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PORTS CAN TALK: DESTINATION-AWARE INTER-PORT DATA SHARING FOR PORT-CALL PLANNING — A CHENNAI PORT CASE STUDY

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Abstract: Ports already share data, and system-to-system port-clearance APIs and practical port-to-port trials show that digital exchange is feasible. The unresolved issue addressed here is how sharing should be governed when the next destination is uncertain, especially in tanker, bulk and tramp trades. This exploratory secondary-data case study uses official Indian port statistics, Chennai Port documents, public Maritime Single Window material, IMO and industry standards, and published research. Chennai handled 1,654 cargo-vessel calls across four vessel groups in 2024–25. Average pre-berthing detention was 16.59 h, of which 16.51 h was recorded as non-port account. The broad "Shippers/Ships/Agents Option" category describes the recorded delay but does not show that information timing caused it. The paper proposes five destination states: D0 Unknown/For Orders, D1 Provisional, D2 Nominated Next Port, D3 Confirmed Port Call and D4 Changed/Cancelled. D2 begins when an authorised party declares a specific next port and that nomination is recorded in the source-side port/MSW record. D3 begins only when the destination port/MSW formally registers the arrival voyage or port call and links it to an authorised reporting party. D3 is not a berth confirmation, port clearance or Notice of Readiness. Each state has a defined trigger, responsible actor, permitted data use and exit rule. The framework is a policy and operational layer for pilot testing, not a new IT platform, and it has not yet been validated with live MSW transaction data.

Key words: destination nomination; information sharing; maritime digitalisation; maritime single window; port call; port planning.

1. INTRODUCTION

Port-call planning depends on more than berth capacity. It also depends on whether the right people receive reliable information early enough. Port-to-port information sharing has already been studied in the Eastern Mediterranean and Rotterdam [1–3]. Singapore's digitalOCEANS Port Clearance API supports system-to-system exchange of port-clearance data and recognises previous port authorities as possible data-source systems [4]. The 2026 Port Call Optimization Guide reports that harmonised data sets have been tested in practical port-to-port trials [5]. Just-in-Time (JIT) arrival and Port Collaborative Decision Making also address the familiar "hurry up and wait" problem [6].

The unresolved issue is how such sharing should work when the next port is not fixed. This matters particularly outside liner trades. A tanker, bulk carrier or tramp ship may sail "for orders", receive the next-port nomination later, or be redirected. Research on tramp shipping shows both limited JIT applicability in some voyages and short planning horizons in which later legs may remain uncertain [7,8]. A system that assumes every ship always has a fixed next port would therefore not match normal shipping practice.

A second problem is turning information into useful action. ETA prediction and congestion forecasting have improved greatly [9–11], but a review of 124 studies found that prediction is still not often linked directly to operational decisions in ports [12]. ETAs can also be inaccurate and may change several times during a voyage [13]. The next port therefore needs more than one ETA. It needs verified events, a clear record of destination status, its own berth-readiness information and rules that keep safety-critical decisions with responsible people.

India is a useful setting for this study because a national Maritime Single Window, MSW-Sagar Setu, already exists. The Ministry reports that all 12 major ports and 56 other-than-major ports are onboarded [14]. Since 1 January 2024, the IMO Facilitation Convention has required Maritime Single Windows internationally [15]. The IMO FAL Compendium includes fields for actual departure time and next port of call [16]. Much of the basic information needed for an early handover therefore already exists. A design principle of the proposed model is to reuse these existing records safely, where feasible, instead of creating duplicate reporting.

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This exploratory study asks three questions. RQ1: What do official statistics show about pre-berthing detention at Chennai compared with all Indian major-port operational units reported by MoPSW? RQ2: How can inter-port sharing be governed when a ship's destination may be unknown, provisional, nominated, confirmed or changed? RQ3: What safeguards are needed before this information is used for port planning? MoPSW reports the two Syama Prasad Mookerjee Port dock systems separately, so the national comparison contains 13 operational rows representing 12 major port authorities. Chennai is then examined in detail because it combines mixed vessel types, a sharp 2024–25 PBDT change, a very high non-port-account share and public operational documentation. The study does not test a causal hypothesis about efficiency gains. Its contribution is a destination-aware governance rule: destination status controls when an external handover may start or stop, while each data item is tied to the source best placed to verify it. The framework is proposed for pilot testing and has not been validated with live MSW transaction data.

2. LITERATURE AND OPERATIONAL CONTEXT

Information sharing helps only when the right information reaches someone who can act on it [2]. Ports, terminals, agents and shipping companies may also have different commercial interests, so they may not be willing to share everything [3]. JIT studies show the same problem: technology alone is not enough. Berth rules, trust and cooperation also matter [6]. For this reason, the proposed system follows a simple principle: share only the information that the next port actually needs.

Recent studies increasingly use AIS and other operational data to predict congestion and ship movements [10,11]. These studies show that ports work as part of a network. The proposed model does not use one fixed ranking for every source. Authority depends on the data field. Actual departure should come from the source port, VTS or MSW record. The next-port nomination should come from an authorised voyage declaration from the ship/operator/charterer channel and be recorded in the port/MSW system. Berth-ready time belongs to the destination port or terminal. AIS is the natural source for dynamic position, course and speed. ETA is then a derived prediction that should be checked against these inputs rather than treated as an unquestioned fact.

Existing digital standards and systems provide the building blocks. The DCSA Port Call Standard records estimated, requested, planned and actual event times and allows a port call or service to be cancelled or omitted [17]. The IMO FAL Compendium contains structured next-port and departure fields [15,16]. Finland's Maritime Single Window allows an "Unknown Port" code and requires voyage information to be updated when the port becomes known; a planned call can also be cancelled [18]. Singapore's digitalOCEANS Port Clearance API shows that port-clearance data can already move system-to-system, including from previous port authorities [4]. The 2026 PCO Guide reports practical port-to-port trials of harmonised operational data [5]. These examples show that digital exchange, unknown destinations and cancellations are not new technical capabilities. The gap addressed here is the operating rule: when should the destination port receive data, what may it use at each certainty stage, and which source should be trusted for each data field?

Digital sharing also creates cyber and data-security risks. IMO guidance stresses interoperability, data governance and cyber resilience [15]. AIS is broadcast openly and can be affected by false data or GNSS interference [19]. It should therefore be used for the dynamic information it is designed to provide, but not as the sole basis for a different field such as commercial destination status. Computers may exchange data and make predictions automatically. They do not make the final safety decision. Berth commitment, speed advice and traffic-management action remain under human control.

The proposed framework targets cases in which the shipping company or charterer already knows the voyage plan but the destination port does not yet have the same operational visibility. The Master continues to report through the normal owner/charterer chain, and the destination agent continues to perform formal port-call work when appointed. The proposed system should not replace that chain. It adds only a limited public-authority handover once a destination has been nominated. This matters less in liner shipping, where the next port is usually known early, and more in tanker and tramp trades, where the destination may remain undecided after sailing.

The paper's contribution is therefore not a new API, an "Unknown Port" code, cancellation logic or port-to-port data exchange. Those functions already exist [4,5,17,18]. The contribution is to combine them into a destination-aware operating rule for mixed maritime trades. D0 means no next port is known. D1 records one or more possible destinations only inside the source-side system; nothing is sent externally. D2 (Nominated Next Port) begins when an authorised voyage-control/declarant channel (for example the Master, owner/operator or charterer, as applicable) declares a specific next port and that nomination is recorded in the source-side port/MSW record. D3 (Confirmed Port Call) is a separate destination-side event: the destination port/MSW has formally registered the arrival voyage or port call and linked it to an authorised reporting party. D3 therefore does not mean berth confirmation, port clearance or acceptance of Notice of Readiness. D4 revokes the old handover if the voyage changes. A second rule assigns each important data field to the source best placed to verify it, instead of assuming that one source is

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always superior. This framework is proposed for pilot testing and has not been implemented or validated with live MSW transaction data.

A declared next port is only planning information. It is not a berth guarantee, a Notice of Readiness, a charter-party commitment or an order to the Master. A provisional destination can also be commercially sensitive. For that reason, D1 remains inside the source-side system. The destination port receives nothing until D2, when a specific next port has been authorised and recorded. At D2, the receiving port may create only a provisional planning record. The move to D3 occurs only after the destination-side port/MSW accepts or creates the formal arrival-voyage/port-call registration and links it to an authorised reporting party. That event makes the call operationally visible for normal planning, but still does not confirm a berth or grant clearance.

India has a practical advantage for testing this idea. MSW-Sagar Setu is already a common platform for ship-related data exchange, and the Ministry states that major ports and 56 other-than-major ports are connected to it [14]. IMO rules also support the reuse of information already submitted electronically [15]. The Singapore API and the 2026 PCO Guide show that system-to-system and port-to-port exchange are technically feasible [4,5]. The proposed model is therefore intended as a policy and operational layer on top of existing MSW arrangements, not as a new national IT platform.

The basic data needed for the handover already exist. The IMO General Declaration contains fields for the departure port, actual departure time and next port [16]. Once the next port reaches D2, these records can support a small authenticated planning packet. The destination port may acknowledge that packet without treating the call as formally confirmed. D3 requires a separate destination-side registration event. India's MSW-Sagar Setu already provides voyage-arrival registration and pre-arrival reporting functions, which could provide a machine-recorded D3 trigger in a pilot [14]. Sensitive information can remain within normal statutory and commercial channels until it is needed.

3. MATERIALS AND METHODS

This is a secondary-data case study. No survey, interview, experiment or human-participant data were used. The study combines three types of evidence: (1) official Indian port statistics, (2) official documents and standards on digital port-call information, and (3) published research on information sharing, JIT arrival, ETA prediction and congestion.

The main numerical source was Basic Port Statistics of India 2024–25, published by the Ministry of Ports, Shipping and Waterways (MoPSW) [20]. The national comparison uses every major-port operational unit reported separately by MoPSW. Because Syama Prasad Mookerjee Port reports Kolkata Dock System and Haldia Dock Complex separately, Table 1 contains 13 operational rows representing 12 major port authorities. The comparison uses average pre-berthing detention time (PBDT) and the share recorded on non-port account. Chennai was not chosen because it was the worst-performing port. It was chosen because it handles different vessel types, showed a sharp change in PBDT in 2024–25, had a very high non-port share, publishes useful operational information, and is part of India's MSW. The case is therefore used for diagnosis, not criticism of the port.

Table 1. All Indian major-port operational units reported by MoPSW

Port / operational unit	PBDT 23–24	PBDT 24–25	Non-port share 24–25
SMPA Kolkata DS	19.21	9.71	68.7%
SMPA Haldia DC	1.15	0.29	93.1%
Paradip	1.22	39.88	96.4%
Visakhapatnam	0.63	0.92	0.0%
Kamarajar	0.59	1.67	99.4%
Chennai	0.33	16.59	99.5%
V.O. Chidambaranar	41.66	33.88	50.6%
Cochin	6.73	8.85	88.4%
New Mangalore	19.80	19.50	81.8%
Mormugao	22.91	29.78	91.6%
JNPA	16.34	17.46	69.0%
Mumbai	0.00	5.59	98.9%
Deendayal	45.50	68.78	88.0%
All major ports	14.14	23.55	84.4%

Source: calculated from MoPSW Basic Port Statistics of India 2024–25 [20]. Syama Prasad Mookerjee Port is shown as Kolkata Dock System and Haldia Dock Complex, as reported in the source. PBDT in hours.

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For Chennai, the analysis separates container, break-bulk, conventional dry-bulk and liquid-bulk calls. MoPSW reports vessel-call counts, average PBDT and a broad reason called "Shippers/Ships/Agents Option". This label does not prove that poor or late information caused the delay. It may include cargo-readiness issues, commercial or chartering decisions, vessel readiness and other causes unrelated to inter-port information flow. The study therefore uses these figures only to describe the recorded delay pattern. It does not calculate avoidable delay, information-caused delay or potential savings.

The five Destination Certainty States (DCS) are a design synthesis, not a statistically derived scale. Their derivation followed four explicit steps. First, the documentary review identified existing operational functions: IMO next-port and departure fields [16], DCSA event and cancellation functions [17], Finland's unknown-port and voyage-change handling [18], Singapore's system-to-system port-clearance exchange [4], and the recognised uncertainty of tramp planning [7,8]. Second, these functions were separated from the governance question that they do not by themselves answer: when is a candidate destination sufficiently certain for external inter-port use? Third, five mutually exclusive states were defined around observable events rather than general judgement. D0 has no specific next port; D1 has one or more possible ports but no authorised nomination; D2 begins with an authorised nomination recorded source-side; D3 begins with destination-side registration of the arrival voyage/port call; and D4 records withdrawal, omission or replacement of the earlier destination. Fourth, each state was assigned an entry trigger, responsible actor/system, permitted data use and exit rule, and the logic was checked against liner, tanker/bulk and "for orders" scenarios.

The proposed design was then checked against MSW-Sagar Setu, IMO FAL/MSW documents, the DCSA Port Call Standard, Singapore's Port Clearance API, the 2026 PCO Guide and Chennai Port documents [4,5,14–18,21]. The D2–D3 boundary was defined deliberately to separate two different events. D2 is a voyage-control event: a specific next port has been authorised by the responsible voyage-control/declarant channel and recorded in the source-side system. D3 is a destination-side port-call event: the destination port/MSW has accepted or created the formal arrival-voyage/port-call registration and linked it to an authorised reporting party, such as an appointed agent or authorised operator/ship representative. Agent appointment by itself does not create D3, and D3 does not mean berth confirmation, port clearance or Notice of Readiness acceptance. The exact local message name may differ between ports, but the trigger must be machine-recorded and auditable. Chennai's expected-vessel report already includes vessel identity, agent, cargo, preferred berth, last port and next port [21]. This study did not use private Sagar Setu transaction data and does not claim that the proposed system has already been implemented.

4. RESULTS

The national comparison shows that Chennai's 2024–25 result needs careful interpretation. Official MoPSW data give Chennai PBDT of 0.00 h in 2020–21, 0.07 h in 2021–22, 0.00 h in 2022–23, 0.33 h in 2023–24 and 16.59 h in 2024–25 [20]. The latest value is therefore a sharp break from the previous four years. The average for all major ports in 2024–25 was 23.55 h [20], so Chennai was not the worst performer. Deendayal and Paradip had much higher PBDT, while Visakhapatnam and Kamarajar were below 2 h. Chennai's turnaround time was 48.73 h and its capacity utilisation was 40.42%; these published figures do not by themselves indicate system-wide physical saturation [20].

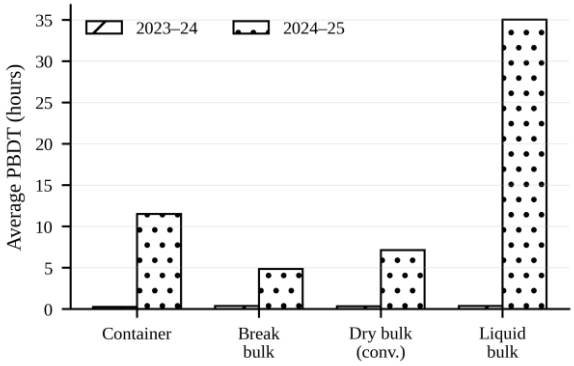


Figure 1. Chennai average pre-berthing detention by vessel type, 2023–24 and 2024–25. Source: MoPSW [20].

The most important point is where the delay was recorded. Of Chennai's 16.59 h average PBDT, only 0.08 h was on port account and 16.51 h was on non-port account. In other words, 99.5% was recorded outside port account [20]. The reason table places the same 16.51 h under the broad heading "Shippers/Ships/Agents Option". This category may include cargo-readiness issues, commercial or chartering decisions, vessel readiness, nomination issues and other causes that better port-to-port information would not solve. It is therefore used only as a descriptive category and not as evidence that information failure caused the delay.

The results also show that this is not only a container case. Chennai handled 1,654 calls in the four vessel groups: 822 container, 286 break-bulk, 92 conventional dry-bulk and 454 liquid-bulk vessels. Liquid-bulk vessels had the highest average PBDT at 35.04 h. Container vessels recorded 11.52 h, conventional dry bulk 7.15 h and break bulk 4.88 h. In every group, almost all reported PBDT was placed under Shippers/Ships/Agents Option [20]. These are descriptive official statistics only; they do not show what part, if any, was caused by infor-

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mation timing or could be reduced by the proposed framework.

Table 2. Chennai vessel-type PBDT and official ship/agent category, 2024–25

Vessel type	Calls	PBDT h	Ship/agent h
Container	822	11.52	11.45
Break bulk	286	4.88	4.81
Dry bulk (conventional)	92	7.15	7.08
Liquid bulk	454	35.04	34.95

Source: MoPSW Basic Port Statistics of India 2024–25 [20]. The Shippers/Ships/Agents Option category is descriptive and is not treated as avoidable or information-caused delay.

The five-year Chennai series also shows why 2024–25 should be treated as a diagnostic year rather than a long-term baseline. Average PBDT remained between 0.00 and 0.33 h from 2020–21 through 2023–24, then rose to 16.59 h in 2024–25 (Table 3) [20]. The aggregate statistics do not explain this break, so the paper does not attribute it to information sharing, port capacity or any single operational cause.

Table 3. Chennai average PBDT, 2020–21 to 2024–25

Year	Chennai PBDT h	Change from prior year h
2020–21	0.00	—
2021–22	0.07	+0.07
2022–23	0.00	−0.07
2023–24	0.33	+0.33
2024–25	16.59	+16.26

Source: MoPSW Basic Port Statistics of India 2024–25 [20].

Figure 2 summarises the proposed handover. At D0, there is no fixed next port and no handover. At D1, one or more possible destinations may be recorded inside the source-side system, but nothing is transmitted to them. D2 begins when an authorised next-port nomination is recorded and activates a minimum authenticated planning packet. The transition from D2 to D3 is not based simply on time, agent appointment or berth discussion. It occurs when the destination port/MSW formally registers the arrival voyage or port call and links it to an authorised reporting party. D3 then permits normal port-call planning. D4 cancels the earlier handover and permits rerouting only after the replacement voyage reaches the appropriate new state.

Table 4. Destination states, transition triggers, responsibilities and permitted use

State	Operational definition and entry trigger	Responsibility	Permitted use and next transition
D0 Unknown / For Orders	No specific next port has been authorised. Entry: voyage remains “for orders”, or an earlier destination is withdrawn without replacement.	Authorised ship/operator/charterer channel maintains status; source port/MSW stores only its own record.	No destination transfer. Move to D1 if an option is considered, or directly to D2 after formal nomination.
D1 Provisional	One or more possible ports are being considered, but no authorised nomination exists. Entry: tentative option recorded.	Authorised voyage-control party; information remains source-side.	No destination transfer. Move to D2 on formal nomination; return to D0 if options are withdrawn.
D2 Nominated Next Port	A specific next port has been formally nominated and recorded source-side. Entry: authorised nomination event with vessel, port, time and originator.	Authorised voyage-control/declarant channel (Master, owner/operator or charterer, as applicable) owns destination status; source port/VTS verifies departure; MSW/shared service routes the packet.	Destination may create an early planning record only. No berth commitment. Move to D3 when destination-side arrival-voyage/port-call registration is accepted; move to D4 if withdrawn.

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State	Operational definition and entry trigger	Responsibility	Permitted use and next transition
D3 Confirmed Port Call	Destination port/MSW has accepted or created the formal arrival-voyage/port-call registration and linked it to an authorised reporting party. This is the D2→D3 trigger.	Destination port/MSW owns call-registration status; agent/operator maintains submitted arrival data; port/terminal owns resource data.	Normal port-call planning and service coordination. Not berth confirmation, port clearance or NOR acceptance. Move to D4 if the call is changed or cancelled.
D4 Changed / Cancelled	Earlier destination is formally withdrawn, omitted or replaced. Entry: authorised change/cancellation event.	Authorised originator issues change/cancellation; MSW/shared service propagates revocation; destination closes the old planning record.	Stop operational use of old record; keep audit trail. Replacement re-enters at D0, D1 or D2 according to its new status.

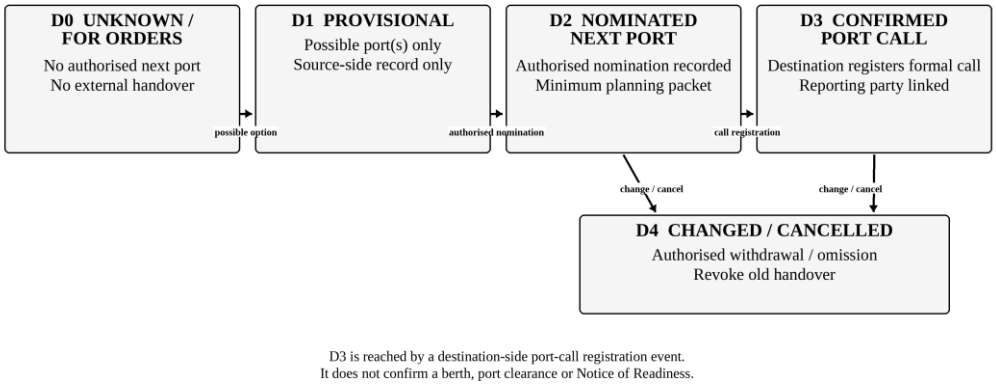


Figure 2. Proposed port-to-port digital handover based on destination status.

At D2, the next port may make provisional planning comparisons; at D3, the same information can enter normal port-call planning. One useful comparison is between expected arrival and expected berth readiness. The difference can be written as M = BRT − ETA. If M is positive, the ship may arrive before the berth is ready. If M is negative, the berth may become free before the ship arrives. This calculation is useful only when the inputs are trustworthy. The model therefore checks each field against its proper source: source-port records for departure, authorised voyage declarations for destination status, destination-port or terminal records for berth readiness, and AIS for dynamic movement. ETA is a derived estimate and should carry a confidence level when inputs disagree.

The study also uses the term Advance Information Horizon (AIH). AIH is simply the time between nomination of the next port and the ship's expected arrival there. A liner service may have a long AIH because its rotation is known early. A tanker may have a shorter AIH if the discharge port is nominated after loading. A ship sailing 'for orders' has no AIH until a port is nominated. If the destination changes, the old AIH ends and a new one starts for the replacement port. This measure helps compare different trades without assuming that they work in the same way.

Table 5. How the proposed handover applies to different trades

Operating case	Typical AIH	System action
Liner / scheduled	Usually long	D2 after nomination; D3 after destination-side call registration
Tanker / bulk, nominated	Variable	D2 after nomination; D3 after formal arrival-voyage/port-call registration
Tramp, for orders	Zero until nomination	D0 blocks transfer; D2 begins after nomination; D3 later if call is registered
Destination changed	Previous horizon ends	D4 revokes old record; replacement re-enters at D0/D1/D2

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The model works differently for different trades. In liner shipping, the next port may already be nominated before departure, so D2 can begin early; D3 follows when the destination-side arrival-voyage/port-call registration is accepted. A tanker or bulk ship may first be only provisional; at D1 the possible destination remains source-side and receives nothing. When the discharge port is formally nominated, D2 starts the handover even if the local agent process is not yet complete. D3 begins later, when the destination system formally registers the call and links it to an authorised reporting party. A ship sailing "for orders" remains at D0 until nomination. If voyage orders later change, D4 cancels the old record and a new D2 begins only when the replacement port is nominated.

5. DISCUSSION

"Ports Can Talk" does not mean that every port should continuously receive all vessel information. No destination-port transfer occurs at D0 or D1. External sharing starts at D2, after an authorised next-port nomination has been recorded. D2 gives the destination only an early planning record. D3 is reached only after the destination port/MSW registers the formal arrival voyage or port call and an authorised reporting party is linked to it. Liner ships usually reach D2 early because their rotation is known. Tanker, bulk and tramp ships may reach it later because voyage orders can change [7,8]. The planning value therefore depends partly on how much time remains between nomination and arrival.

The system does not replace the Master–owner/charterer–agent chain. Normal commercial reporting and the agent's formal port-call work continue as before. A future Indian pilot would test whether selected information already recorded in a port/MSW can move automatically from the source side to the nominated next port at D2, instead of creating another manual e-mail or report. The destination may acknowledge this early record, but D3 is not reached until its own MSW/port workflow registers the formal arrival voyage or port call. The normal agent or authorised reporting party then continues the statutory and operational port-call process.

There is no single source hierarchy for all data. Table 6 assigns each important field to the source best placed to verify it. The source port or VTS verifies actual departure. Destination status comes from the authorised voyage declaration recorded in the port/MSW system. AIS provides position, course and speed. Berth readiness comes from the destination port or terminal. If sources conflict, the system lowers confidence and asks for human verification instead of silently choosing one source.

Cybersecurity and confidentiality must be built in from the start. D1 remains source-side partly because a merely possible destination can be commercially sensitive. At D2, the early packet should contain only what the nominated next port needs: vessel identity, verified departure, nominated destination, declared or computed ETA, relevant dimensions or draught, and limited readiness information. Access should be role-based and messages should be authenticated and time-stamped. If the digital link fails, the parties return to normal Master, agent, VTS and port-clearance procedures.

Human control remains essential. The system may warn that a ship will arrive before the berth is ready, but it should not automatically order speed changes, allocate a berth, send tugs or change traffic instructions. Those decisions involve safety, contracts and legal authority. The model therefore uses automatic data exchange and prediction, followed by a human decision.

Environmental effects are outside the present analysis. If a future pilot shows that earlier verified handover changes vessel arrival timing, a separate study could test whether fuel use or emissions also change. Such benefits should not be inferred from the Chennai data used here.

India may not need a new reporting platform for a pilot. MSW-Sagar Setu already provides national infrastructure [14], while IMO and DCSA standards provide a common language for port-call events [15–17]. Singapore's API work and the 2026 PCO Guide also show that system-to-system and port-to-port exchange are technically feasible [4,5]. The proposed model is a policy and operational layer that could be tested within existing infrastructure. A pilot should focus on data routing, access rights, field-specific provenance and operational use. It should record destination changes, AIH, actual departure, ETA revisions, berth-ready time, arrival and berthing, and test whether earlier trusted information changes a real planning decision. The answer to RQ3 is therefore threefold: verify each field against the proper source, keep safety-critical decisions under responsible human authority, and protect the exchange through access control, authentication, confidentiality and a safe fallback to existing procedures.

JIT planning also depends on berth-allocation rules and timely service information [22,23]. Recent JMTE work likewise highlights digitalisation and new technology in maritime operations [24].

A pilot also needs clear responsibility rules. The authorised voyage-control/declarant channel (Master, owner/operator or charterer, as applicable) is responsible for the destination nomination and for issuing any later change or cancellation. The source port/VTS verifies only the events it actually records, such as actual departure; the MSW or shared handover service routes the D2 packet and any later revocation but does not validate the commercial voyage order. The destination port/MSW is responsible for the D3 confirmation event because D3 exists only when that system registers the formal arrival voyage or port call. The agent or other authorised reporting party is responsible for the formal pre-arrival data it submits, while the destination port or terminal remains

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responsible for berth-readiness and resource information. Every state change should be time-stamped with its originator so that D1→D2, D2→D3 and D2/D3→D4 transitions are auditable. D1 data stay source-side, and D2 data remain planning information rather than a berth promise. Predictions should be traceable, but final navigation and harbour decisions remain with the responsible human authority.

Data sharing should be kept to the minimum needed. An early D2 handover does not require the full cargo manifest, crew list, security plan or charter-party terms. More detailed data can be added later through the normal port-call process. Limiting early data reduces the impact of leaks and protects commercial confidentiality.

The framework must also work safely when something goes wrong. A wrong next-port nomination should be easy to correct, an old ETA should be flagged, and conflicting source-port, destination-port and AIS information should require checking. During a cyber incident, the automated link should be isolated if necessary. If the platform fails completely, normal voice, e-mail, VTS and agency procedures must remain available.

Table 6. Field-specific data provenance in the proposed handover

Data item	Primary verifying source	Supporting cross-check
Actual departure	Source port / VTS / MSW	AIS movement after departure
Destination nomination / status	Authorised ship/operator/charterer declaration recorded in port/MSW	Agent or formal port-call record once appointed
Position, course, speed	AIS / ship navigation sensors	VTS or radar where available
Berth-ready time	Destination port / terminal	Berth and terminal plan
Formal call / agent status	Destination port/MSW and appointed agent	Ship/operator record

6. LIMITATIONS

The study has four main limitations. First, it uses annual port statistics, not vessel-by-vessel records. We cannot identify which individual calls were delayed or prove that earlier information would have changed the result. This means the present study cannot establish cause and effect. Second, the MoPSW category "Shippers/Ships/Agents Option" is broad and must not be treated as a direct measure of communication failure. It may include cargo-readiness issues, commercial or chartering decisions, vessel readiness and other causes unrelated to inter-port information flow. Third, Chennai's 2024–25 PBDT is unusual compared with the previous four years: the official series is 0.00, 0.07, 0.00, 0.33 and 16.59 h from 2020–21 to 2024–25 [20]. The paper treats 2024–25 as a diagnostic case that needs further study, not as proof of long-term inefficiency. Fourth, the proposed destination states and field-specific provenance rules have not yet been tested with live MSW data. A domestic pilot would require agreed operating roles among the source port, destination port, ship/operator/charterer channel, terminal and agent, not only technical connection. Without pilot testing, technical feasibility within Sagar Setu, stakeholder acceptance and operational effect remain unknown. Use between countries would also require agreement on system compatibility, liability, cybersecurity and commercial data rights.

7. CONCLUSIONS

Port-to-port digital exchange is already established. Singapore's Port Clearance API and the 2026 PCO

Guide show that system-to-system and practical port-to-port exchange are not new [4,5]. The novelty claimed here is narrower: a destination-aware governance rule for mixed trades in which no external handover occurs before nomination, the handover can be revoked and rerouted when voyage orders change, and each critical data field is tied to the source best placed to verify it.

Official Indian data show why Chennai is a useful mixed-trade case. In 2024–25, the port handled 1,654 calls in the four analysed vessel groups and recorded average PBDT of 16.59 h. Of this, 99.5% was classified as non-port account [20]. Across the four vessel groups, almost all reported PBDT was placed under the broad Shippers/Ships/Agents Option category. These figures describe the operational context only. They do not show what part, if any, was caused by information timing or could have been avoided through earlier inter-port sharing.

The proposed solution uses five destination states with explicit event-based transitions. D0 means no fixed next port. D1 is a source-side provisional record and sends nothing to a possible destination. D2 (Nominated Next Port) starts a minimum handover when an authorised specific-port nomination is recorded in the source-side port/MSW system. D3 (Confirmed Port Call) begins only when the destination port/MSW registers the formal arrival voyage or port call and links it to an authorised reporting party; this is not a berth confirmation, port clearance or Notice of Readiness. D4 cancels the earlier handover and reroutes it only after a replacement voyage

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reaches the appropriate new state. The framework does not rank one data source above all others. Instead, actual departure, destination status, vessel movement and berth readiness each come from the source best placed to verify that field. AIS remains important for dynamic movement, but it does not define commercial destination status.

The next step should be a vessel-level pilot using historical or live Sagar Setu records for selected Indian port pairs. It should record when the next port was nominated, whether the destination changed, when the agent was appointed, how the ETA changed, when the berth became ready, and the actual PBDT. Two testable hypotheses could guide that pilot. H1: after accounting for vessel type, route and port conditions, a longer verified Advance Information Horizon is associated with a smaller mismatch between vessel arrival and berth-ready time. H2: ETA estimates built from field-appropriate, cross-checked inputs have lower absolute error than single-source or manually updated ETA estimates. These are future hypotheses, not findings of the present study. Separate operational data would be needed to test any safety or emissions effect.

8. FUNDING

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9. CREDIT AUTHORS STATEMENT

Yogesh Chandralal Shah: Conceptualization; Methodology; Formal analysis; Investigation; Data curation; Visualization; Writing – original draft; Writing – review & editing; Project administration.

10. DECLARATION OF GENERATIVE AI USE

During preparation of this manuscript, OpenAI ChatGPT was used for literature-discovery support, organisation and calculation of publicly available secondary data, drafting assistance, language editing and document formatting. All numerical values and cited sources used in the manuscript were checked against the referenced scholarly or official sources during manuscript preparation. The author takes responsibility for the final content.

11. CONFLICT OF INTEREST

The author declares no competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

12. DATA AVAILABILITY

All quantitative data used in this study are derived from publicly available Government of India port statistics. A supplementary CSV containing the extracted values and source labels accompanies the manuscript. No proprietary vessel-level or Sagar Setu transaction data were used.

13. ETHICS STATEMENT

The study used public secondary data and documentary sources only. No human participants, personal data, interviews or surveys were involved; ethics approval was therefore not required.

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