (42%)	211 (40%)	526 (41%)
Strongly not impracticable	161 (22%)	81 (15%)	242 (19%)

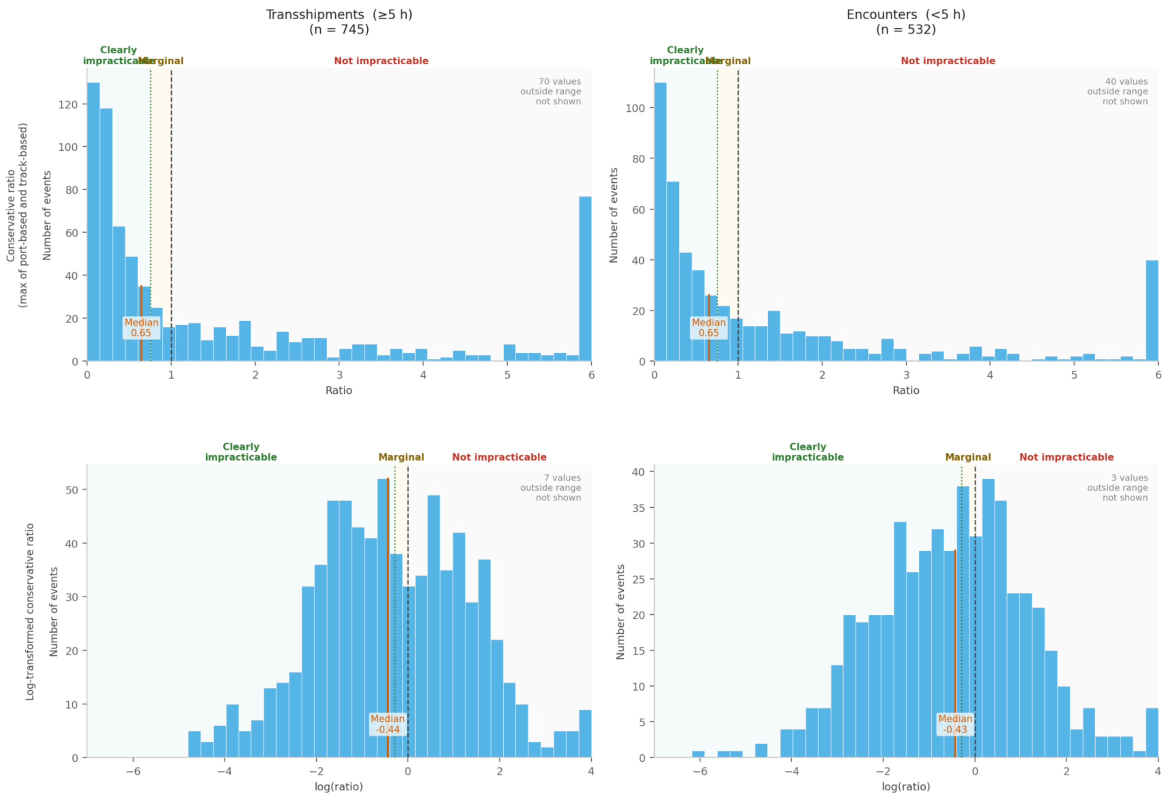


Figure 9. Distribution of the impracticability ratio for transhipment events (≥5 h, left column) and encounters (<5 h, right column), stratified by duration. Top row: raw conservative ratio (maximum of port-based and track-based ratios), clipped at 6 for display; values exceeding this range are noted. Bottom row: natural log-transformed conservative ratio. In both rows, background shading indicates the three classification tiers — clearly impracticable (ratio < 0.75), marginal (0.75–1.0), and not impracticable (≥1.0) — with tier boundaries marked by dotted and dashed vertical lines. The orange line shows the median for each panel.

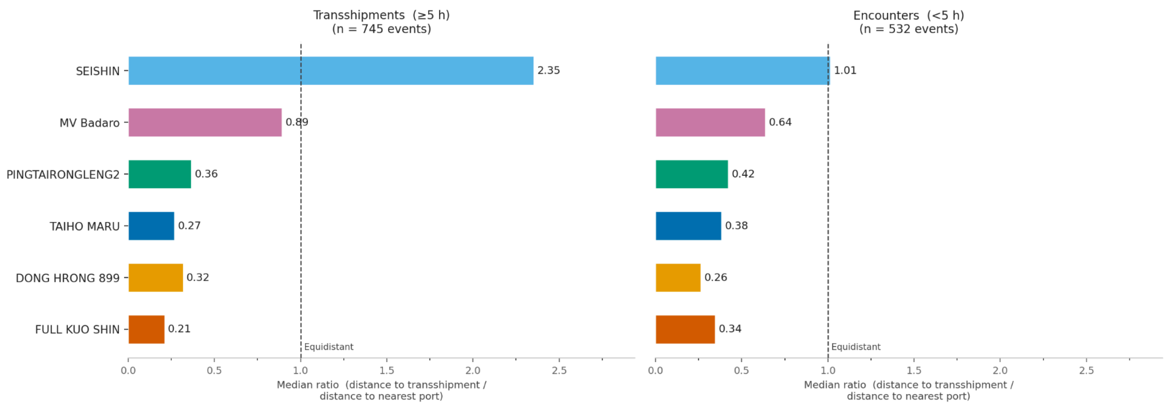


Figure 10. Median impracticability ratio by carrier vessel for transhipments of five hours or longer (left) and encounters lasting fewer than five hours (right). The ratio represents the distance from the fishing centroid to the transhipment location divided by the distance to the nearest suitable transhipment port. Values below 1 indicate that the transhipment location was closer to the fishing grounds than the nearest port; values above 1 indicate the port was more accessible. The dashed line marks the equidistant threshold. Carrier vessels are ordered by their overall median ratio across all events.

Temporal trend analysis

To examine whether the impracticability ratio changed over the study period, the conservative ratio for each event was log-transformed and plotted against event date. A locally weighted scatterplot smoothing (LOESS) curve was fitted to the full event-level series using a bandwidth of 0.15 to capture broad temporal structure while remaining responsive to local variation (Figure 11). A linear trend was estimated by ordinary least-squares regression of the log-ratio on elapsed days from the first event, with the slope expressed as change per year. Statistical significance was assessed using the two-tailed t-test on the regression slope (Table X) .

To summarise the distribution at coarser resolution and allow visual assessment of seasonal patterns, events were aggregated into year-quarters (Q1–Q4 of each calendar year). For each quarter, a box-and-whisker plot was produced showing the median, interquartile range, and 1.5× IQR whiskers (Figure 12). Boxes were coloured by calendar quarter to allow comparison of same-season quarters across years. LOESS and linear trends were fitted through the sequence of quarterly medians using a bandwidth of 0.4. Both figures share the same reference lines: a dashed line at $\log(1) = 0$ marking the equidistant threshold, and a dotted line at $\log(0.75) = -0.29$ marking the boundary between the clearly impracticable and marginal tiers.

The bandwidth parameter is a proportion of the total number of data points used as the local neighbourhood for each smoothed estimate. A value of 0.15 means that for each point on the curve, the nearest 15% of observations are used in the local weighted regression. A value of 0.4 for the quarterly series means 40% of the quarters contribute to each smoothed value, reflecting the sparser data and the need for a wider window to produce a stable estimate.

Neither the event-level nor the quarterly trend analysis detected a statistically significant change in the log impracticability ratio over the study period (Table 7). The event-level linear regression yielded a slope of +0.018 log-units per year ($p = 0.513$), with the ratio of variance explained approaching zero ($r^2 < 0.001$). The LOESS curve on the same series showed a modest rise toward the equidistant threshold around 2021–2022, followed by a return to lower values, a transient fluctuation rather than a directional trend. The linear trend fitted through quarterly medians was effectively flat (slope = −0.010 log-units per quarter, $p = 0.666$, $r^2 = 0.009$), consistent with the event-level result.

Table 7. Linear trend results for the log-transformed impracticability ratio, fitted at event level and through quarterly medians.

Model	n	Slope	p-value	r^2
Event-level (log-units yr^{-1})	1,277	+0.018	0.513	<0.001

Quarterly medians (log-units quarter⁻¹)	24	−0.010	0.666	0.009

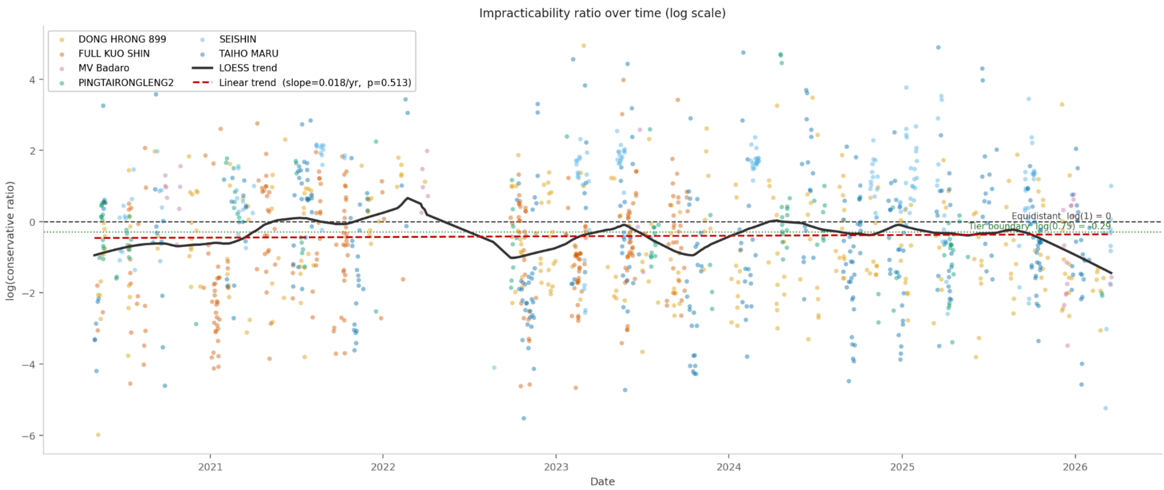


Figure 11. Log-transformed impracticability ratio for all events (n = 1,277) plotted against event date, coloured by carrier vessel. The dashed horizontal line marks the equidistant threshold (log(1) = 0); the dotted line marks the clearly impracticable tier boundary (log(0.75) = −0.29). The black line shows a LOESS trend (bandwidth = 0.15); the red dashed line shows the linear trend (slope = +0.018 log-units yr⁻¹, p = 0.513).

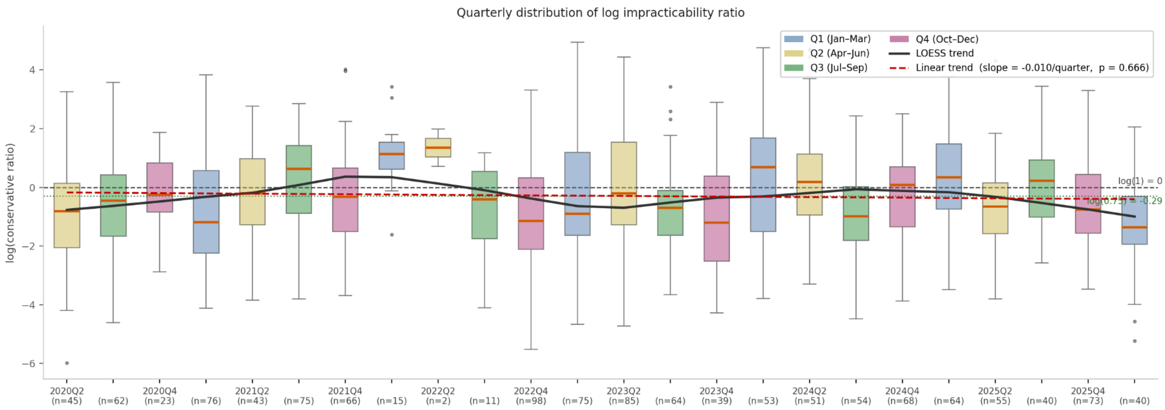


Figure 12. Quarterly distribution of the log-transformed impracticability ratio (n = 1,277). Boxes are coloured by calendar quarter and show the median, interquartile range, and 1.5× IQR whiskers. Dashed and dotted reference lines mark the equidistant threshold (log(1) = 0) and clearly impracticable tier boundary (log(0.75) = −0.29), respectively. The black line shows a LOESS trend through quarterly medians (bandwidth = 0.4); the red dashed line shows the linear trend (slope = −0.010 log-units quarter⁻¹, p = 0.666).

Seasonality analysis

To assess whether the impracticability ratio varies systematically across the calendar year, log-transformed conservative ratios were grouped by calendar month and tested for distributional differences using the Kruskal–Wallis test. The analysis was conducted on all 1,277 events pooled across carrier vessels and years.

The Kruskal–Wallis test detected statistically significant variation across months ($H = 32.38$, $p = 0.001$) (Figure 13). Monthly median log-ratios ranged from −1.19 (November) to +0.15 (March), with January (−0.92) and February (−0.91) also among the lowest. March was the only month in which the median exceeded the equidistant threshold (log(1) = 0), indicating that for the typical March event the transhipment location was further from the fishing grounds than the nearest suitable port. The same test applied to calendar quarters (Q1–Q4) returned a borderline result ($H = 7.80$, $p = 0.050$), suggesting a weak quarterly signal that warrants cautious interpretation.

The elevated March median is not attributable to a single carrier vessel. SEISHIN, which has the highest overall ratio, accounted for 43% of March events (n = 40 of 92) compared to its 14% share across all months. However, excluding SEISHIN, the March median remained +0.09, still the highest of any month and above the equidistant threshold. TAIHO MARU (median +0.45, n = 21) and MV Badaro (median +0.27, n = 5) also recorded positive March medians, indicating that the pattern is present across multiple vessels and is not an artefact of SEISHIN's disproportionate representation in that month. This multi-vessel consistency also lends weight to the borderline quarterly signal, as Q1, which includes March, contains a higher concentration of above-threshold events than other quarters.

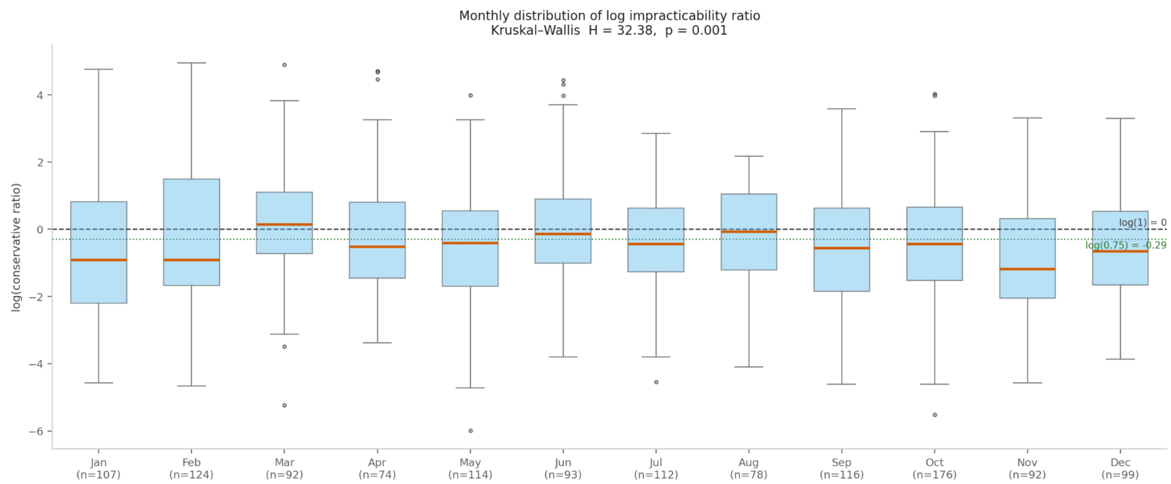


Figure 13. Monthly distribution of the log-transformed impracticability ratio for all events (n = 1,277), pooled across carrier vessels and years. The orange line shows the monthly median; boxes span the interquartile range; whiskers extend to 1.5× the IQR; outliers are shown as individual points. Dashed and dotted reference lines mark the equidistant threshold (log(1) = 0) and clearly impracticable tier boundary (log(0.75) = −0.29), respectively. Kruskal–Wallis $H = 32.38$, $p = 0.001$.

Relationship between fuel price and transhipment location

Fuel cost is central to the impracticability argument: if travelling to a suitable port imposes a significantly greater economic burden than transshipping at sea, the cost differential is largely a function of distance and fuel price. If the impracticability argument has economic substance, vessels should respond to higher fuel prices by transshipping closer to their fishing grounds, minimising unnecessary travel. This effect would be detectable as a negative correlation between fuel price and the impracticability ratio.

To test this, monthly Singapore Marine Gas Oil (MGO) prices sourced from Ship & Bunker were matched to the monthly median log-transformed impracticability ratio across the study period (Figure 14 Singapore is the world's largest bunkering port, so Singapore MGO prices are treated as a standard index for fuel costs in the Asia-Pacific region, including for distant-water fleets operating in the WCPO. The analysis tests whether higher fuel prices are associated with lower impracticability ratios, that is, whether vessels tranship in locations that are relatively closer to their fishing grounds when fuel costs are elevated.

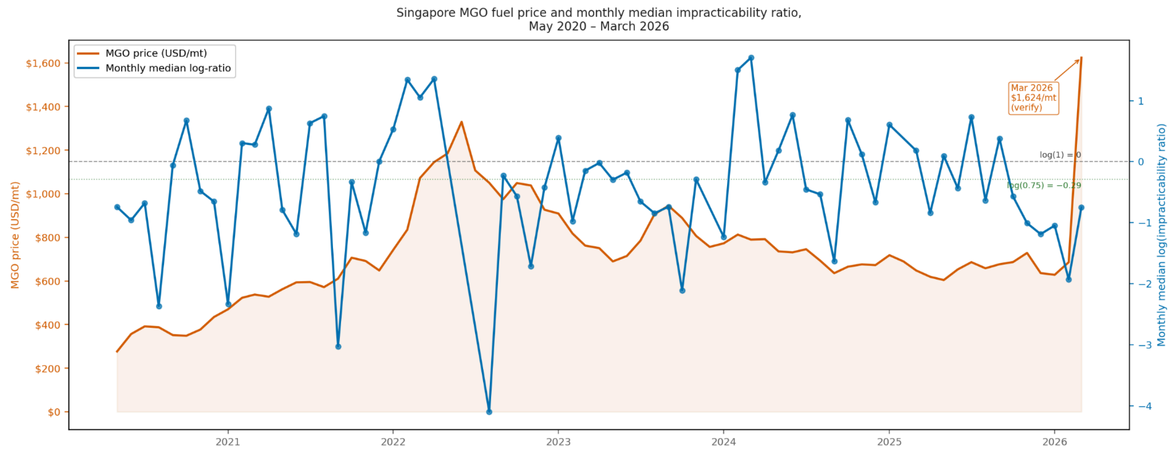


Figure 14. Monthly Singapore MGO bunker fuel price (USD/mt, left axis) and monthly median log-transformed impracticability ratio (right axis), May 2020 – March 2026. Dashed and dotted horizontal lines mark the equidistant threshold (log(1) = 0) and clearly impracticable tier boundary (log(0.75) = −0.29), respectively. The March 2026 fuel price value ($1,624/mt) is flagged.

The Spearman correlation between monthly fuel price and the monthly median log impracticability ratio was weak and non-significant ($r = 0.111$, $p = 0.377$, $n = 65$, Figure 15). The direction of the correlation is weakly positive, the opposite of what the impracticability hypothesis would predict. Extending the analysis to lagged fuel prices tests whether prices one or two months prior predict the current ratio, produced no stronger result. At a one-month lag, $r = 0.033$ ($p = 0.796$); at two months, $r = 0.003$ ($p = 0.981$). There is no evidence that higher fuel prices are associated with lower impracticability ratios at any of the time lags examined.

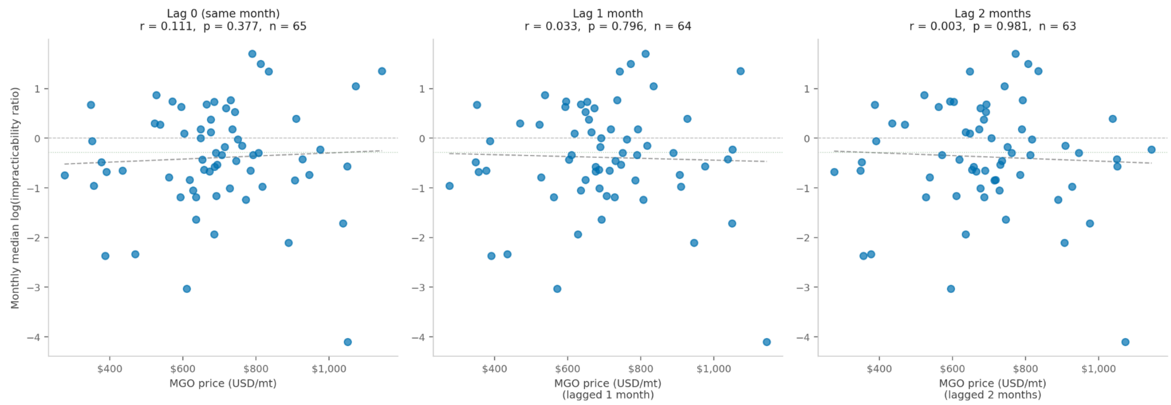


Figure 15. Spearman correlation between monthly Singapore MGO fuel price and monthly median log impracticability ratio at zero, one, and two month lags (March 2026 excluded). Dashed and dotted horizontal lines mark the equidistant threshold (log(1) = 0) and clearly impracticable tier boundary (log(0.75) = −0.29), respectively. The grey dashed line shows the ordinary least squares regression fit.

In summary, no significant relationship was found across any of the additional specifications tested: substituting 3-month and 6-month rolling average fuel prices, excluding SEISHIN, and using median distance to the transhipment location as a direct measure of travel cost all produced equivalently null results. SEISHIN was excluded as a sensitivity check because its median impracticability ratio (1.96) is roughly five times higher than that of the next carrier vessel, making it the most influential single observation in the dataset; its removal had no effect on the result.

A binary outcome analysis tested whether the monthly proportion of events with a ratio of 1.0 or above varies with fuel price. While this analysis offered a directionally consistent pattern, with higher sustained fuel prices weakly associated with fewer not-impracticable events at a 2-month lag ($r = -0.164$, $p = 0.215$), it falls well short of statistical significance.

The absence of any detectable fuel price effect across a range of time aggregates suggests that transhipment location decisions are not meaningfully governed by fuel cost. This further indicates that companies' operational decisions regarding transhipments are not influenced by operational impracticabilities.

Detailed track analysis

The impracticability ratio developed in Lehmann et al. (2024) and applied in this report uses straight-line distances from a fishing centroid as a proxy for the cost of reaching a transhipment location or a suitable port. This approach was designed for computational efficiency and practical replicability: it can be derived from the fishing event data produced by Starboard, and the underlying logic is robust enough to be verified by an analyst examining a vessel track directly. It also handles the significant AIS outages that characterise many fishing vessel records, since a fishing centroid can be computed from whatever position data is available without requiring a complete track.

Actual track lengths, segmented into transit, fishing, and transhipment activity, would produce more precise estimates of the distances vessels travel and the fuel expenditure associated with each phase of a deployment. However, this approach requires continuous records and substantially more analytical effort per vessel, and its results become unreliable when data coverage is sparse. The analysis presented in this section applies that more detailed method to a small, carefully selected set of vessels chosen partly on the basis of data quality, and should be read as a test of the approach rather than a fleet-representative result.

Track length was computed by summing Haversine great-circle distances between consecutive AIS positions, treating the Earth as a sphere. This introduces a small negative bias relative to the WGS84 ellipsoid of approximately 0.3%, which is negligible at the distances involved.

Fishing vessels

The journeys of six fishing vessels flagged to Chinese Taipei , South Korea, China, Japan, and Vanuatu were selected for detailed analysis of actual distances travelled. The vessels were chosen as the best combination of a large number of transhipment events in our dataset and fewest gaps in AIS data (Table 8).

For each vessel, up to three fishing trips were analysed, each spanning the period from a prior transhipment event or a port departure to a subsequent transhipment with a carrier vessel. Each trip is characterised by duration at sea, track length, AIS data coverage, and the closest FFA-designated transhipment port in the seven days prior to the transhipment.

The fishing trip durations ranged from 14 to 148 days, with track lengths of 2,152 to 22,155 nautical miles. Thirteen trips were bounded by a prior transhipment event; the remaining four commenced at a regional Pacific port. In the last seven days before the transhipment on the high seas, the closest longline transhipment capable port was between 218 and 1,407 nautical miles away, greatest distances recorded for TOYOKUNI MARU NO.31 and XIN SHI JI 17 HAO operating in the far eastern Pacific (Table 9, Figure 16).

The six vessels selected represent the flag states present in the network, but the sample is not statistically representative of the broader fishing fleet. Therefore, the results should be read as illustrative of the distances typical fishing vessels travel rather than as fleet-wide averages. Fishing trip track lengths of thousands of nautical miles reflect the scale of movement involved in a single interval between transhipments. These figures cover only the journey in the region, as they exclude the transit from home ports in northeast Asia to and from the western central Pacific, a distance of approximately 9000 NM.

Despite covering these distances, in the days immediately before each transhipment event, several vessels passed within range of a suitable port. For nine of the 17 trips analysed, the straight-line distance from the vessel's closest approach to a port in the seven days prior to the transhipment represented less than 10% of the total trip track length, and for five of those trips, less than 5%.

Table 8: Fishing vessels selected for AIS track segment analysis, one to two per flag state. Selection criteria reflect complementary analytical strengths: event volume, carrier diversity, temporal coverage, and network connectivity.

Vessel	Flag	MMSI	Justification
JIN DE MAN NO1	Chinese Taipei	416004214	Highest event count (20) and duration (166.6h) of any FV; covers full study period 2020–2026
SING MAN YI NO3	Chinese Taipei	416230800	Only FV transshipping with 4 carriers; best candidate for cross-fleet comparison
GRAND EAST	Vanuatu	577319000	Cross-carrier Vanuatu vessel bridging Korean (SEISHIN), Japanese (TAIHO MARU), and Chinese Taipei(FULL KUO SHIN) carrier networks; consistent annual coverage 2022–2025
PANALOX505	South Korea	440549000	Exactly 2 events with each of the 3 Korean-serviced carriers (MV Badaro, SEISHIN, TAIHO MARU); clean data with no identity anomalies
XIN SHI JI 17 HAO	China	412679210	Only Chinese FV with transhipment events in every year 2020–2026; 13 events and 115.4h suggest reliable AIS
TOYOKUNI MARU NO.31	Japan	431714000	Best of a shallow pool (only 5 Japanese FVs in network); highest duration among Japanese vessels (23.7h); 2024–2026

Table 9. AIS-derived metrics for 17 bounded fishing trips across six fishing vessels, each ending in a high-seas transhipment event in the Convention Area. Trip start boundaries are either a prior transhipment event or a regional Pacific port departure. Nearest port distance is calculated over the final seven days of track before the transhipment.

Date of TS	Carrier vessel	Trip duration (days)	Track (NM)	Nearest port	Nearest port approach (NM)	Distance ratio (port/track)
JIN DE MAN NO1						
2022-12-15	DONG HRONG 899	28	3,173	Funafuti	306	0.10
2023-07-15	DONG HRONG 899	30	3,077	Funafuti	241	0.08
2023-09-15	DONG HRONG 899	25	2,564	Funafuti	237	0.09
SING MAN YI NO3						

2021-07-27	DONG HRONG 899	17	2,417	Funafuti	218	0.09
2021-10-17	FULL KUO SHIN	42	4,888	Majuro	596	0.12
2022-09-29	FULL KUO SHIN	28	3,431	Kirimati	806	23%
GRAND EAST						
2022-10-14	TAIHO MARU	14	2,152	Kirimati	389	18%
2023-03-11	SEISHIN	148	22,155	Kirimati	877	4%
2024-09-03	TAIHO MARU	69	8,019	Kirimati	712	9%
PANALOX505						
2024-07-22	SEIYU	35	4,542	Funafuti	274	6%
2023-02-28	SEISHIN	101	13,545	Kirimati	594	4%
2023-06-22	MV BADARO	113	15,143	Funafuti	257	2%
XIN SHI JI 17 HAO						
2023-11-02	TAIHO MARU	82	11,753	Kirimati	650	6%
2024-12-14	TAIHO MARU	18	2,412	Kirimati	594	25%
2025-03-21	TAIHO MARU	18	3,171	Kirimati	226	7%
TOYOKUNI MARU NO.31						
2024-02-08	TAIHO MARU	118	14,135	Kirimati	897	6%
2026-01-18	TAIHO MARU	52	6,533	Kirimati	1407	22%

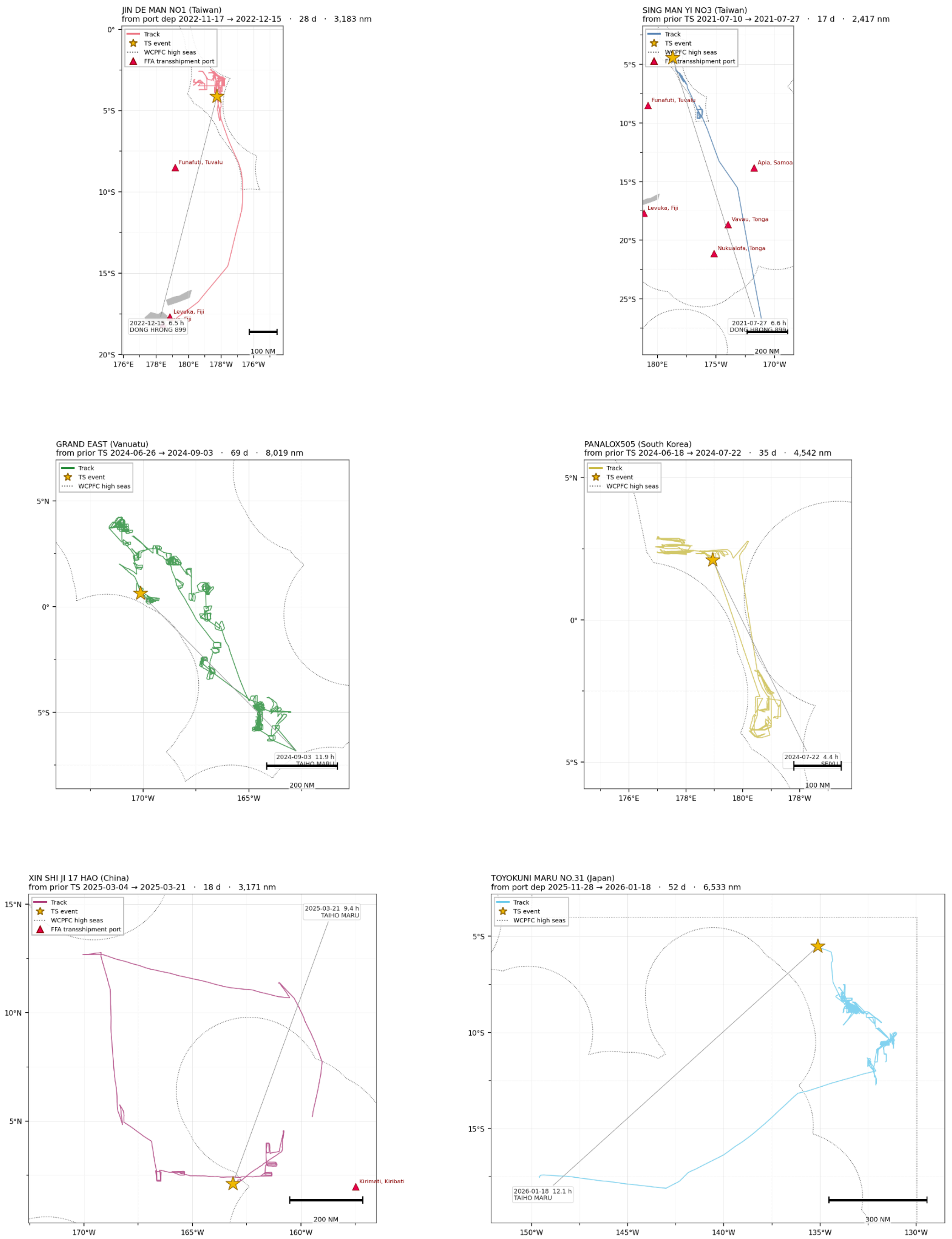


Figure 16. AIS tracks for one selected fishing trip per vessel across the six study vessels, spanning 2021 to 2026. Each trip is bounded by a prior transhipment event or port departure (noted in the panel title) and ends at the transhipment event marked by a gold star. Red triangles indicate FFA-designated transhipment ports within the map extent. Dotted lines show the WCPFC high seas boundary.

Carrier vessel TAIHO MARU

Over the study period, TAIHO MARU completed 18 high-seas deployments, all departing from Kaohsiung, Chinese Taipei with one exception in September 2022 (departure from

Shimizu). Deployments averaged 65.2 days (range 51.4 to 80.6 days). The vessel conducted 424 transhipment events considered in this study, with a median event duration of 6.4 hours. The distance travelled by the TAIHO MARU on this journey is 12,768 NM.

Starboard also estimates 40 inferred transhipments. Inferred transhipments are events where only the carrier vessel is visible on AIS, with no fishing vessel counterpart, but the vessel's behaviour matches patterns observed during confirmed transhipments. Starboard identifies these events using a rule-based classifier requiring slow speed, favorable wind and wave conditions, and consistent vessel orientation.

Transhipment activity is concentrated in the high seas area north of the Solomon Islands and Vanuatu, and in the high seas tongues between Tuvalu, Kiribati, and French Polynesia. Some activity extends into the adjacent IATTC Convention Area. At the conclusion of each high seas deployment, TAIHO MARU makes a brief call at Majuro, Republic of the Marshall Islands, typically of only a few hours duration, before continuing to northeast Asia. On return transits to northeast Asia, the vessel calls at ports in South Korea, China, and Japan.

The journey starting with departure from Kaohsiung, Chinese Taipei on 9 September 2025 was chosen for detailed analysis. The track was segmented into transit, positioning, and transhipment or loitering using the Starboard activity detection and speed thresholds (Figure 17). In summary:

- Departure port: Kaohsiung, Chinese Taipei — 9 Sep 2025, 10:22
- At sea: 50 days, 10 hours, 27 minutes
    - 42 likely transhipments with 30 fishing vessels
    - 4 inferred transhipments
    - 8 destination changes
    - Loitering: 17 days, 8 hours, 12 minutes
    - Missing AIS data: 20 hours, 51 minutes
- Port call: Majuro, Marshall Islands — 29 Oct 2025, 20:49 to 22:29 (1 hour, 39 minutes)
- At sea: 9 days, 3 hours
- Arrival port: Shimizu, Japan — 8 Nov 2025, 01:45

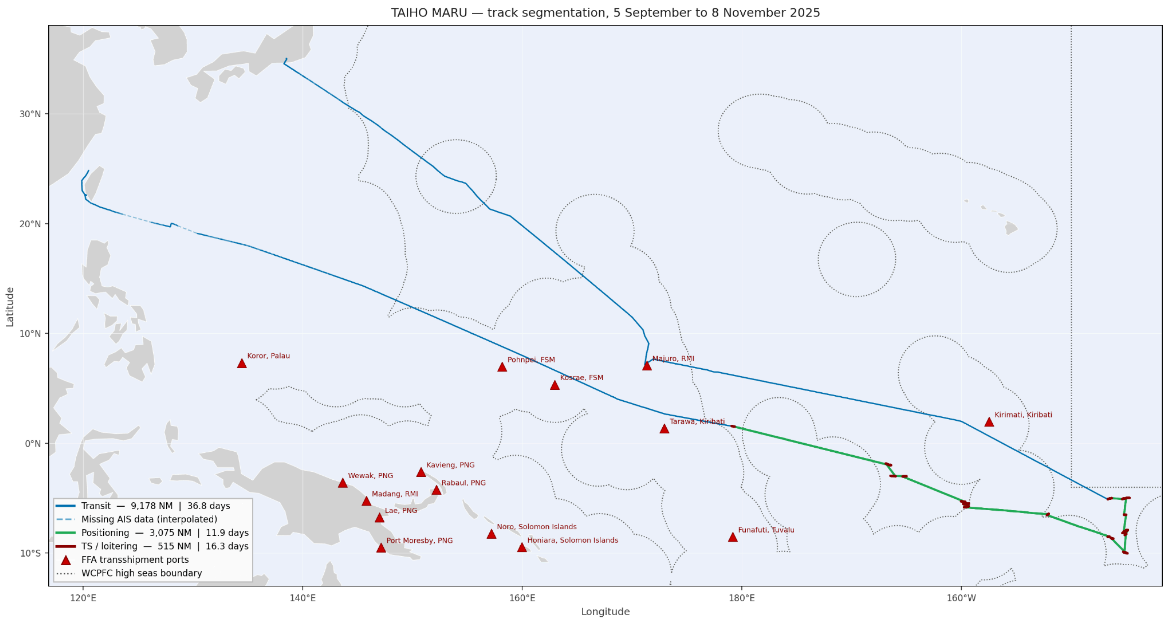


Figure 17. TAIHO MARU vessel track, 5 September to 8 November 2025, segmented by activity. Blue: transit to and from northeast Asia. Green: positioning within the transhipment operating window (speed > 3 knots), including repositioning between transhipment hotspots. Dark red: TS/loitering (speed ≤ 3 knots). Dashed segments indicate AIS reception gaps interpolated as straight lines. Red triangles indicate FFA-designated transhipment ports. The dotted line marks the WCPFC high seas boundary.

The 64-day deployment covered a total of 12,768 NM. Transit to and from northeast Asia accounted for 9,178 NM (71% of total distance) over 36.8 days, including two AIS gap segments on the outbound leg (268 NM interpolated). Within the transhipment operating from the first to the last recorded transhipment event (28 days), the vessel spent 16.3 days at speeds below 3 knots conducting transhipments and loitering, covering only 515 NM, and a further 11.9 days repositioning between transhipment hotspots at higher speeds over 3,075 NM (Table 10).

Table 10. Track segmentation for TAIHO MARU, 5 September to 8 November 2025. Transit covers all track before the first and after the last transhipment event, irrespective of speed. Repositioning covers track within the transhipment operating window at speeds above 3 knots, including repositioning between transhipment hotspots. TS / loitering covers track within the operating window at speeds of 3 knots or below, consistent with active transhipment or waiting behaviour. AIS gap segments are interpolated as straight lines and counted within their respective activity class.

Segment	Distance (NM)	Time (days)
Transit (to/from NE Asia)	9,178	36.8
Repositioning (within WCPO)	3,075	11.9
Transhipment / loitering	515	16.3
Total	12,768	65.0

The fuel consumed operating under main engine power during positioning and transhipment activity amounts to approximately 3,590 NM of equivalent steaming distance. This cost would be largely avoided if the vessel were to conduct transhipments in port rather than at sea. The two FFA-designated ports closest to the observed transhipment hotspots are Tarawa and Kiritimati, both in Kiribati. A direct route from Kaohsiung, Chinese Taipei via Tarawa and Kiritimati to Shimizu, Japan covers 9,165 NM — within 13 NM of the vessel's actual transit distance of 9,178 NM (Table 10). Calling at Tarawa and Kiritimati would have eliminated the 3,590 NM of positioning and at-sea transhipment steaming while leaving the transit distance essentially unchanged, reducing total fuel consumption by approximately 28% compared to the actual voyage.

Port use and costs

In-port transhipment delivers documented economic, monitoring, and data quality benefits to the region. The WCPF Convention encourages members to conduct transhipment in port where practicable. The practice of high-seas transhipment as investigated in this report proves that the gap between that policy intent and operational reality is wide. It costs Pacific islands countries with suitable port facilities both revenue and monitoring and opportunities. Importantly, it also deprives the region of the data quality, monitoring and verification benefits to scientific and compliance efforts in tuna management within the WCPO.

The findings of this report do not support claims that transhipping in port is impracticable from a travel-distance point of view for approximately half of the high seas transhipment events investigated here. To fully appreciate the operational decisions involved in choosing transhipment at sea over transhipment in port, this section outlines potential port costs and other factors within the region.

Factors in the choice of transhipment port

There are several relevant decision-making drivers behind the choice of transhipment port made by tuna longlingers or purse seiners and Blaha (2019)[7] identifies five in the context of the purse seine fleet. We demonstrate below how the same drivers apply to the longline fleet, and how they change from trip to trip, necessitating vessel masters to continuously re-evaluate their decision of where to transship next.

Fishing grounds and licensing

Denominated port in licensing conditions. Some countries require transhipment in their own ports as a licensing condition. This normally applies to their own flagged vessels, or to vessels fishing exclusively in their waters under chartering or joint venture arrangements. The condition overrides every other element of the decision, but it is a crude tool and most operators object to it. This type of licensing condition generally does not apply to the high seas fleet. For example, in Kiribati it applies only to the purse seine fleet, while longliners are permitted to leave the EEZ and tranship on the high seas.

[7] Blaha, F 2019.
https://www.franciscoblaha.info/blog/2019/12/9/factors-contributing-to-the-choice-of-port-for-transhipment-by-purse-seiners

Proximity to fishing grounds. Anecdotal information from the purse seine industry indicates that proximity to fishing grounds is the single most important factor in a vessel's choice of transhipment port[8]. This report shows that is not consistently the case for the longline fleet.

Distance from the fishing grounds to where carriers are available remains an economic factor through fuel consumption, but the burden falls on the fishing vessel rather than the carrier.

Tuna trading companies position carriers where fishing conditions make them convenient to fishing vessels. Both parties want the transhipment completed quickly so the fishing vessel can return to the grounds. Specific requirements arising from the trip, the terms of the catch sale, the logistics involved, and the preferences of masters and vessel managers can still dictate a more distant port.

Specific needs arising from the fishing trip

Access to services. Fishing vessels and carriers carry a large amount of machinery and technology requiring parts and maintenance: propulsion, generators, hydraulics, refrigeration for hundreds of tonnes of fish, and electronics. Most repairs are carried out on board. Where shore-based work is needed, operators prefer ports with well-stocked facilities and staff capable of supporting a rapid turnaround.

Shore health facilities. Evacuation of a critically injured crew member is governed by maritime and crew welfare rules. Outside life-threatening cases, most masters will steam a further 24 or 48 hours to reach the port with the better medical facilities.

Airline connections. Key personnel, including vessel managers, need frequent and varied international air connections.

The master of the vessel

Vessel masters often make the final decision regarding a range of operational approaches, each of which can impact a choice or use of a transhipment port. Some of the conditions influencing their choices are:

Safety of the anchorage. The master of each fishing vessel and carrier holds ultimate responsibility for the safety of the vessel. Transhipment takes place at the carrier's anchorage, often with two fishing vessels alongside at once, one to port and one to starboard, all held by the carrier's anchor. Firm holding ground matters, and no dragging is paramount. Dragging follows exposure to wind and swell, so the more sheltered the anchorage the better. Enclosed lagoons are always preferred to open ones.

Quality and cost of port agents. Agents are central to tuna transhipment and their role is not well studied. They act as intermediaries between masters, vessel managers, traders, carriers, and line agencies. They interact constantly with the vessel's master and officials to keep documentation in order, arrange solutions to most problems that arise, and provide translation for a fleet that largely operates in Asian languages. A choice of agents with

[8]Blaha, F Pers comm. with representatives from KOFA, Tri-marine, FCF and others (2022, 2026).

capable staff available 24/7 is a significant driver for masters and the better the agent is the less problem they have.

Regulatory reliability. For masters eager to go back at sea fishing after the shortest possible time in port, having immigration, biosecurity, customs, and the other line agencies lined up on arrival avoids wasted time. This has to be a seven-day operation, and such masters proffer ports with good functioning authorities..

Ease of access to shore. Easy access to a wharf near the main facilities in town also influences a master's choice as crew can easily go to shore for food and entertainment, and also local SIM cards with affordable data plans so crew can contact family.

Weak regulatory oversight. Weak oversight by national fisheries administrations of port state measures best practice and IUU fishing acts as a perverse incentive for some skippers.

The vessel manager

Vessel managers also have an influence on port choice since ultimately the port and carrier costs affect the economics of the vessels they manage, as such they may direct the vessels to ports that may not be the first choice of the master, or they may be further from fishing grounds. Some of the conditions influencing their choices are:

Costs. Anchorage, berthing, pilotage, line agency, and transhipment volume fees together form a supplementary influence on port choice. More expensive ports sometimes offset the difference with better services, observer availability, and similar advantages. The cost of agents also counts here, and relates to their quality as discussed above.

Carrier licensing. Carriers need a licence to operate in each port state, normally renewed annually. Operating across several states multiplies that cost and pushes carriers towards basing themselves in a single port.

Relationship with carriers. Options vary with existing contractual arrangements, and cargo space trading between operators shifts the decision from trip to trip. An operator may offer space to a rival if doing so fills the carrier and sends it towards the processing country, particularly when cannery stocks are low.

Ease of doing business. A conducive, secure, and low-bureaucracy business environment is a major advantage for any country seeking to attract port use. Transhipment is no exception.

Wharf Access

Transhipment is generally defined in legislation as the transfer of fish from one vessel to another, as distinct from landing, which moves fish through shore-based facilities and falls outside this study. Access to a wharf that supports provisioning, discharge of fish and gear, and maintenance work amplifies several of the benefits set out above, along with the demands that come with them.

The cost structure of a port call

Distance from the fishing grounds is a key factor, and the opportunity cost of steaming further varies with the size and efficiency of the vessel. For every fishing day lost, a vessel forgoes potential daily profit and still carries its operating costs. Where port costs and transhipment levies across regional ports exceed that opportunity cost, a fishing vessel has no reason to choose a transhipment port closer to the grounds over the nearest high seas rendezvous with a carrier.

Port entry does not attract a single fee. A fishing vessel or carrier calling at a designated port incurs between 30 and 50 discrete charges, imposed by multiple authorities and commercial parties that generally operate independently of one another. The consolidated figure the agent presents to the operator therefore conceals a heterogeneous set of obligations, each with its own legal basis and method of calculation.

The charges fall into four categories:

1. Port authority charges. The port acts as landlord and service provider, levying port dues, dockage, mooring, pilotage, security, and waste reception. These charges are generally published in a formal tariff and assessed on gross tonnage and time alongside, which makes them the most predictable component of the total.
2. Border agency charges. Customs, immigration, quarantine and biosecurity, and port health authorities recover the cost of discharging statutory control functions rather than supplying a commercial service. Their fees are typically fixed per call or per crew member and bear no relation to vessel size.
3. Fisheries and monitoring charges. This category covers port entry authorisation under the Port State Measures Agreement or similar requirements, inspection and boarding fees, observer placement and debriefing, transhipment monitoring, and transhipment and landing levies. Most are of recent origin. In many cases they also include a licence for carriers to operate in national waters.
4. Agency charges. The ship's agent consolidates the various charges, applies a coordination fee, and adds a percentage overhead on services arranged on the vessel's behalf.

Tables 11 and 12 set out estimates for the main purse seine transhipment ports in the WCPO.

Table 11: Carrier of 6,000 GRT and 130 m in length, staying in port for 30 days

Type of fee or charge (US$)	Funafuti	Tarawa	Majuro	Rabaul	Pohnpei
Licence fee per year	$25,000	$86,030	$10,000	$1,305 to $5,220	$1,200
Transhipment charge	$0	$0	$1,500	$0	$0
Port charges (incl. pilotage)	$6,480	$17,352	$3,000	$700	$10,726
Agency fees	~$1,500	$1,500	$1,600	$1,500	$3,825
Environmental levy	n.a.	$216	$150	$0	n.a.
Other government charges	$6,870	n.a.	$700	n.a.	n.a.
Total per 30-day visit*	$14,850	$19,068	$6,950	$2,200	$14,551
Total per day*	$495	$636	$231	$73	$485

* Excludes the annual licence fee charged to carrier vessels.

Table 12: Fishing vessel of 70 m in length, transhipping 920 t and staying five days in port

Type of fee or charge (US$)	Funafuti	Tarawa	Majuro	Rabaul	Pohnpei
Transhipment levy	$6,540	$2,760	$1,500	$0	$2,070
Port charges (incl. pilotage)	$2,880	$1,244	$1,800	$475	$1,339
Environmental levy	$0	$54	$0	$0	$0
Other government charges	$716	n.a.	$700	n.a.	n.a.
Observer cost	$108	$0	$0	$0	$0
Security cost	$0	$180	$0	n.a.	n.a.
Agency fees	$2,160	$700	$1,500	$1,500	$1,950
Total per visit	$12,404	$4,938	$5,500	$1,975	$5,359
Total per vessel for five events*	$76,872	$43,758	$34,450	$12,075	$41,346
Total per tonne for five events*	$17	$10	$7	$3	$9

* Excludes the annual licence fee charged to carrier vessels.

Port savings for a carrier

Port offloading presents a fundamentally different fuel profile for both carriers and fishing vessels. Once secured at anchor, the carrier shuts down its main engine entirely, running only auxiliary generators to maintain refrigeration, electricity and deck machinery. As discussed in the section *Fuel costs of at-sea transhipment*, shutting down the main propulsion engines on large carrier vessels can cut fuel cost in half in comparison to maintain them at sea, even at low speeds.

At-sea transhipment by large carrier vessels is considerably more fuel-intensive than port alternatives. That differential weighs directly on both the CV's and FV's operational economics and environmental footprint.

Approach to fisheries port charges

As the previous section outlines, the cost structure of port calls is multifaceted, with a range of different port charges applied to a vessel. The distinction of greatest practical significance is not which body levies the charge but the basis of how charges are applied. Charges scale variously with gross tonnage, duration of stay, crew complement, or the number of occasions on which officials must physically attend the vessel. However, a substantial proportion of charges do not scale at all and remain the same regardless of vessel type or size. For example, a 350 GT longliner incurs broadly the same customs, immigration, sanitation certification, and boarding transport costs as a 5,500 GT carrier despite being less than a fifteenth of the tonnage.

Non-fisheries costs can be standardised and optimised only so far. Therefore, one additional lever to further incentivise port visits by longline vessels is in the setting of scaled fisheries transhipment charges. Despite the economic benefits of transhipping in port rather than at sea, vessels and fleets are still making the operational decision to tranship at sea.

As a result, to even further strengthen the existing economic arguments for transhipment in port, Pacific island nations could consider additional levers to further incentivise this practice. However, without appropriate cooperation from LL and CV fleets to recognise and engage with these incentives, the application of such levers may only further economically disadvantage Pacific island nations.

Summary and conclusions

This report applied the impracticability framework developed by Lehmann et al. (2024) to 1,644 transhipment events recorded across six carrier vessels operating in the WCPFC Convention Area between May 2020 and March 2026. The six vessels were selected as the most active carriers in the dataset, collectively representing the principal flag states involved in high-seas transhipment in the region: Chinese Taipei China, South Korea, and Panama with beneficial ownership in Japan and Chinese Taipei. Together they account for the large majority of high-seas transhipment activity in the Convention Area over the study period.

The findings speak directly to both limbs of the two-part impracticability test established under CMM 2009-06: the requirement for significant economic hardship, and the requirement that in port transhipment would demand a significant and substantial alteration of a vessel's historical mode of operation.

The impracticability ratio

The central finding is straightforward. Across 1,277 events for which the impracticability ratio could be calculated, 42% are not impracticable under the distance-based test, meaning a suitable port was at least as accessible as the chosen transhipment location. Of these, 19% have a ratio above three, indicating that the journey to the high-seas transhipment location was more than three times the distance to the nearest suitable port. These are cases where the economic hardship argument is least supportable on its own terms.

The pattern holds across all six carrier vessels and is consistent between transhipments of five hours or longer and shorter encounters. It is not an artefact of any single carrier's operational area or flag state composition. For each vessel, a substantial share of recorded events fails the distance test.

Over the six years of the study period, the impracticability ratio shows no statistically significant trend. Vessels tranship at the same distances relative to available ports now as they did in 2020. The WCPF Convention requires members to encourage their vessels to tranship in port, and CMM 2009-06 sets out a framework under which members would progressively promote in-port transhipment and reduce reliance on the impracticability exemption. Six years of vessel tracks show no sign of either taking effect.

The economic hardship argument

The economic hardship limb of the impracticability test is typically argued in terms of fuel costs: the additional distance a vessel must travel to reach a suitable port, multiplied by the cost of fuel, constitutes the financial burden of compliance. This report tested whether that logic is detectable in vessel behaviour by examining whether monthly Singapore MGO bunker prices are associated with changes in the impracticability ratio across the study period. They are not. At zero, one, and two-month lags, the Spearman correlation between fuel price and the monthly median log-transformed ratio is weak, non-significant, and in the wrong direction.

The absence of this signal may partly reflect a limitation of Singapore MGO as a benchmark. Most fishing vessels in this fleet bunker at sea rather than in port, and there is good reason to think they do not pay spot market prices. The Pacific longliners bunker at sea may be paying under-market prices not subjected to taxes. Vessels flagged to China, Chinese Taipei, and South Korea operate from countries that are documented buyers of Russian crude at substantial discounts to market, and which provide significant government fuel subsidies to their distant water fleets.

If operators are paying materially less for fuel than the Singapore MGO benchmark implies, two things follow. The absence of a correlation between MGO prices and transhipment location decisions is unsurprising and carries less analytical weight than it otherwise would. And the cost differential between meeting a carrier at sea and travelling to a port is smaller than a market-rate calculation would suggest, which narrows the economic hardship argument rather than supporting it.

What the distances actually look like

The centroid-based impracticability ratio translates vessel behaviour into a single metric efficiently. The fishing vessel track analysis in this report provides a different view of the same question, one grounded in actual distances sailed.

Six fishing vessels spanning five flag states were selected for detailed track analysis on the basis of data quality and flag state coverage. Despite covering between 2,152 and 22,155 nautical miles during individual fishing intervals, and despite operating across broad areas of the equatorial Pacific, several of these vessels came within a straight-line distance equivalent to less than 5% of their total trip track length from a suitable FFA-designated transhipment port in the week before transshipping. The port was not out of reach; it was passed.

The carrier vessel analysis tells a related story from the supply chain side. A detailed segmentation of TAIHO MARU's September to November 2025 deployment shows that transit to and from northeast Asia accounted for 71% of total distance covered. A routing alternative via the two nearest FFA-designated ports, Tarawa and Kiritimati, would have eliminated approximately 3,590 nautical miles of positioning and at-sea transhipment steaming while leaving the transit distance essentially unchanged, reducing total estimated fuel consumption by around 28%. This cost falls outside the formal scope of the impracticability test as currently framed, which considers only the fishing vessel's expenses. For vertically integrated operations where the same ownership group controls both the carrier and the fishing fleet, however, the carrier's fuel expenditure should be part of the same commercial calculation.

Fleet organisation, vertical integration, and historical mode of operation

The second limb of the impracticability test requires that complying with a prohibition on high-seas transhipment would force a vessel to alter its historical mode of operation in a way that is significant and substantial. This condition was designed for vessels whose operational model is genuinely built around remote-area fishing, where at-sea transhipment is a practical necessity rather than a preference. The network and ownership analysis in this report raises a direct challenge to that framing for a significant portion of the fleet.

Carrier-fishing vessel relationships are organised along national and commercial lines. Flag clustering is near-complete for most carriers: DONG HRONG 899 transshipped with Chinese Taipei -flagged vessels in 130 of 136 recorded partnerships; PINGTAIRONGLENG2 with Chinese vessels in 91 of 98; MV Badaro exclusively with South Korean vessels. This pattern is not explained by geography.

Two operators go further: Pingtairong Ocean Fishery controls both PINGTAIRONGLENG2 and 11 of its regular fishing vessel partners, and Dongwon Industries controls MV Badaro and six associated vessels. In both cases, the same owner directs fish from its own fishing vessels to its own carrier on the high seas. That points towards a supply chain choice, not a geographic constraint.

Korean companies including Sajo Industries, Dongwon Fisheries, and Silla distribute their fleets across multiple carriers, and SEISHIN serves vessels from Korean, Chinese, and Chinese Taipei ownership groups. This flexibility is further evidence that transhipment logistics are actively managed commercial decisions. The impracticability test's second limb assumes a fixed, externally imposed constraint. The network data shows an arrangement that is neither.

Temporal trends and seasonality

Neither the event-level trend analysis nor the quarterly aggregation detects a statistically significant change in the impracticability ratio over the study period. The fleet's transhipment behaviour, measured against the distance-based test, has been stable across six years. March is the only calendar month in which the median impracticability ratio consistently exceeds the equidistant threshold, a pattern present across multiple carrier vessels and not attributable to any single operator. The mechanism behind this seasonal signal is not clear from the available data, but its presence across vessels is consistent with fleet-wide scheduling patterns playing some role in where transhipments occur.

Conclusions

CMM 2009-06 requires flag states to apply the impracticability test to individual vessels and events rather than applied at fleet level. The 2024 report reiterated the importance of vessel-level application and presented the distance-based framework as a proof of concept for doing so. The current analysis, covering 1,277 events across six carriers over six years, provides the systematic, fleet-wide evidence base that was not available in 2024. This evidence supports the earlier recommendations and makes them harder to rebut. The metrics are reproducible, updateable as new data become available, and straightforward for use by members assessing individual impracticability claims. Specific carrier and flag state combinations where the ratio is consistently above one are identifiable in this dataset and provide a natural starting point for targeted scrutiny.

Two findings in this report go beyond the 2024 recommendations and warrant additional consideration. First, the absence of any temporal trend over six years indicates that the current framework has not produced a shift toward greater port use. Self-regulation under the impracticability exemption has not worked, and that conclusion is now supported by six years of data rather than a three-and-a-half-year sample.

Second, the ownership analysis reveals a structural point: the exemption requires that in-port transhipment would cause significant economic hardship and, additionally, that the vessel would have to make significant *and* substantial changes to its historical mode of operation, both of which must be satisfied. Vertically integrated operators, where the same owner controls carrier and fishing vessels, face difficulty on both counts; the supply chain architecture is of their own design, and neither test can be meaningfully applied at vessel level alone. Members assessing hardship claims should also require disclosure of actual fuel costs and government fuel support, since assessments based on market benchmark prices will systematically overstate the compliance burden for subsidised fleets.

The 2024 report recommended that the WCPFC consider establishing an independent high-seas transhipment observer programme along the lines of those operating in other tuna RFMOs. This analysis strengthens that recommendation. The network data show that 176 fishing vessels transshipped with more than one carrier, and that short encounters are concentrated around specific carrier-flag combinations that are difficult to monitor through carrier-level observer coverage alone. An independent programme, combined with systematic application of the distance metrics developed here, would provide the oversight infrastructure needed to give the impracticability test practical effect rather than leaving it as an unverified declaration.

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