D1.1. Assessment and alignment of on-going JIT / Port Call Optimisation Standardisation Initiatives including legal frameworks

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Authors: José Andrés Giménez Maldonado, Gonzalo Sandiás, Jorge Melero

Contributing Partners: Jorge Lara, Gabriel Ferrús (Fundación Valenciaport), Manolis Annetis, Faouzi Ntachan (NTUA), Jussi Martio (VTT), Roberto Vettor (NAPA), Benjamin Reitz (DLR), Maiju Kaski, Olli Soininen (FinTraffic), Mees Van der Wiel (DCSA), Peter Rygaard Andersen (Blue Visby)

Reviewers: Jussi Poikonen (AWAKE.ai), Julia Pahl (SDU), Manolis Annetis, Panagiotis Sotiralis (NTUA)

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List of Acronyms

AD	Application Documents
AI	Artificial Intelligence
AIS	Automatic Identification System
AtoN	Aid to Navigation
API	Application Programming Interface
ATA	Actual Time of Arrival
ATC	Actual Time of Completion
ATD	Actual Time of Departure
BIMCO	Baltic and International Maritime Council
CAB	Conformity Assessment Body
CEN	Comité Européen de Normalisation
CHE	Container Handling Equipment
CII	Carbon Intensity Indicator
COLREG	International Regulations for Preventing Collisions at Sea
CRS	Container Release System
DCSA	Digital Container Shipping Association
DED	Data Element Directory
DLR	Deutsches Zentrum für Luft-und Raumfahrt
DTLF	Digital Transport and Logistics Forum
ECDIS	Electronic Chart Display and Information Systems
EDI	Electronic Data Interchange
EDIFACT	Electronic Data Interchange for Administration, Commerce, and Transport

EEXI	Energy Efficiency Existing Ship Index
eFTI	Electronic Freight Transport Information
EGDH	Expert Group on Data Harmonization
EMSWe	European Maritime Single Window Environment
ENC	Electronic Navigational Chart
EPC	Electronic Port Clearance
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
ETS	Estimated Time Service
ETS	Emissions Trading System
EU	European Union
FAL	Facilitation of International Maritime Traffic Convention
GDPR	General Data Protection Regulation
GHG	Greenhouse emissions
GMDSS	Global Maritime Distress and Safety System
HD ENC	High-Density Bathymetry Electronic Navigational Chart
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IAPH	International Association of Ports and Harbors
ICT	Information and Communication Technology
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
IHO	International Hydrographic Organization
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organization

IoT	Internet of Things
ISM	International Safety Management
ISO	International Organization for Standardization
ISPS	International Ship and Port Facility Security
IT	Information Technology
ITPCO	International Taskforce Port Call Optimisation
JIT	Just-In-Time
MARPOL	International Convention for the Prevention of Pollution from Ships
MCP	Maritime Connectivity Platform
MIR	Maritime Identity Registry
MoU	Memorandum of Understanding
MSR	Maritime Service Registry
MTD	Message Type Directory
MTU	Maximum Transport Unit
NMSW	National Maritime Single Window
NVOCC	Non-Vessel Operating Common Carrier
NTUA	National Technical University of Athens
OTI	Ocean Transportation Intermediary
OVS	Operational Vessel Schedule
PBP	Pilot Boarding Place
PKI	Public Key Infrastructure
PortCDM	Port Collaborative Decision Making
PSC	Port State Control
PSV	Platform Supply Vessel

PTA	Planned Time of Arrival
PTD	Planned Time of Departure
PTS	Planned Time of Service
RCS	Real-Time Cargo System
RENC	Regional Electronic Navigational Chart Coordinator
RFID	Radio-Frequency Identification
RIM	Reporting Interface Module
RTA	Requested Time of Arrival
RTD	Requested Time of Departure
RTDE	Real-Time Data Exchange
RTS	Requested Time Service
SAR	International Convention on Maritime Search and Rescue
SDOs	Standards Development Organizations
SECOM	Secure Communication between Ship and Shore
SED	Segment Directory
SMDG	Ship Message Design Group
SME	Small and Medium-sized Enterprises
SOLAS	International Convention for the Safety of Life at Sea
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
TEN-T	Trans-European Transport Networks
TIC4.0	Terminal Industry Committee 4.0
TMS	Terminal Management System
TOS	Terminal Operating System
UNCTAD	United Nations Conference on Trade and Development

UNTDID	United Nations Trade Data Interchange Directory
VAR	Validation and Verification Authority
VTS	Vessel Traffic Services
VTT	Technical Research Centre of Finland Ltd

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Keyword list

- Port Call Process
- Just-In-Time (JIT) Optimization
- Legal Framework
- Contractual Framework
- Stakeholder Analysis
- Commodity Sales Contract
- Charter Party
- Contractual Process
- Port Call Optimisation
- Shipping
- Maritime
- Ports
- Vessel
- Standards
- Regulations

Disclaimer

Table of Contents

1. Executive summary

The purpose of this deliverable is to provide a comprehensive analysis of the standardization and regulatory framework impacting the maritime port sector. This analysis serves as a reference for the MISSION project, which aims to develop a digital platform to optimize navigation and port call operations, targeting Just-In-Time (JIT) arrival efficiencies. Understanding the various standards that support the sector and facilitate process harmonization among stakeholders is crucial for identifying those best suited to MISSION's objectives.

The need for this deliverable arises from the challenges the maritime port sector faces in optimizing port call operations in terms of time and resources. These challenges are partly due to the numerous participants involved, each with different interests and capacities. The diverse range of stakeholders and their varied roles complicate coordination due to the high degree of interdependence among process participants. MISSION seeks to address these issues by developing a digital tool that enhances communication between parties, enabling interoperability and improving planning through digital technologies such as Artificial Intelligence (AI), digital twins, and big data.

Deliverable D1.1 aims to generate a reference document on existing standards to support other work packages (WPs) in developing the digital solution. This involves defining the scope of the process under analysis, identifying key stakeholders and their influence, and understanding the regulatory framework governing the sector.

The analysis methodology includes a review of relevant literature and publications from leading sector organizations to ensure a rigorous theoretical foundation for developing recommendations and potential actions. Workshops with project consortium experts provides practical insights and validate the document's content.

The study is focused on the operational phases of port calls, including passage planning, port call requests, berth arrival, cargo handling, and departure. This framework, based on Facilitation of International Maritime Traffic Convention 5 (FAL 5), offers a detailed view that encompasses all maritime services and cargo types. The analysis details stakeholder roles and their impact on JIT operations, using FAL 5 as a reference for consistency.

Following the definition of the process and stakeholders, the analysis reviews standardization entities, their developments, and their impact on the process. This provides an overview of the types of standards, their development, maturity, and sector impact. Similarly, the regulatory framework is examined to understand its influence on maritime port operations.

The key findings indicate that the standardization landscape for port call optimization is generally well-covered, with numerous standards developed by various entities. However, low implementation levels suggest practical use remains limited. Regulatory frameworks can drive JIT operations through environmental compliance incentives, but overregulation may hinder operational flexibility.

In conclusion, the analysis underscores the need for increased digitalization in the sector to enhance standard implementation. Fostering collaboration among organizations can help avoid overlaps and clarify standards. Supporting stakeholders with funding for digital infrastructure, particularly for small and medium-sized enterprises, is crucial for broad participation. Additionally, reducing regulatory rigidity and harmonizing regulations will help minimize resistance to JIT optimization. These measures aim to improve project outcomes and provide a clearer understanding of the sector's current state, supporting more effective decision-making in the future.

2. Introduction

This introduction aims to provide the context for the development of this work, outline the characteristics shaping the issue at hand, and define the specific objectives of this deliverable within the project. Additionally, it will explain how the results will support both the industry and the project in moving closer to achieving more efficient and coordinated port call operations.

2.1. Problem Statement

As in many other sectors of the economy and trade, the maritime-port logistics sector faces the challenge of reaching new levels of efficiency, which can only be achieved through the integration of advanced digital technologies. These technologies offer the sector new ways of operating, allowing visibility beyond what traditional methods can provide. However, one of the main obstacles this sector encounters is the complexity of finding efficiencies in an industry that relies on a vast number of stakeholders, each involved in different processes, and with a wide diversity of activities, organizational sizes, and capabilities. It is within this context that the MISSION project emerges with the objective of creating a fully digitalized voyage and port call optimization system. This system will enable collaboration among stakeholders, allowing the synchronization of ship schedules, optimization of ship operations, and coordination of port services, with the primary goal of improving operational efficiency and reducing fuel consumption.

The pursuit of harmonizing and coordinating activities to achieve port call optimization and JIT arrival in such a fragmented sector presents several significant challenges. First, finding ways to streamline communication to ensure seamless information transfer, necessary for proper and coordinated decision-making, requires that this broad set of stakeholders can align by using the same languages, meanings, protocols, and standards. This is essential to achieve the interoperability needed for all parts of the process to have a shared understanding, without adding unnecessary layers of complexity that could hinder the flexibility of operations. Secondly, it is important to consider how these initiatives fit into a sector that is already subject to various regulations, which may affect the successful implementation of JIT arrival. Whether environmental, safety, or administrative in nature, these regulations introduce different levels of rigidity, often requiring compliance with requirements that may not always align with an optimal operational process.

2.2. Objectives

This deliverable aims to assess the ongoing standardization efforts related to port call optimization, with the expectation that these standards will be consolidated and adopted industry-wide in the coming years. Its focus is on identifying operational processes and digital standards that can be integrated into MISSION's Digital Control Centers. The evaluation will cover standards from key organizations such as International Standards Organization (ISO)/ International Maritime Organization (IMO) and International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), which address maritime traffic broadly, as well as more specific standards like Digital Container Shipping Association (DCSA) and Terminal Industry Committee (TIC4.0), which focus on container traffic from both shipping and terminal perspectives.

Furthermore, Deliverable 1.1 will play a key role in advancing and consolidating these standards by testing and validating their practical application in real-world operations, showcasing the potential of standardized real-time digital data exchange. As part of WP1, this deliverable will also define decision support principles for optimizing port calls and voyages, while developing operational roadmaps for the relevant technical standardization committees. These efforts will contribute to the project's overarching goal of enhancing the efficiency of ship operations and port services, ultimately improving overall performance, and reducing fuel consumption.

3. Port Call Process Description and analysis

In this chapter, the process of port call and stakeholder context will be described in order to directly relate the study of various initiatives within a specific framework. Due to the complex ecosystem and the large number of stakeholders involved both directly and indirectly in the maritime port sector, it is crucial to understand which parts will be included in the analysis and why. This aims to provide clarity for the subsequent analysis, primarily to understand how different standardization initiatives might either promote or hinder the implementation of Just-In- Time operations.

3.1. Port Call Process Flow

The first step in this document is to define the workflow of the port call process, aiming to provide a comprehensive understanding of the relevant phases, procedures, events, and communications that are part of this process. This analysis will serve as a reference for better grasping the reality when determining how industry standards and the legal framework govern port operations. This effort seeks to elucidate and streamline subsequent analyses by presenting a clear overview of the entire process.

This section requires subdivision into two distinct levels of analysis owing to their inherent complexity and distinctiveness. These levels are delineated as operational processes dictated by significant events (primarily defined by key timestamps) and administrative procedures influenced by message communication. The analysis of this subdivision will adhere to the predetermined phases outlined earlier. Following these separate analyses, a third section will be devoted to establishing the relationship between both processes, aimed at identifying connections and interactions within the overarching operational process flow

3.1.1. Operational Process Flow

The operational flow of a port call process is one of the most significant stages within maritime port activity due to the numerous parties involved. These parties must have precise information at the right time to efficiently carry out their duties, thereby minimizing potential delays that could impact the rest of the ecosystem. These challenges are prevalent in most ports worldwide, which is why various organizations such as United Nations Conference on Trade and Development (UNCTAD), International Taskforce Port Call Optimisation (ITPCO), DCSA, or TIC4.0, among others, have sought through initiatives addressing the problem from various perspectives to improve the situation.

To carry out this analysis, the first step is to determine the boundaries of the port call process in relation to the needs and objectives of the project, in order to better understand the context in which the research will be conducted. To address this need, this Deliverable will be based on the guidelines outlined in the IMO FAL.5. CIRC.52 Guidelines For Harmonized Communication And Electronic Exchange Of Operational Data For Port Calls (International Maritime Organization, 2023). This document provides a series of guidelines based on the IMO Compendium and other relevant models. They serve as a flexible guide for implementing the JIT concept in ports, adapting to local processes. The benefits of JIT include improving maritime traffic efficiency and optimizing port operations and the overall logistics chain.

D1.1. ASSESSMENT AND ALIGNMENT OF ON-GOING JIT / PORT CALL OPTIMISATION STANDARDISATION INITIATIVES INCLUDING LEGAL FRAMEWORKS

This document defines the most relevant steps of the port call process. The FAL.5 divides it into two major phases: the contractual phase and the operational phase. While this Deliverable focuses on the operational part of the port call process, it is important to consider the various characteristics of the contractual phase that can impact the successful outcome of the operational phase. The following list summarizes the steps of the port call process:

Contractual phase

1. *Sale of goods contract (bulk sector)*
2. *Contract for chartering ships*
3. *Sale of goods contract (bulk sector), carriage contract (container sector)*
4. *Terminal contract*

Operational phase

1. *Passage planning*
2. *Berth planning arrival, including VTS[1]/pilotage area planning (if relevant)*
3. *Port planning arrival, including VTS/pilotage area planning (if relevant)*
4. *Vessel/Cargo service planning*
5. *Port/berth arrival*
6. *Vessel/Cargo service*
7. *Berth planning departure, including VTS/pilotage area planning (if relevant)*
8. *Port planning departure, including VTS/pilotage area planning (if relevant)*
9. *Berth/port departure*

The definition of the reference process for the project will primarily focus on that presented by the IMO FAL.5; however, this work will also include some phases that, while necessary, are not part of those defined by the IMO. The following is the definitive list of the process phases:

Phases to be considered in the project:

1. *Passage Planning*
2. *Port Call Request*
3. *Port/berth arrival*
    a. *Internal Navigation*
    b. *Nautical Services*
4. *Vessel/cargo service*

From the list provided by IMO FAL.5, this work will focus solely on the relevant operational phases: Passage Planning, Berth and Port Planning Arrival, Port/Berth Arrival, and Vessel/Cargo Service Planning. An exception is made by including the port call request phase, usually part of the Port Planning Arrival/Port/Berth Arrival phases, which encompasses the administrative procedures required to secure authorization for a port call. The Port/Berth Departure phase will not be detailed, as it mirrors the events and stakeholders involved in the Port/Berth Arrival phase.

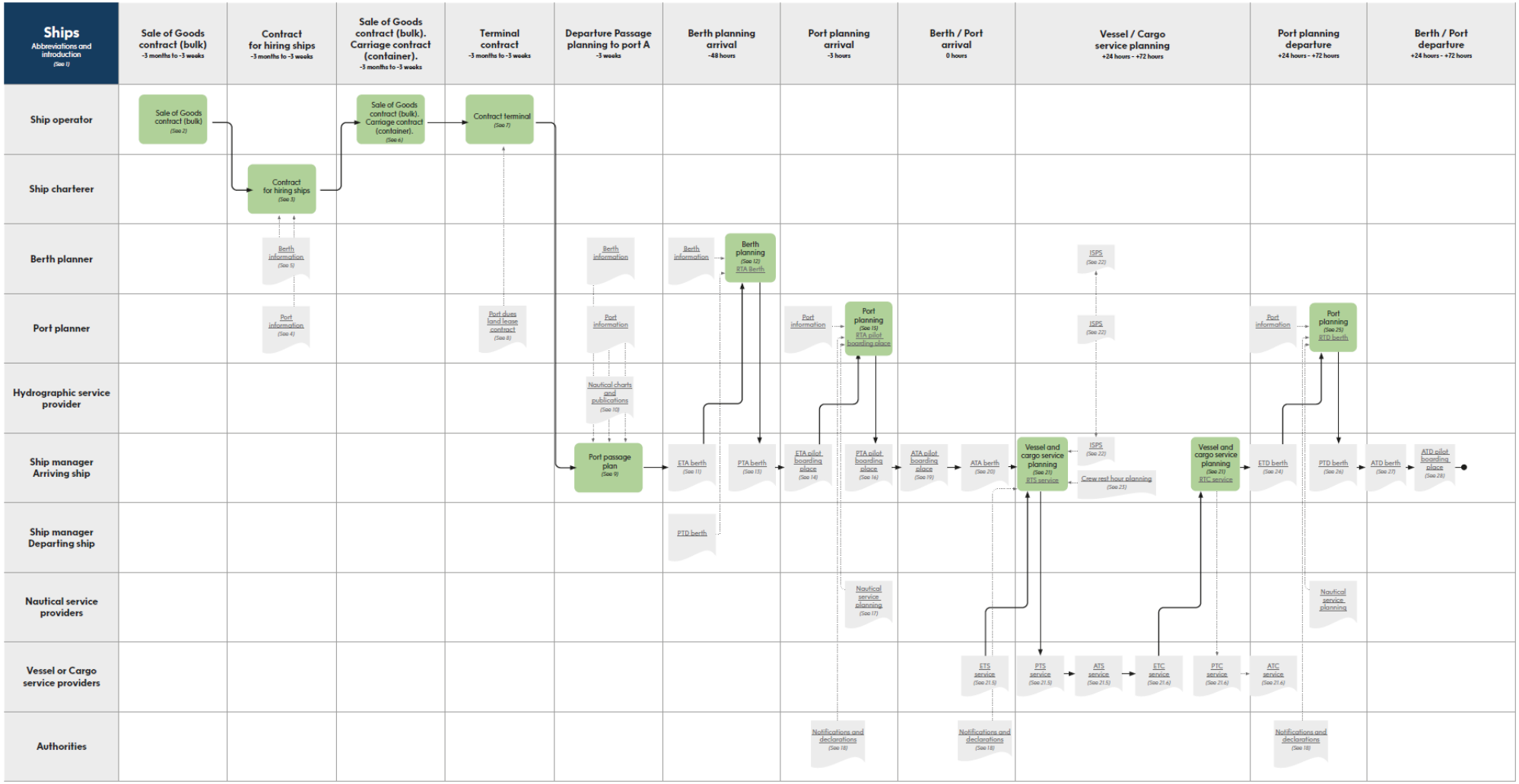
The Contractual Phase is omitted from this analysis, as it will be covered in Deliverable D1.2. Moreover, phases such as Berth Planning Arrival and Port Planning Arrival (both involving VTS/Pilotage Area Planning), as well as Berth and

[1] Vessel Traffic Service (VTS)

Port Planning Departure (with VTS/Pilotage Area Planning), are excluded, as they are smaller parts of broader phases and, therefore, it is unnecessary to provide a detailed description. This framework has been selected by the document's authors due to its general nature; it is not tied to any specific type of cargo or particular port. The omissions and additions outside of FAL.5 were made due to the need to include relevant information from the perspective of standardization and the legal framework, aspects that will be explained and become clearer as the document progresses.

Before starting to describe each phase of the process, it is important to have a comprehensive view of it to provide a broad context of how the process looks from a more general perspective. Figure 1 illustrates the port call process in diagram form, including stakeholders and key events from the Sale of Goods Contract to the current departure. As mentioned, this section of the work will focus on the operational processes from the Port Passage Plan to the current departure, excluding events related to the Contractual Phase. This diagram exemplifies the sequence of events, the responsible parties, and the type of information generated and shared among them. While this outline covers the entire process, the level of detail is low, so it will be necessary to delve deeper into the phases that are important and impactful to the overall process.

Figure 1. Business Process of Port Call, (ITPCO, 2024)



In order to facilitate understanding and visibility of the process, it has been decided to divide the diagram from Figure 1 into sections. The partitioned sections will be Figure 2, related to the contractual phase and the processes prior to the departure from the previous port. Figure 3 shows the processes and relevant events for the port arrival stage, including both planning and execution, and finally,

Figure **4** shows the planning and execution process for port departure.

Figure 2. Business Process of Port Call, Pre-arrival (ITPCO, 2024)

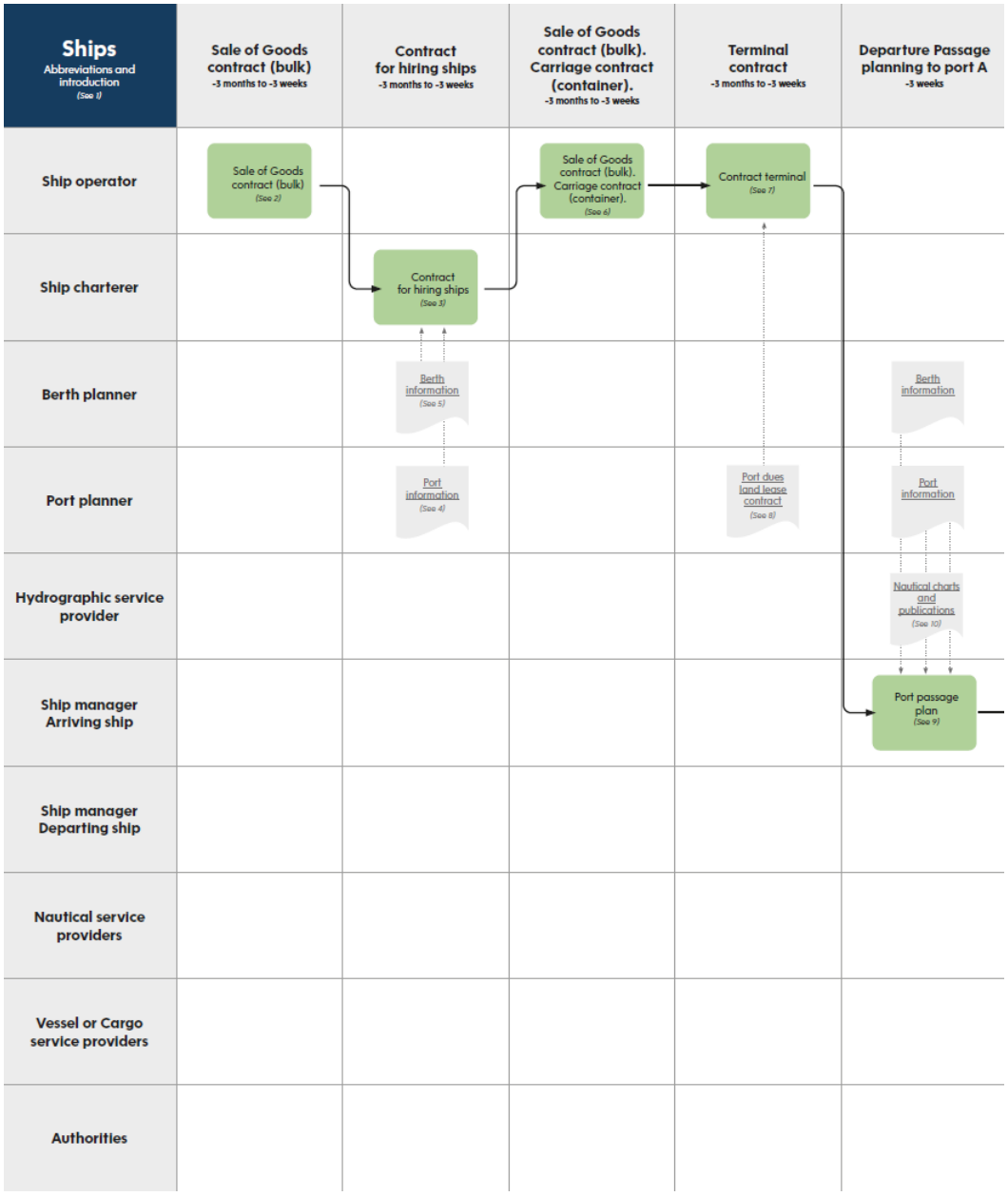


Figure 3. Business Process of Port Call, Arrival Planning (ITPCO, 2024)

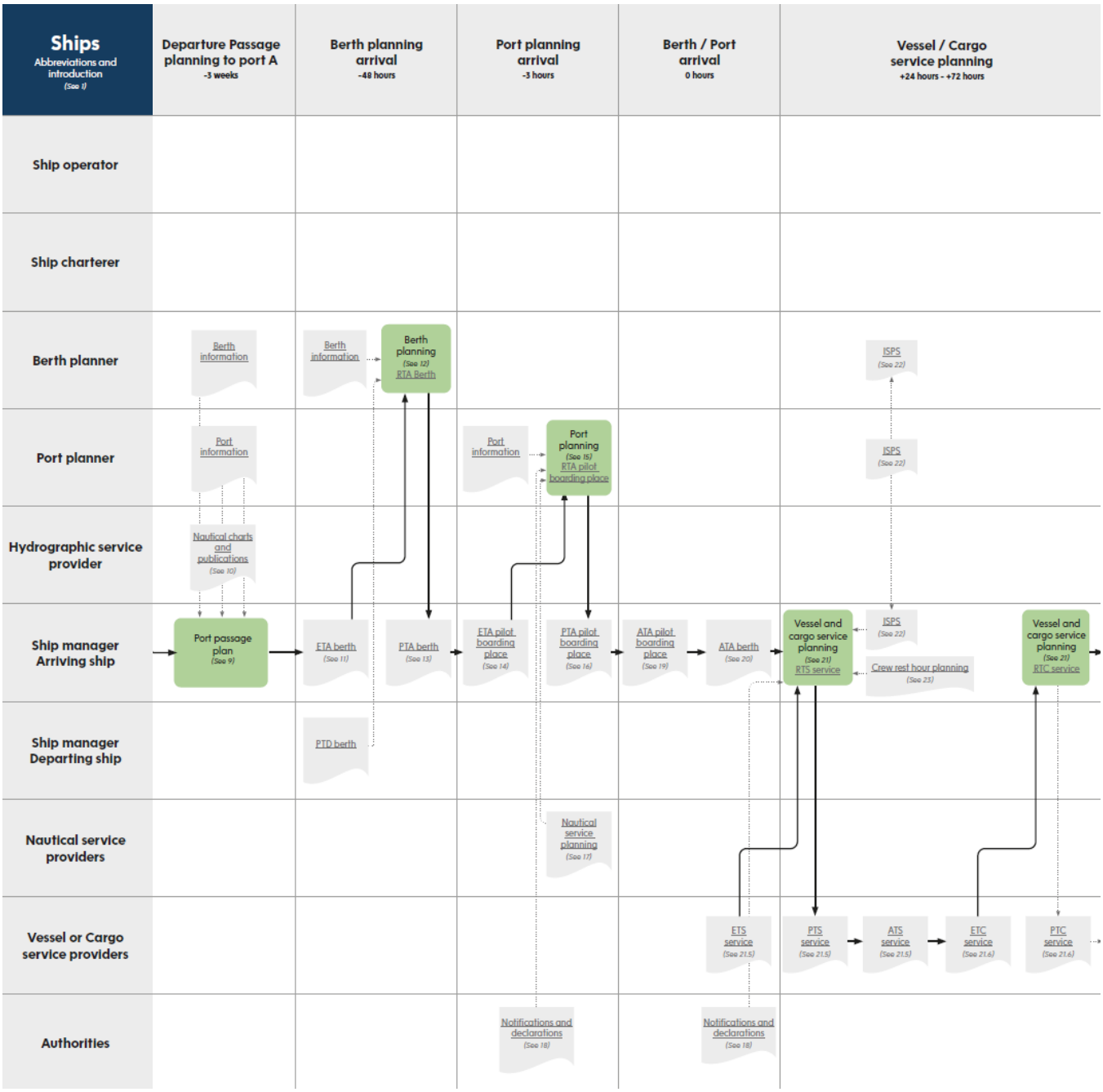
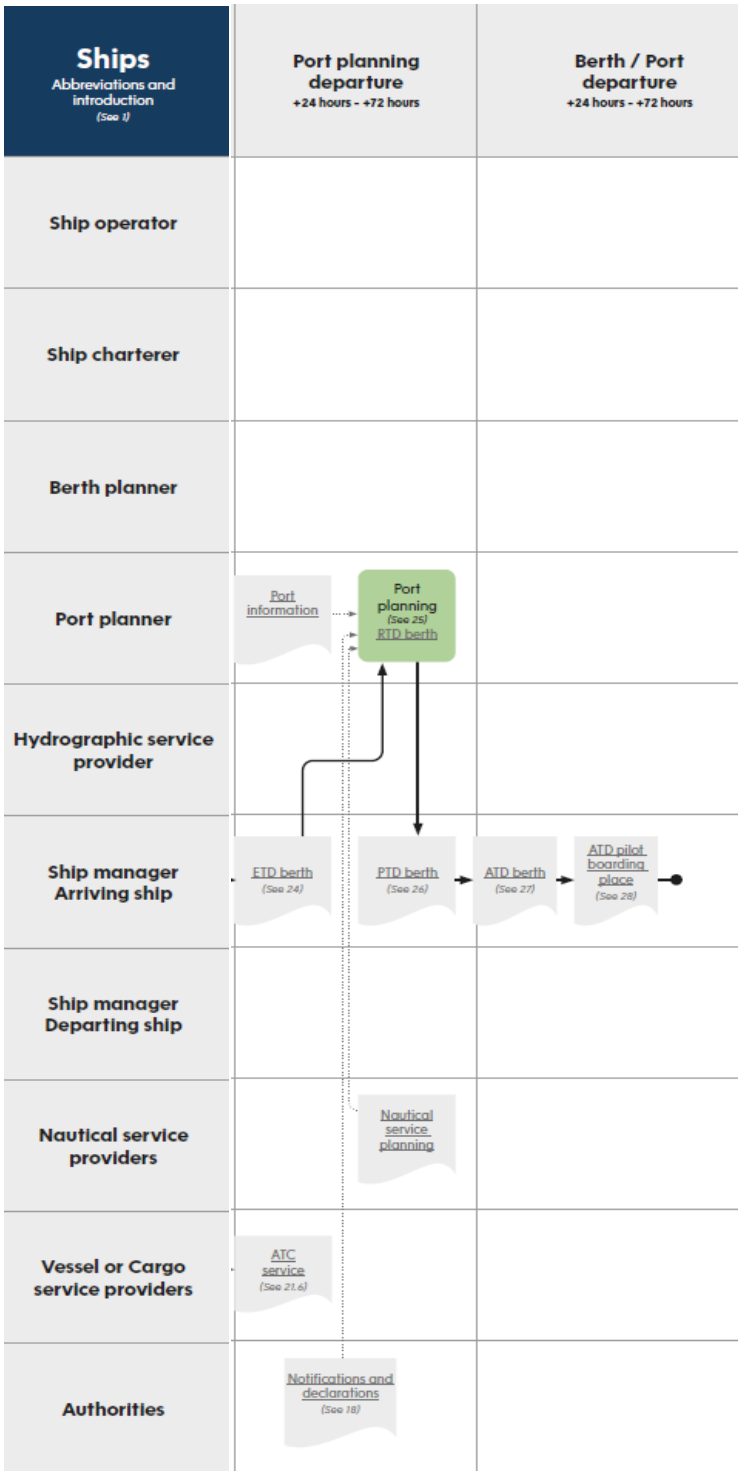


Figure 4. Business Process of Port Call, Departure Planning (ITPCO, 2024)



D1.1. ASSESSMENT AND ALIGNMENT OF ON-GOING JIT / PORT CALL OPTIMISATION STANDARDISATION INITIATIVES INCLUDING LEGAL FRAMEWORKS

The focus of the analysis in this section, from an operational standpoint, will be determined by grouping the events within the phases of the process mentioned earlier. From the departure from the previous port to the actual departure after the cargo operations, various subprocesses occur, and the events within these subprocesses must be known by the participating parties. This enables the synchronization of the process, minimizing the time the vessel spends in port to an acceptable minimum. The following are the phases and their events:

- **Passage Planning:** The first stage within the operational phase of the port call process according to Resolution A.893 Guidelines For Voyage Planning *(IMO, 1999)*, defines this subprocess as the activities of gathering all relevant information for the planned voyage or passage; detailed planning of the entire voyage or passage from berth to berth, including areas requiring a pilot; execution of the plan; and monitoring the progress of the vessel in implementing the plan. It commences with the announcement of the ETA upon the vessel's departure from its previous port and extends until the vessel's Actual Time of Arrival (ATA) within the traffic area of the port. In this stage, the events occurring between the ETA and ATA within the traffic area entail the coordination and confirmation of nautical services such as pilotage, towage, and mooring. Prior to the vessel's entry into the traffic area, these services must be meticulously coordinated and confirmed.

- **Port Call Request:** Once the preparation of the passage planning is completed, the port arrival planning phase begins, with the port call request and the negotiation of the date and time of arrival at the berth and the port being the two most relevant processes. The objective of this phase is to agree on a date and time committed by the parties for the vessel's arrival at the agreed points. The first process is berth arrival planning, which starts with the communication of the ETA (Estimated Time of Arrival) at the berth and culminates with the agreement between the parties on the PTA (Provisional Time of Arrival) at the berth. Once this planning is agreed upon, the port arrival planning is negotiated, considering the Pilot Boarding Place as the point of arrival at the port. The sequence is the same as in the previous process, starting with the transmission of the ETA to the pilot boarding place until the PTA for that place is agreed upon. These processes will be detailed in the next section, analysing the responsibilities of the stakeholders in the process.

- **Port/berth arrival:** The subsequent phase is the internal navigation and nautical services, which commences once the vessel enters the port area (ATA pilot boarding place) and concludes when it is ready to be moored at the terminal berth (ATA berth). The events within this phase revolve around the execution of nautical services such as pilotage and towage. Additionally, the key stakeholders involved in this stage of the process include VTS and the Port Authority. These authorities, when established, typically oversee VTS operations, often adhering to the recommendations and standards set forth by the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA). Their role encompasses organizing and guiding traffic through confined and congested waters, channels, as well as facilitating approaches and departures within port limits and associated sea areas.

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- **Vessel/Cargo service:** This phase concentrates on the loading and unloading operations typically performed by terminal operators and begins once the vessel is moored at the berth (ATA berth). To carry out these operations, there must have been a prior exchange of the vessel's stowage information between the ship agent and the terminal operator, allowing the terminal to plan the vessel and yard operations. In addition to cargo services, services for the vessel are also planned and executed, such as bunkers, lube oil, potable water, provisions, stores, waste per IMO/MARPOL Class, repairs, cargo handling, cargo lashing, terminal operator, and cargo survey. This process concludes once the actual time of completion service (ATC service) for both the cargo and the vessel is confirmed.

- **Berth/Port Departure:** The final stage of a vessel's port call corresponds to the departure operations. For this process to begin, all operations at the berth must be completed, including both cargo-related activities and the vessel services that were required. The process itself starts with the confirmation of the ATC service and the announcement of the ETD by the ship manager. Along with the confirmation of notifications and declarations and the planning of nautical services, the PTD is established. This triggers the rest of the processes, ultimately confirming the vessel's departure from the port from the ATD pilot boarding place.

The analysis developed here aims to contextualize future developments in the deliverable. This reference process will frame the analysis of the different standards and legal frameworks that will influence the development of JIT operations. For this reason, the analysis has been taken from a general perspective, without considering any specific type of port or a particular port. Being based on references made by the IMO, it allows for consideration of its applicability to the different port contexts in which JIT implementation is desired.

3.1.2. Information exchange process flow

Once the process has been analysed from an operational perspective, highlighting those events that initiate and conclude subprocesses, the next step is to examine all information exchanges and communications that enable these events to occur. In this section, we will define the communications that take place from start to finish, identify the responsible parties, determine the purpose of the information, and specify the means and formats used for communication. Similar to the analysis of operational processes, we will strive to identify common communications across the different types of traffic considered in this project.

This section will be divided into the three types of information exchanged throughout the process: nautical information, operational information, and administrative information. This categorization has been selected to be consistent with the business process of port call diagram defined by ITPCO.

Nautical Data:

At the onset of the process, the initial information needs arise, primarily focusing on the nautical characteristics of the destination port. This is essential to prevent any potential risks related to safety (the term “safety” referencing to the protection of human life, property, and the environment), considering the environment as the prevention of emissions, as well as the prevention of accidents that harm marine life and the marine environment. The information required according to the Guide for Nautical Data, jointly produced by ITPCO, IAPH, and IHMA, is presented based on Nautical Charts and Nautical Publications:

Nautical Charts: are specialized maps designed for marine navigation, displaying essential details such as depths, seabed nature, elevations, coastlines' configuration, hazards, and navigational aids. They come in two main forms: Paper Charts, which serve as backups for electronic charts, and Electronic Navigational Charts (ENCs), which

conform to the S-57 standard and are used in Electronic Chart Display and Information Systems (ECDIS). A variant, the High-Density Bathymetry (HD ENC), provides more detailed bathymetric information compared to standard ENCs.

Official Nautical Charts are issued by government-authorized Hydrographic Offices or relevant institutions, following IHO recommendations for validation and distribution through RENCs and VARs. Typically, the update interval between new measurements and chart updates onboard is about 4 weeks. Unofficial Nautical Charts may be provided by local ports for more frequent updates but do not meet SOLAS carriage requirements. Therefore, ships must use official charts, while unofficial charts can be used by pilots. It is essential that all members of a vessel's Bridge Team use charts from the same source to ensure consistent information.

Nautical Publications: offer supplementary information related to Nautical Charts and are essential for all SOLAS vessels. They complement Nautical Charts by providing additional details for a specific area. Official Nautical Publications are issued by government-authorized Hydrographic Offices or relevant institutions and their update frequency depends on the availability of new information, making it variable.

Unofficial Nautical Publications are typically issued locally by ports or other publishers to provide more frequent updates or additional details not found in official publications. These are often referred to as Port Information Books or Guides. While official Nautical Publications meet SOLAS carriage requirements, unofficial ones do not. The variability in information between official and unofficial sources can make it challenging to determine the most reliable data for navigation.

Operational Data:

Berth and Port planning: Operational information needs to be shared to provide the rest of the participants in the JIT arrival process with insight into future scenarios. As mentioned earlier, timestamps of events serve as references for participants to initiate or conclude their subprocesses. Therefore, communicating these events and the corresponding times (present or future) is crucial to achieving synchronization. The following table (Table 1) shows the most relevant events in the negotiation process of the PTA berth and PTA pilot boarding place, as well as the responsibilities of each actor in the process. Each event in this process is a process in itself, which will vary depending on the actors taking on the different roles.

Table 1. Process for time arrival definition

Event	Sender	Receiver
ETA berth	Vessel (Ship Agent)	Terminal
RTA berth	Terminal	Vessel (Ship Agent)
PTA berth	Vessel (Ship Agent)	Terminal
ETA pilot boarding place	Vessel (Ship Agent)	Port
RTA pilot boarding place	Port	Vessel (Ship Agent)
PTA pilot boarding place	Vessel (Ship Agent)	Port

The initial set of operational process information concerns the negotiation regarding the vessel's arrival at the berth. This communication involves the vessel's captain and the ship agent, who relay the ETA berth to the Terminal. Subsequently, this information is processed by the terminal and incorporated into its internal berth planning. A communication is then sent to the Vessel and the Shipping Agency with a Requested Time of Arrival based on the terminal's internal berth planning. Once the Vessel receives the RTA berth, it adjusts its speed and communicates its Planned Time of Arrival (PTA) at the berth to finalize the arrival date and time with the terminal.

The planning of port activities, including traffic within port domains and coordination of nautical services, falls under the responsibility of the Port Authority, which in some cases delegates some of these functions to the VTS. The definition of an ETA pilot boarding place serves as a reference for the deployment of the activities. The negotiation of this event begins with an ETA pilot boarding place communicated by the Vessel based on its Voyage Plan to the Port. Similar to the negotiation of the ETA berth, in this case, the Port provides the Vessel with an RTA (Requested Time of Arrival) pilot boarding place. Finally, the Vessel transmits to the Port the PTA (Planned Time of Arrival) pilot boarding place, which has been defined based on the vessel's real possibilities in its voyage depending on navigation conditions, speed, among other factors.

The transfer of all this information currently occurs through email or by telephone communications. Except for some specific cases, there is no internationally recognized standard for electronic communication of this type. Although the IMO seeks to establish a standard system for exchanging this information through the IMO Compendium, it has not been widely and universally implemented to date.

Nautical Services: The nautical services defined in the previous section are activated once the vessel is within the port domain. Pilot boarding, towage, and mooring services must be closely coordinated to ensure efficient and safe operations. Coordination is typically led by the Port Authority directly or by its delegates (VTS, Pilot, etc.). As mentioned earlier, the reference for activity planning is the PTA (Planned Time of Arrival) pilot boarding place. Communications between parties usually take place via VHF radio and through telephone communication. These communication methods are used to declare the start and end events of each of the subprocesses. The consequences of this methodology include the loss of information for improving operations management and the likelihood of errors due to erroneous interpretation, ambiguities, and potential misunderstandings.

Ship-terminal operations: Communications at this stage of the process are centralized around the exchanges between the Vessel and the Terminal. The purpose of these communications is to provide relevant information for the proper planning of terminal operations to meet operational requirements from the Shipping Line's perspective and their own needs. Planning from the terminal's perspective focuses on two clear sub-tasks: on one hand, the planning of the vessel's loading and unloading, and based on this planning, the yard planning is triggered.

Currently, and widely adopted in the sector globally, the communication of this information is carried out digitally based on the UN/EDIFACT standard (information about EDIFACT standards will be detailed later in the report). These messages provide information for the subprocesses of arrival, cargo operations, and departure. Each set of messages is specifically designed to represent the necessary information for each instance.

Table 2. EDIFACT messages sent between vessels and terminals

Type	Name	Description
Ship Planning	BAPLIE	Bay plan
	MOVINS	Stowage Instruction
Container Messages	COPRAR	Vessel Discharge / Loading Order
	COARRI	Vessel Discharge / Loading Order
	COPARN	Full-in Booking Order / Empty-out Release
Vessel Schedule	IFTSAI	Used for transmission of vessel schedule
	VESDEP	Vessel Departure Message
Terminal Performance	TPFREP	Terminal Performance Report sent from a terminal to a carrier.
VERMAS	VERMAS	Used to report VGM (Verified Gross Mass)

The incorrect transfer of this information completely limits the proper evolution of the port call process. Both the terminals and the vessels rely on this information to carry out their processes. The terminal does not allow a vessel to enter its berth unless the required information has been confirmed. Similarly, during the departure process, the vessel needs the information about the ship'' cargo to authorize and begin the departure process from the terminal. These two examples show how such limitations can seriously affect the successful outcome of a JIT operation, impacting the entire process, not just those related to the terminals and vessels.

Departure: The departure stage within the overall port call process can be considered the mirror process of arrival. Therefore, the communications in the departure process and the formats in which they occur are similar to those in arrival, whether it is through radio frequency communication, email, or telephone. These communications are not standardized or centralized.

Table 3 Process for time arrival definition

Event	Sender	Receiver
ETD berth	Vessel (Ship Agent)	Terminal, Port
RTD berth	Port	Vessel (Ship Agent)
PTD berth	Vessel (Ship Agent)	Terminal, Port
ATD berth	Vessel (Ship Agent)	Port
RTA pilot boarding place	Port	Vessel (Ship Agent)
PTA pilot boarding place	Vessel (Ship Agent)	Port

Administrative data:

Regarding administrative information, the most widely referenced source, which provides an agnostic view on the type of port and national regulations, and at the same time addresses the minimum information exchange necessary in a port call with sufficient precision, is the IMO Compendium which establishes standards for administrative data. This tool is intended for parties in the process who design systems to support the electronic exchange of information necessary for a ship's arrival, stay, and departure at a port. By standardizing data elements and electronic messages, the IMO Compendium streamlines information exchange between ships and ports, ensuring interoperability of single window systems and easing administrative tasks associated with port formalities. It includes data sets and a reference data model agreed upon by major organizations involved in electronic information exchange under the FAL Convention. More details are available in the IMO Compendium.

EMSWe: Currently, the development of the European Maritime Single Window Environment (EMSWe) aims to harmonize and centralize the various administrative tasks carried out by the different actors involved in this process. While the initiative will be analysed in depth later in the work, here we aim to show the scope of application and the type of information required for the proper completion of a port call from start to finish. The Delegated Regulation (EU) 2023/205 detailed the data set about the information required by the national authorities for administrative and operational purposes. The following are the elements that must be presented:

A. *Reporting obligations stemming from legal acts of the Union:*
   1. *Notification for ships arriving in and departing from ports of the Member States*
   2. *Border checks on persons*
   3. *Notification of dangerous or polluting goods carried on board*

   4.1 Advance waste notification

   4.2 Waste delivery receipt

   5. Ship pre-arrival security information

   6.1 Number of persons sailing on board passenger ships

   6.2 Information on persons sailing on board passenger ships

   7. Customs formalities

      7.1 Notification of arrival

7.2 Presentation of goods to customs
7.3 Temporary storage declaration of goods
7.4 Customs status of goods
7.5 Electronic transport documents used for transit
7.6 Exit notification
7.7 Exit summary declaration
7.8 Re-export notification

8. Safe loading and unloading of bulk carriers
9. Notification of arrival of ships eligible for an expanded inspection
10. Maritime transport statistics

B. IMO Facilitation Committee (FAL) documents and reporting obligations stemming from international legal instruments:

1. *General Declaration*
2. *Cargo Declaration*
3. *Ship's Stores Declarations*
4. *Crew's Effects Declaration*
5. *Crew List*
6. *Passenger List*
7. *Dangerous Goods*
8. *Maritime Declaration of Health*

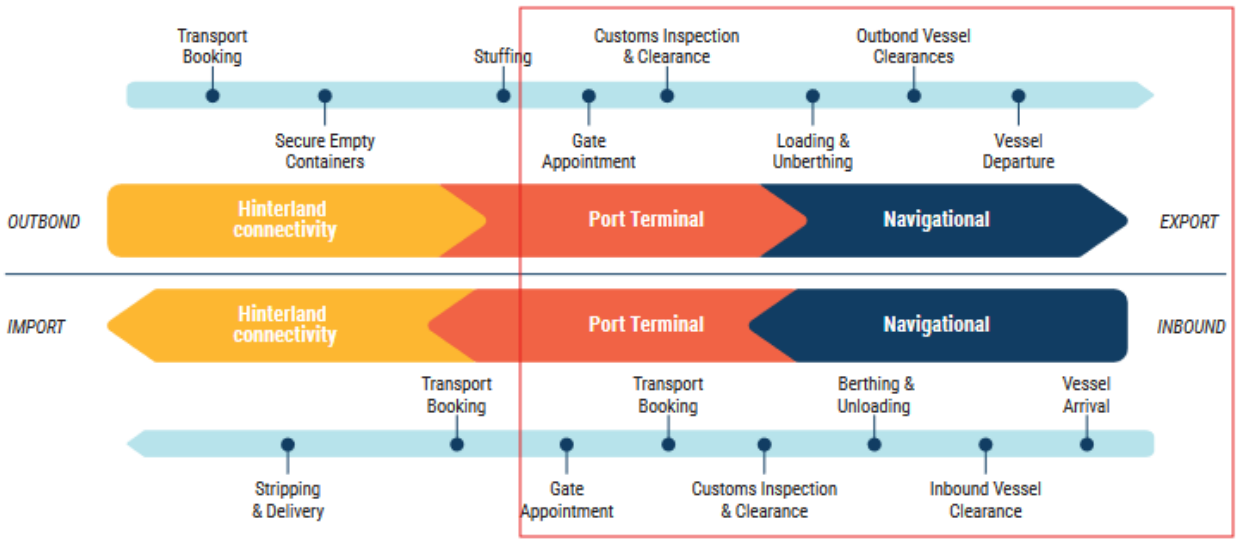
These procedures cater to the informational needs essential for smooth facilitation, fostering collaboration and engagement among stakeholders. Tailored to the European landscape, they align disparate contexts, minimizing redundancy and optimizing logistical efficiency.

Compliance dictates that accredited conformity assessment bodies oversee the process in accordance with European regulations.

The role of Port Community Systems: At this point, it is important to mention the role that Port Community System (PCS) platforms can play as centralizers of administrative processes. Although these types of digital platforms are not widely implemented, it is important to consider them as they are the trend within the sector in medium to large-sized ports. In broad terms, PCS platforms have taken on the functions of a national maritime single window by integrating communications from systems that coexist in the maritime port environment and connecting with the hinterland. This centralization allows for sharing information with much less effort, avoiding process duplication, and thus increasing interoperability.

As shown in Figure 5, PCS in their most widespread application encompass the entire logistics chain, placing the port and its connection to the surroundings at the centre. Regarding the port call, the administrative processes related to arrival and departure information are centralized in these types of platforms. Concerning the administrative processes of the port call request, which are directly linked to the maritime single window, it is possible, as mentioned earlier, for the PCS to assume these functions. Thus, all administrative processes related to the port call would be managed from these types of platforms.

Figure 5. Port Community Systems – Strategic Role. (World Bank Group, 2023)



It is important to highlight this tool because, in a JIT Arrival context, the transfer of information is possibly the greatest challenge faced by this type of initiative. Having a digital platform that streamlines processes, ensuring they are developed in a seamless, transparent, and secure manner, significantly increases the potential applicability of these types of solutions.

3.2. Stakeholders overview

Due to its inherent complexity, a port call operation has many involved stakeholders, even transcending the port boundaries. From the consignee to the recipient, there are many organisations that may influence how a port call unfolds and its requirements. Furthermore, international conventions and institutions may introduce additional requirements or unified procedures to ensure an adequate information flow.

Central roles in a port call are played by the port actors, a complex system of service providers and authorities. Each of these has a different role, ranging from guiding and tugging the boat safely to ship unloading and loading operations. For a JIT port call, it is imperative that all of these partners exchange the relevant information on their operations and characteristics in a timely, effective way. In recent times, classic communication means such as VHF radio, phone calls and e-mails are progressively being replaced by standardised single windows and messaging systems.

To provide more clarity, this deliverable has divided the stakeholders into "operational" and "information exchange" perspectives. However, operational efficiency cannot be achieved without adequate information exchange, ultimately interlinking both concepts. Therefore, the analysis will take these links into account. It is important to highlight at this point that there are stakeholders who play a role in both the operational and information exchange aspects, so both roles will be analyzed separately in the different sections.

3.2.1. Operational Perspective

The description of stakeholders involved in port call operations will focus on those directly participating in the process, highlighting the impacts that shifting from uncoordinated operations to JIT operations would have on their activities. To simplify the analysis, stakeholders have been grouped according to the process, with three different subgroups established based on their role within the operations. The subgroups considered will be seaside (all those related to the ship), nautical services, port operations, and authorities.

Sea-side:

Shipping Charterer: The shipping charterer is the person or company who hires a ship from a shipowner for a period of time. The contract which governs the ship's hiring has an influence on the port call and its costs. There are two main ways of chartering a ship: time charter and voyage charter.

In a time, charter, the charterer is granted the use of as vessel and its crew for a specified period of time from a shipowner. No agreement is required on ports of call and destinations since this is at the complete discretion of the charterer. Consequently, the latter may direct the vessel's movements and cargo operations within agreed and imposed contractual limits. While the owner retains the obligations to pay for the vessel's operational aspects (maintenance, crewing, etc.), it is the charterer's duty to pay for fuel and supply costs, cargo operations and port charges. Because of this, in such a contract, the charterer will have the main influence over the choice of port call type due to the potential JIT port calls have for cost reduction. Time charters are the preferred way to contract ships nowadays.

In turn, in a voyage charter, the contract specifies the transportation of a specific cargo on a single voyage between designated ports. They are usually paid on a per-ton basis, with the charterer paying a set price for every ton of cargo they transport. This is the preferred choice when the total cargo they are transporting is significantly less than the maximum gross cargo tonnage of the ship.

Alternatively, both parties may agree on a single payment that allows the charterer to transport as much cargo as they desire. In this case, it is the ship's owner's duty to ensure that the cargo weight does not exceed the gross maximum tonnage of the vessel. Charterers usually rely on this method when they are carrying a significant amount of cargo.

In contrast to time charters, besides cargo delivery, it is the ship owner's responsibility to pay for all associated costs of the voyage: in addition to maintenance and staffing, berthing, loading/unloading and fuel are paid by it. As a consequence, the ship owner will be the organization pressing for a JIT port call to reduce the trip overall cost. Furthermore, if the charterer exceeds the agreed time, it must pay demurrage charges to the ship owner, further making JIT port calls more attractive.

Ship operator: is responsible for the strategic use of the vessel, including how it is employed and its port destinations. This role involves making high-level decisions about the ship's deployment based on commercial needs and logistical considerations. The ship operator could be a charterer, a shipowner, or another party with a vested interest in the vessel's deployment. Their decisions shape the vessel's itinerary, manage commercial contracts, and coordinate with other stakeholders to optimize the ship's use and profitability.

D1.1. ASSESSMENT AND ALIGNMENT OF ON-GOING JIT / PORT CALL OPTIMISATION STANDARDISATION INITIATIVES INCLUDING LEGAL FRAMEWORKS

Within the JIT process, stakeholders such as ship operators typically benefit from the optimization of port turnaround times, enhancing the productivity of assets as well as the management of operations. Being responsible for the vessel's itinerary and potential improvements in route design, operating in ports capable of JIT operations could lead to gains in competitiveness for both parties (ship operators and ports).

Ship manager: oversees the daily operations and maintenance of a vessel. This role is crucial for ensuring the ship functions efficiently and adheres to maintenance schedules. The ship manager could be a company or an individual working onshore, handling tasks such as crew coordination, routine repairs, and compliance with regulatory requirements. Additionally, they might manage administrative responsibilities, including communication with port authorities and other relevant stakeholders. Their role is pivotal in maintaining the vessel's operational readiness and ensuring all necessary procedures are followed.

While this role is less actively involved in the operational process compared to ship operators, their activities are coordinated to varying degrees with port call operations. The planning and execution of their responsibilities could be affected if requirements change in a JIT arrival scheme.

Shipping agent: plans and manages the vessel schedules, including port calls. They send the bay plan and the technical characteristics of the vessel to the terminal and to the port to facilitate cargo operations and ensure that all logistics are in place for a quick turnaround. The shipping agent's coordination with port authorities and service providers is crucial for maintaining the JIT schedule and optimizing overall operations. Also acts as the liaison between the vessel and the port, coordinating all aspects of the port call and ensuring that all services are arranged and provided on time. Its responsibilities may vary depending on the type of contract and service arrangements between contracting parties.

Nautical services:

Pilots: Pilots control the ship during the arrival and departure phases, guiding it safely to and from the berth. They need to be aware of the vessel's arrival to the Pilot Boarding Point and communicate with the ship typically via VHF radio, whose range is usually 20 nm. In some ports like Valencia, pilots also manage the Communications Centre. The efficient scheduling and availability of pilots are crucial for minimizing delays, as they directly influence the timing of the vessel's berthing and departure. Ships that can show proof of regularly calling at a certain port might be exempted from pilotage services, speeding up the overall port call process.

Towage Company: Tugs assist in steering the vessel during berthing and unberthing operations, especially in tight port areas. They must be contracted in advance, and their availability is critical. The efficiency and readiness of tug services impact the overall port call duration significantly. Timely and precise tug operations help prevent delays and ensure the vessel can be manoeuvred as needed without waiting.

Mooring service: Mooring personnel or automated mooring systems secure the vessel to the berth upon arrival and release it upon departure. The readiness and efficiency of these systems are vital for quick berthing operations. Automated systems, in particular, offer the advantage of reducing human intervention and speeding up the mooring process.

Vessel Traffic Services: VTS are systems installed on the shore to provide vital information messages to ships regarding positions, other traffic, meteorological hazard warnings and even managing traffic within a port or waterway. Usually, they are provided by the Operations Control Centre. This centre is responsible for guiding vessels to their assigned berths, managing traffic within the port, and ensuring that berthing operations are conducted smoothly. In Valencia, this responsibility falls on the pilots. They need to coordinate with terminals to get real-time

updates on berth availability and organize the sequence of vessel movements to avoid conflicts and delays, especially for JIT operations.

Port operations:

Terminals/Cargo Service: are the services related to loading and unloading, inspection, and grouping of cargo. Typically, this role in ports is carried out by port terminals, which handle dock and cargo yard management and oversee the dispatch of goods to the hinterland. The role of the terminal as a cargo service provider is central to operations, being one of the parties responsible for negotiating the ETA and expected to create the necessary conditions onshore so that resources are in place and available as per the agreed day and time. Involvement in the JIT arrival process at a port call is crucial; without their commitment and effective execution, the success of such initiatives is unlikely.

Berth Planner: The berth planner is a person who plans, schedules and manages the allocation of port berths at a seaport. Depending on the port, this person might work for the port authority or a private terminal operator. Its capability to precisely plan and determine resources, its overall view on port operations and how they work and its experience play a crucial role in JIT port calls. More specifically, good berth planning can lead to time savings that, in turn, transforms into reduced waiting times, enhanced efficiency, cost savings and improved environmental planning.

Port Planner: this role, like the berth planner, is not a stakeholder in itself but rather a key function that must be performed by certain actors within the process. It is mentioned in this document to emphasize that this function is typically carried out by port authorities. The main responsibility of the port planner is to manage all port calls, ensuring the optimal functioning of the port facilities and coordinating with the various stakeholders involved. This role is crucial for ensuring compliance with safety, security, and environmental care standards. Efficient management of port calls will facilitate the implementation of JIT operations and can enhance the competitiveness of the port by increasing productivity and optimizing the turnaround time of vessels in port.

Hydrographic service providers: Hydrographic service providers arrange for the collection and compilation of hydrographic data and the publication, dissemination and update of relevant nautical information necessary for safe navigation such as nautical charts, depth charts and others. These services can be provided by public (for example, the national hydrographic office) and private offices. A publication of significance is the Mariner’s Handbook (NP100), published by the United Kingdom Hydrographic Office. The book contains updated critical navigation information on current navigation and pilotage data, weather and oceanographic insights (currents, weather conditions, etc.) that help with the route selection, information on local navigation regulations essential to efficient port operations and environmental guidance. Any company aiming to adopt JIT port calls shall ensure that it has an up-to-date version of these documents.

Vessel or Cargo Service Providers: various service providers, such as those handling repairs, maintenance, and waste management, need to plan their activities around the vessel's port call schedule. Effective planning and execution are crucial to avoid delays and ensure that all necessary services are completed within the limited time available. Similarly, bunkering, refuelling, external power providers must receive requests in advance and align their operations with cargo handling activities. Efficient bunkering operations are essential to minimize the vessel’s total time in port. These providers must coordinate closely with both the vessel and the terminal to ensure that fuel and other supplies are delivered promptly within the designated time window.

Indirect:

Land Transport Company: Transport companies would benefit from reduced waiting times: Trucks and trains can arrive at the port just as cargo is ready for loading or unloading, reducing idle times and optimizing fleet utilization This would translate into lower operational costs thanks to lower fuel consumption and labour costs. Furthermore, scheduling would be improved due to the better route planning and scheduling the JIT system allows, leading to more efficient operations.

Land Transport Terminal (Railway Terminal): Railway terminals will see significant advantages with a JIT system. Firstly, terminals can allocate resources more effectively, avoiding congestion and maximizing the use of infrastructure and labour. Secondly, improved coordination with ports reduces bottlenecks and streamlines the transfer process between ship and rail. Lastly, with better predictability and scheduling, terminals can handle more cargo in a given time frame, increasing throughput and profitability.

Freight Forwarders: act as intermediaries managing logistics for their clients, and a JIT port call system offers them better planning thanks to the provision of accurate information on ship arrival times. This allows for better planning and coordination of logistics services. As with the land transport companies, costs improve due to reduced demurrage charges and lower inventory holding costs due to faster cargo turnover. As a consequence, the end user sees improved reliability and timeliness in delivery schedules that enhance customer satisfaction and competitiveness.

Consignees: The shipping's end customer would reap the benefits in the form of timely deliveries thanks to accurate delivery windows that ensure goods arrive when needed, reducing storage costs and the risk of stockouts, improved inventory management, thanks to the alignment of JIT arrivals with inventory strategies, reducing excess inventory and associated costs. A further benefit would be an enhanced supply chain reliability: greater predictability and reliability in the supply chain support better planning and operational efficiency.

European and National Authorities: would see reduced waiting times and optimized transport schedules leading to lower emissions from trucks and ships, contributing to the all-important environmental sustainability goals. The whole commerce and economy would also benefit through the improved efficiency in logistics and transportation, boosting economic activity and competitiveness. Last, but not least, enhanced infrastructure utilisation, better planning and scheduling make more effective use of existing infrastructure, delaying the need for costly expansions.

3.2.2. Information Exchange perspective

Based on the description of stakeholders from the information exchange perspective, it becomes clear which actors in the process have the authority to request certain information, those who are obligated to transmit it, and those who depend on the information to plan, coordinate, and execute the various tasks and activities they are responsible for.

Authorities:

Port Authority: The port authority oversees and manages the entire port operation. They process call information, handle call requests, and coordinate berth assignments. They play a strategic role in optimizing port traffic and can offer economic incentives for adopting JIT port calls, which contribute to more efficient and streamlined operations. The port authority's role in managing infrastructure and resources ensures the smooth flow of port activities. In addition to the above, port authorities, in their role as managers of port call requests, are responsible for requesting the necessary information to approve a port call. When PCSs are in place, information exchanges are centralized through the platform, which also functions as the EMSWe.

Customs: Customs authorities are responsible for clearing the vessel and its cargo. Efficient customs operations are critical to maintaining the flow of goods and minimizing delays. Containers, ideally, should be on the “green circuit” to expedite processing, especially for JIT operations where time is essential.

Sea-side:

Shipping Charterer: At this stage, the Shipping Charterer, as a stakeholder from the information perspective, according to the process detailed by the ITPCO, requires port and berth information to carry out their tasks. This information is usually necessary because it is typically part of the clauses required to create the Charter Party. It is important to note that this type of information is mainly required in tramp services, especially when dealing with bulk cargo. The individuals responsible for providing this information are both the port planners and the berth planners.

Port operations:

Shipping operator: similar to the process of contracting a ship, when arranging port and terminal services, the ship operator requires information about port dues. This information is typically provided by the port planner, usually under the responsibility of the port authority. Depending on the circumstances, these costs are borne by either the ship operator or the ship agent.

Terminals/Cargo Service: as discussed in the previous section, terminals have a primary role in this process: negotiating the PTA for berth since, in most cases, they take on the role of berth planning. Therefore, from the perspective of information exchange, their main responsibility is to respond to the ETA berth received from the ship agent or ship operator by sending the RTA berth. Additionally, as they are responsible for managing the docks, terminals are also tasked with providing technical specifications of the docks to those who request it. Lastly, another type of information that terminals must receive is related to the unloading operations, usually coming from the ship agent, to facilitate ship and yard planning activities.

Port Planner/Port Authorities: regarding operations, the involvement of Port Authorities is evident in the negotiation of the ETA for the pilot boarding place. Once the ship agent indicates the ETA, the port planner from the Port Authority is responsible for proposing the RTA for the pilot boarding place. Additionally, similar to the terminal, the port, through the port planner, must provide technical specifications to other interested parties who request them. Communications are conducted via email and telephone, with VHF radio used for real-time coordination. This allows for efficient management of vessel movements within the port and ensures that all parties are aware of the operational schedules and requirements.

Hydrographic service providers: the entities serving as hydrographic service providers are responsible for delivering information related to nautical charts and publications. This information is essential for safe navigation and must comply with regulations such as SOLAS, among others.

Vessel or Cargo Service Providers: Actors responsible for providing services to both cargo and vessels primarily focus on communicating key time-related information regarding when the service should be performed. They communicate the Estimated Time Service (ETS) to the ship managers. After receiving the Requested Time Service (RTS) from the ship managers, they process the information and agree on a Planned Time of Service (PTS). Following this planning phase, they are responsible for updating key information, such as the actual time the service is performed and all estimated completion times for the services.

Ship manager/Ship agent: At the center of communications are the figures representing the vessel's interests in relation to the authorities, particularly regarding the notification of expected arrival and departure times. As outlined

in **¡Error! No se encuentra el origen de la referencia.**, the primary communications revolve around notifying the ETA and PTA for the berth, ETA and PTA for the pilot boarding place, and similar notifications for the departure process. Additionally, these figures are responsible for providing the necessary information to meet the port call request requirements and secure berth confirmation in compliance with EMSWe regulations. They must also ensure the clearance of cargo and unloading processes with customs.

Nautical services:

The three main nautical services—mooring, towage, and pilotage—play a crucial role in communicating operational details and coordinating with ship managers or ship agents as part of the nautical service planning. To ensure timely service, these nautical operations generally require advance notice, typically ranging from 2 to 3 hours, and in some cases up to 6 hours. This notice period depends on the service location relative to the stations of pilots, tugs, or line handlers (ITPCO, 2022). Proper coordination and timely communication are essential to align the services with the vessel's schedule and operational needs. These communications occur both upon arrival and departure.

4. Process and JIT Standardization initiatives

Once the stakeholders and the port call process have been defined, we will proceed to describe those bodies, entities, and organizations that operate as standardization bodies (SDOs) or whose work is aimed at harmonizing data, processes, communications, among others, in the maritime and port sector. This description seeks to establish the links that may exist between these initiatives and the port call optimization and JIT processes, as their activities can have a significant impact on the dynamics of implementing such processes. The analysis will be divided into those standards focused on harmonization related to operational processes, and those with applications more related to digitization.

4.1. Operational-Focused Standards

This section will provide a comprehensive overview of the leading standardization bodies (SDOs) and organizations that are essential for driving alignment within the maritime and port industries, specifically focusing on the operational side of the sector. These entities play a crucial role in establishing consistent frameworks for information exchange, process harmonization, and semantic harmonization, directly impacting operational efficiency at ports worldwide. Their work lays the foundation for smoother coordination, enhanced collaboration, and more efficient operations, which are key for optimizing port calls and enabling JIT processes.

4.1.1. International Maritime Organization (IMO)

In April 2018, the IMO adopted resolution MEPC.304(72), setting the Initial IMO Strategy to reduce greenhouse emissions (GHG) from ships, aiming to phase them out within this century. The strategy includes various measures: short-term, mid-term, and long-term, emphasizing the importance of port development to facilitate emission reduction. This includes providing renewable energy sources for ship power, supporting low-carbon and zero-carbon fuels, and optimizing logistics and planning.

Achieving these goals requires a combination of operational, technical, and fuel-related measures, along with collaborative efforts from all maritime industry stakeholders. The critical role of ports is highlighted in resolution MEPC.323(74), adopted in May 2019, encouraging cooperation between ports and shipping sectors. This resolution invites IMO Member States to improve data quality and availability, develop global digital data standards, enhance slot allocation policies, and promote JIT Arrival of ships. JIT Arrival allows ships to optimize their speed to ensure timely arrivals, thus reducing GHG emissions and supporting the IMO's strategy. The IMO has undertaken three important initiatives to support stakeholders in achieving these objectives. The following sections will describe the specifics and applications of these initiatives.

IMO Compendium

The IMO Compendium on Facilitation and Electronic Business serves as a crucial framework for standardizing maritime information. This reference model is designed to harmonize the semantics and format of information

relevant to the maritime industry, ensuring consistent data exchange across different stakeholders. The compendium provides a unified data set and reference model that facilitates interoperability between various IT systems, streamlines the Maritime Single Window (MSW) processes, and enhances port call optimization. Additionally, it supports the development of green and digital corridors by promoting efficient and environmentally friendly maritime operations.

Collaboration with key international organizations, such as the World Customs Organization (WCO), the United Nations Economic Commission for Europe (UNECE), the International Organization for Standardization (ISO), and the International Hydrographic Organization (IHO), ensures comprehensive alignment across the entire supply chain. This collaborative effort helps to integrate and standardize data exchanges, further supporting the efficiency and effectiveness of maritime processes.

Since July 2019, the IMO Expert Group on Data Harmonization (EGDH), established by the Facilitation Committee, has been tasked with the technical maintenance and expansion of the IMO Compendium. This ongoing work ensures that the compendium remains up-to-date and continues to meet the evolving needs of the maritime industry (IMO, 2024).

IMO Guidelines for harmonized communication and electronic exchange of operational data for port calls.

IMO Facilitation Committee, at its forty-seventh session (13 to 17 March 2023), approved the annexed Guidelines for harmonized communication and electronic exchange of operational data for port calls. These guidelines are intended to provide guidance to the implementation of an electronic and automated exchange of operational data between a ship and a port. As part of this guidance, the guidelines also provide definitions of the general port and ship related parties. The guidelines also make references to the IMO Compendium, IMO Reference Data Model and other specifications where relevant and encompass international standards that are non-technical only: data element definitions are based on the IMO Compendium and a logical diagram for the port call process. The relevant technical standards (API specifications, technical and business performance requirements) are in process of being developed within ISO TC 8 (IMO, 2024).

These guidelines are port and trade agnostic. Benefits of, i.e., JIT Arrival concepts are not limited to only the shipping industry, in particular to vessel traffic service centres, to ensure safe and efficient traffic flows, but will also assist the port industry to better plan and organize port operations, and eventually the complete logistic chain. They contain definitions of the different work processes or events related to a ship's port call and its planning. This includes at what times electronic messages need to be exchanged and between which parties.

IMO GIA JIT Arrival Guide

The Global Industry Alliance to Support Low Carbon Shipping (GIA) was officially launched on 29 June 2017. The aim of the GIA is to develop innovative solutions to address common barriers to decarbonising the shipping sector. The GIA was established under the framework of the GEF-UNDP-IMO GloMEEP Project and following the conclusion of the GloMEEP Project at the end of 2019, the GIA continues under the framework of the IMO-Norway GreenVoyage2050 Project. The overall goal of IMO GreenVoyage2050 is to support implementation of the IMO GHG Strategy (Resolution MEPC.377(80)), and in particular, provide support to developing countries in their efforts to reduce GHG emissions from ships. The IMO GHG Strategy sets out a clear vision and levels of ambition, one of which is to reach net-zero GHG emissions from ships by or around, i.e., close to, 2050 compared to 2008. The project consists of four components:

- *Component 1 – Developing global tools to support implementation of the Initial IMO GHG Strategy*

- *Component 2 – Capacity building, policy and NAP development*
- *Component 3 – Strategic partnership development*
- *Component 4 – Technology cooperation, innovation and pilot demonstrations*

In 2020 the GloMEEP project and members of the GIA published the document "GEF-UNDP-IMO GloMEEP Project and members of the GIA, 2020: JIT Arrival Guide – Barriers and Potential Solutions" (hence called "IMO-GIA JIT Arrival Guide"). The purpose of this IMO-GIA JIT Arrival Guide is to provide information and proposals to the port and shipping sectors as well as port and maritime administrations on how to facilitate JIT Arrival of ships – with a view to reducing GHG emissions by optimizing the port call business process and providing sustainable solutions to customers in the end-to-end supply chain (IMO, 2020). In particular, this IMO-GIA JIT Arrival Guide provides a useful toolkit for shipowners, ship operators, charterers, ship agents, shipbrokers, port authorities, terminals and nautical services providers, and other relevant stakeholders who ultimately play a key role in implementing the necessary changes and facilitating the exchange of communication required to realize JIT Arrival from a port perspective.

Conclusion of the IMO-GIA JIT Arrival Guide was that JIT Arrival presents a feasible opportunity to reduce fuel consumption, and hence both CO2 emissions and fuel costs. In particular for ships that operate on relatively high speeds and sail relatively short distances between ports (e.g. container shipping), a relatively short advance notice on the berth availability can already result in substantial savings. JIT Arrival is a 'free tool' which can generate savings and may be industry driven (another reason why it may be most worthwhile adopting it). JIT Arrival may change the way of operating in the supply chain; better information, more transparency, more efficiency in the port. Other advantages include e.g., increased navigational safety in port approaches and anchorages; improved resource planning of pilots, tugs and berths; reduced ship hull fouling, less exposure of ships to piracy, and improved rest hour planning of crews and port personnel.

The document identified a number of barriers and potential solutions to these barriers where JIT Arrival requires collaboration among many stakeholders including port authorities, terminals, shipping companies, service providers etc. Barriers to JIT Arrival can be broadly categorized into operational and contractual barriers. Operational barriers refer mainly to the exchange of high-quality or reliable data between stakeholders in the port, and to and from the ship. Contractual barriers mainly apply to the ability of the data receiver to use the data, e.g., to optimize the ship speed en route.

The IMO-GIA JIT Arrival Guide acknowledges that barriers to JIT differ for different shipping trades, with those being operated on a time charter (i.e. container shipping) experiencing less contractual barriers than those under voyage charter (i.e. bulkers and tankers).

4.1.2. International Taskforce Port Call Optimization (ITPCO)

The International Taskforce Port Call Optimization originally formed in January 2014 in response to IMO Maritime Environment Protection Committee (MEPC) Resolution MEPC.323 (74) detailing the IMO MEPC strategy for reducing GHG. ITPCO is neutral body which brings together experts across the maritime industry to work collectively in order to make vessel and port operations more efficient through greater cooperation across the various parties involved. These parties include ship operators, ports, terminals, ships agents and hydrographic offices.

The mission of ITPCO is to improve and standardize wherever feasible the exchange of nautical, administrative and operational data between ship and shore, ensuring all relevant parties are able to facilitate an efficiently completed vessel port call, be it for containers, bulk, liquid bulk or general cargo, passengers or crew.

As part of this work, a widely understood, common language of terms has been agreed to enable clear communication and understanding. These terms being consistent across the maritime industry and can be found in ITPCO publications.

The port call process is based on high-level business process of port calls, which is based on IMO regulations, BIMCO contracts, and requirements of port authorities and other stakeholders, making it a port and trade agnostic process. It has been created by the industry (a group of leading ports and shipping lines) and validated during Industry Roundtable sessions organized by the IMO Global Industry Alliance (GIA) to Support Low Carbon Shipping.

Using the same framework as shown in Figure 1 in sub-chapter 3.1, this instance shows the different types of data exchanged during the process:

Figure 6. Nautical data Exchange in the Business Process of Port Call (IMO, 2024).

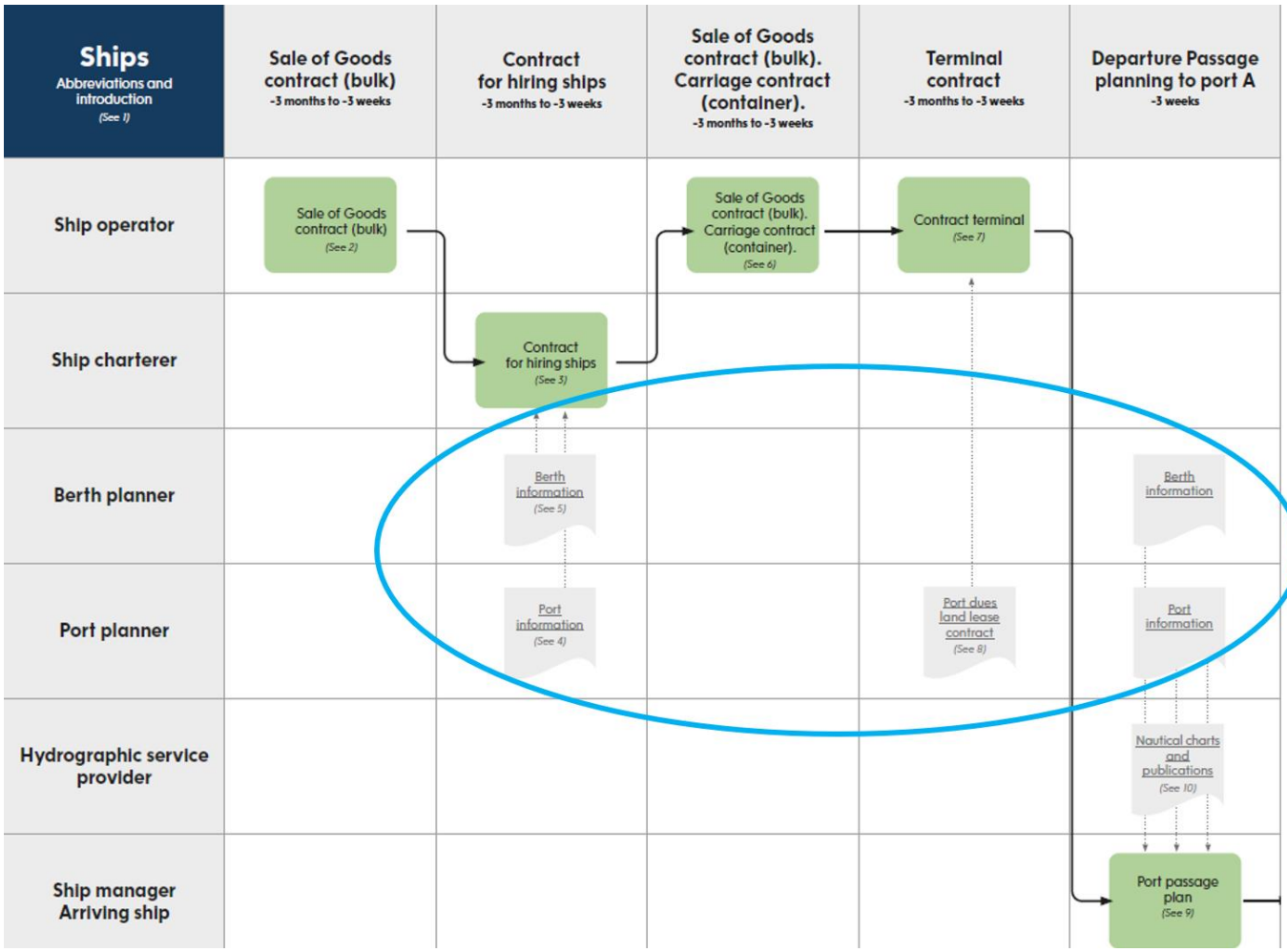


Figure 7. Operational data Exchange in the Business Process of Port Call (IMO, 2024)

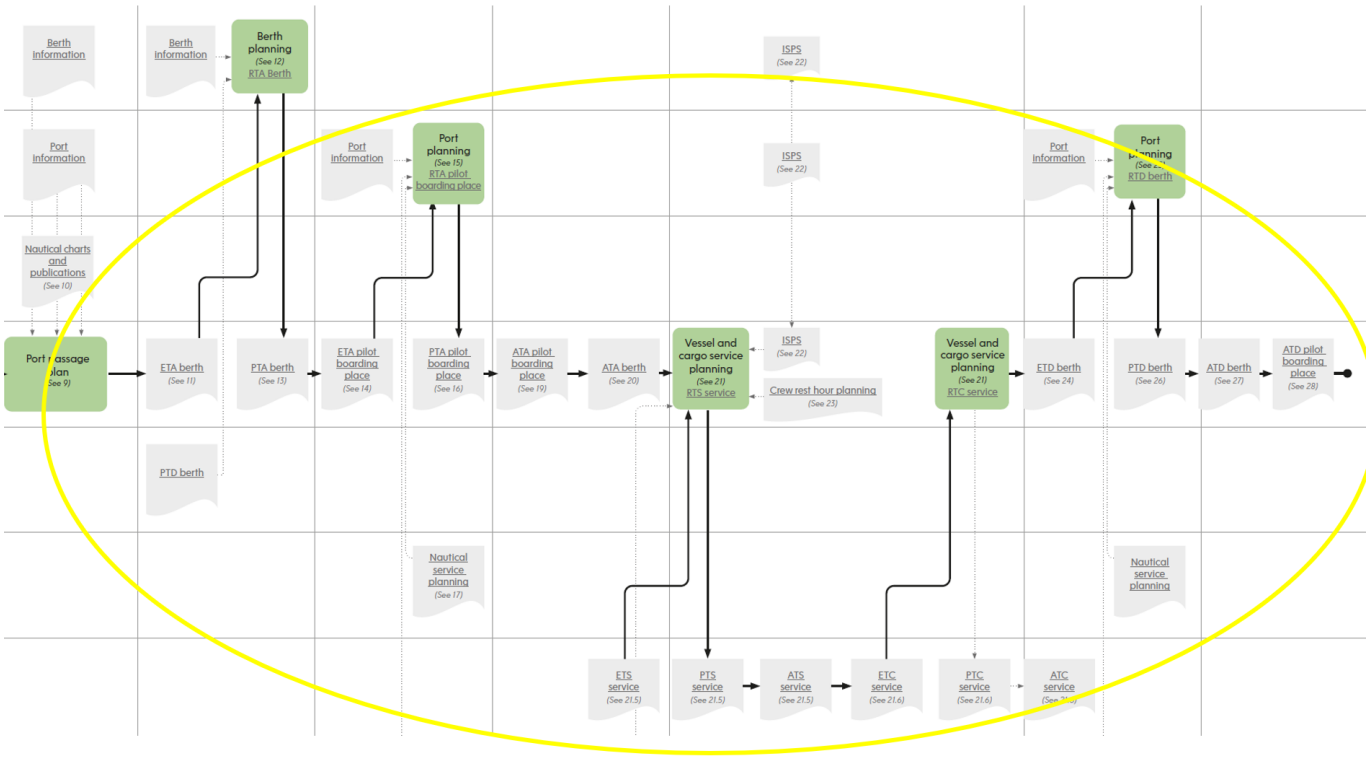
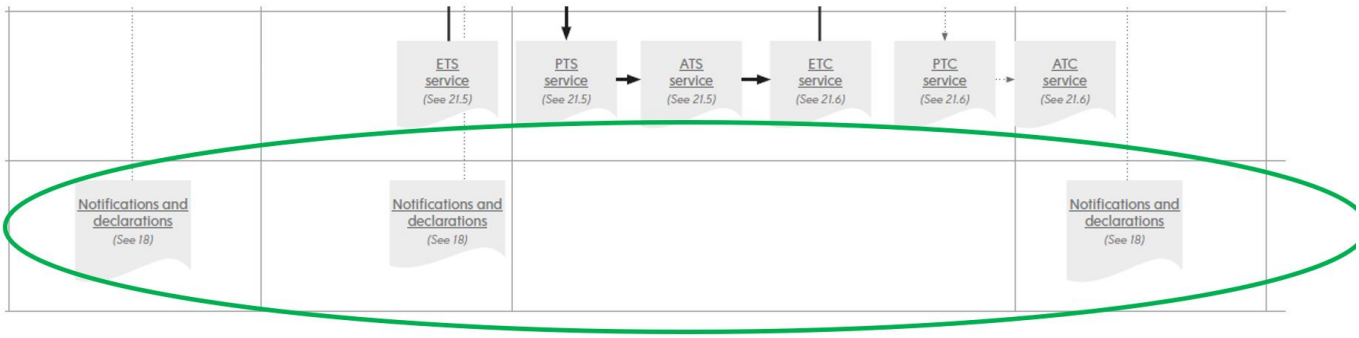


Figure 8. Operational data Exchange in the Business Process of Port Call (IMO, 2024)



Data to be exchanged within the process is divided in the following data sets:

- *Nautical data (blue): data provided by Hydrographic Offices in navigational charts, Nautical Publications or coast pilots, and tide tables.*
- *Administrative data (green): data submitted by ships or other non-authority parties to authorities in notifications and declarations.*
- *Operational data (yellow): data submitted to non-authority parties as part of planning or execution of certain operations.*

ITPCO has defined the following data standards for timestamps, aligned with the IMO Compendium (IMO, 2024):

1 Estimated/Requested/Planned/Actual Time of Completion of Vessel or Cargo services

.1 Data numbers in IMO Compendium: IMO0301, IMO0302,IMO0303, IMO0304

.2 Definitions for these timestamps are as per IMO Compendium. For example, the date and time a service provider completes the cargo services

.3 Abbreviations: ETC, RTC, PTC, ATC

.4 Further fine-tuning of definition may be required for operations regarding completion of this specific service; whether the ship is ready for departure (can start unmooring, meaning the first line can be released) when other services may not be completed yet

.5 Geo reference: Berthing position of the ship (direct and indirect)

2 Estimated/Requested/Planned/Actual Time of Completion of Nautical services

.1 Data numbers in IMO Compendium: IMO0301, IMO0302, IMO0303, IMO0304

.2 Definitions for these timestamps are as per IMO Compendium. For example, the date and time a service provider completes the nautical services

.3 Abbreviations: ETC, RTC, PTC, ATC at a certain location, e.g., terminal, where the terminal is the nautical service provider of the information

.4 Further fine-tuning of definition for operations may be required regarding the start time of the unmooring service (first line released) and regarding completion time unmooring service (last line released)

.5 Geo reference: Berthing position of the ship (direct and indirect)

3 Estimated/Requested/Planned/Actual Time of Departure Berth

.1 Data numbers in IMO Compendium: IMO0066, IMO0236, IMO0237, IMO0065

.2 Definitions for these timestamps are as per IMO Compendium. For example, the date and time the ship departs from berth

.3 Abbreviations: ETD, RTD, PTD, ATD Berth, where the Berth is the specific location

.4 Further fine-tuning of definition for operations may be required. For example, last line released

.5 Geo reference: Berthing position of the ship (direct and indirect)

4 Estimated/Requested/Planned/Actual Time of Arrival Berth

.1 Data numbers in IMO Compendium: IMO0064, IMO0234, IMO0235, IMO0063

.2 Definitions for these timestamps are as per IMO Compendium. For example, the date and time the ship arrives at berth

.3 Abbreviations: ETA, RTA, PTA, ATA Berth, where the Berth is the specific location

.4 Further fine-tuning of definition for operations may be required. For example, first line secured.

.5 Geo reference: Berthing position of the ship (direct and indirect)

5 Estimated/Requested/Planned/Actual Time of Arrival Pilot Boarding Place

.1 Data numbers in IMO Compendium: IMO0064, IMO0234, IMO0235, IMO0063

.2 Definitions for these timestamps are as per IMO Compendium. For example, the date and time the ship arrives at the pilot boarding place, where the pilot boarding place is the specific location

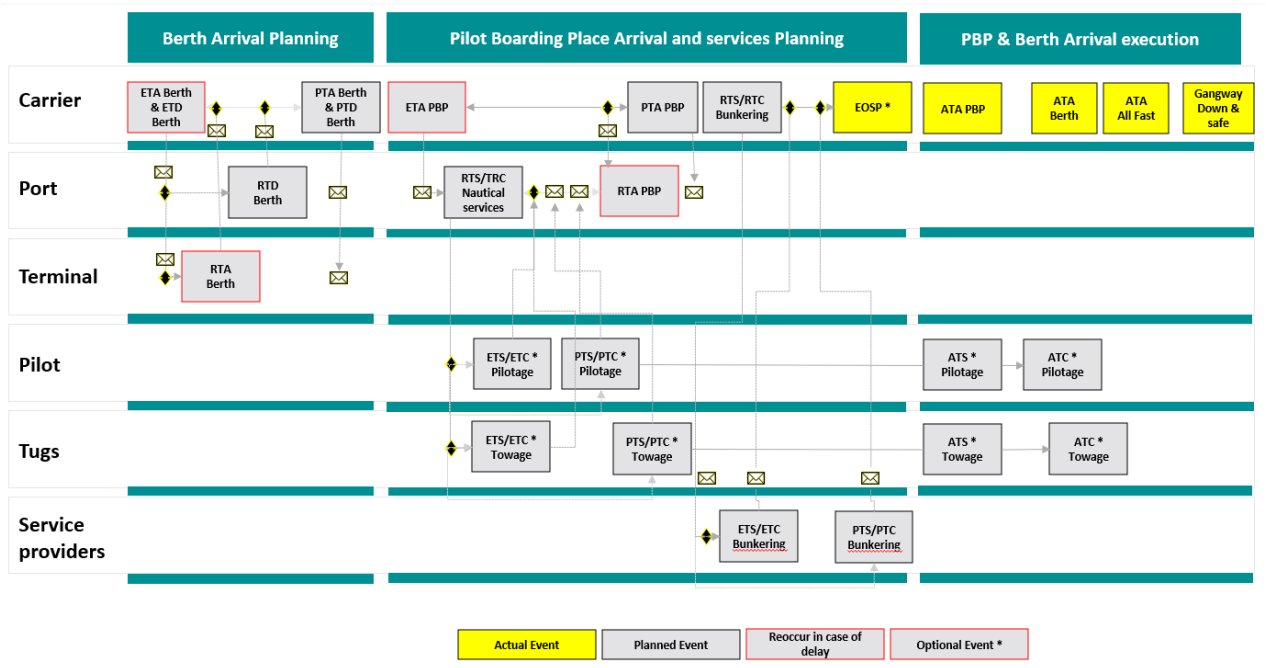
.3 Abbreviations: ETA, RTA, PTA, ATA Pilot Boarding Place

.4 Geo reference: Pilot boarding place

4.1.3. Digital Container Shipping Association (DCSA) Standards

DCSA is a non-profit, independent organization established in 2019 by 9 of the largest container shipping companies to establish IT standards that would enable interoperability of technology solutions across the container shipping industry. The purpose is to facilitate digital interconnectivity and seamless data communication that anyone who touches the industry can leverage. Next to standardized messages and documentation, DCSA also works on practical adoption solutions, such as standardised APIs and data models. Included in the DCSA work, is the JIT implementation framework and its API and message format which facilitates instant communication of accurate, usable data for every event, making port call communication faster and unambiguous. The JIT implementation framework is a global technical standard for JIT port calls based on the semantics and definitions of the IMO-GIA JIT Arrival Guide. It includes open-source API definitions, an interface standard, message format and business process. The framework is lightweight, with only 22 data attributes. It includes all important port call events, which means users can pick and choose from 112 event timestamp messages to exchange with their port call partners. By moving container shipping towards a JIT port call process, DCSA port call standards will enable container ships to optimise their steaming speed, thereby lowering fuel consumption and reducing GHG emissions.

Figure 9. Port Call Process From Berth Arrival Planning to PBP & Berth Arrival Execution (DCSA, 2022).



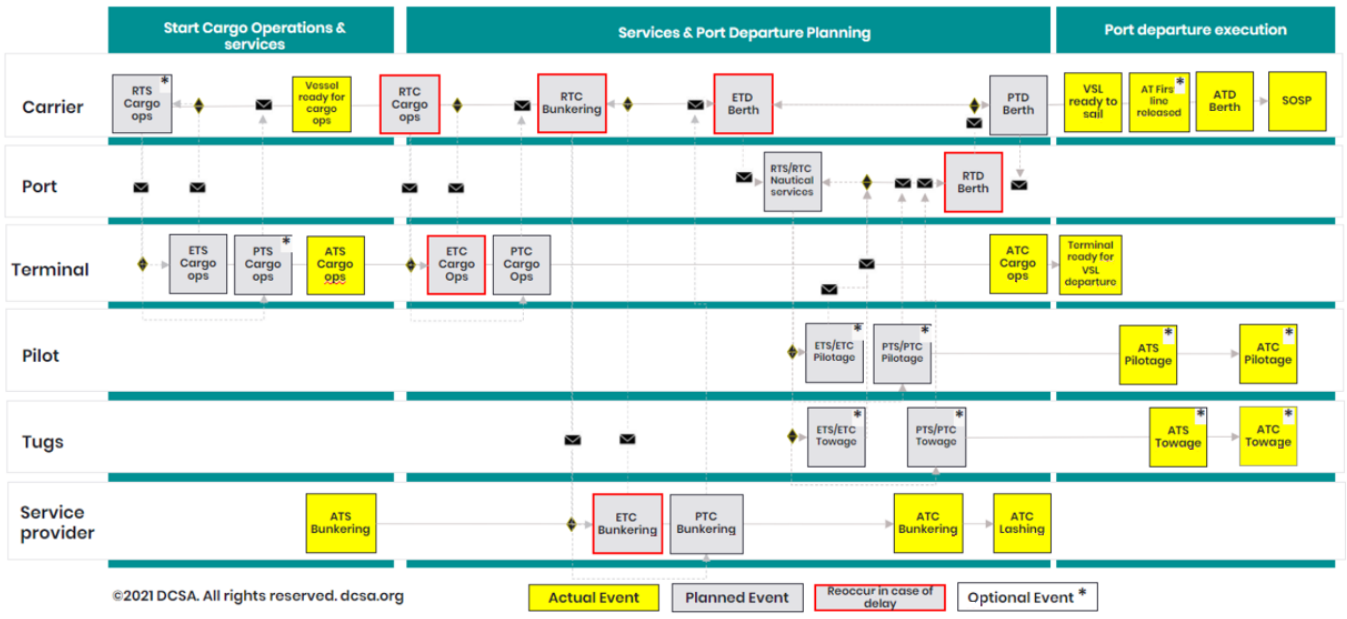
As part of the DCSA JIT Port Call framework, DCSA and its member carriers have published port call data definitions, based on existing standards from ITPCO and IMO, interface standards and messaging API (application programming interface) specifications, which address the 6 main parts of a port call:

- *Berth arrival planning*
- *Pilot boarding place arrival and service planning*
- *Pilot boarding place and berth arrival execution*
- *Start cargo operations and services*
- *Services and port departure planning*
- Port departure execution

The complete framework of JIT Port Call supports digital port call planning, increased operational efficiency and optimal resource utilisation.

The Interface Standard for JIT port call focuses on the process starting at the communicated operational estimated time of arrival at a port prior to arriving at Pilot Boarding Place (PBP) and at berth. The high-level process below is covering 50 timestamps, detailed process maps are available for the complete framework.

Figure 10. Port Call Process From Start Cargo Operations to Port Departure Execution (DCSA, 2022).



The process includes consecutive events (Arrival at Pilot Boarding Place, Arrival at Berth, Start of Cargo Operations and other services, Completion of Cargo Operations and Departure from Berth) which all include the cycle of planning events (Estimated, Requested and Planned) and the actual event.

Figure 11. Cycle of Planning Events

Other standards of DCSA include:

- the Operational Vessel Schedules standard which enables the automatic sharing of vessel schedule data and exception-related information between carriers, operational partners (i.e., terminals), and their solution providers,
- the Commercial Schedules standard which creates a common way for carriers to communicate vessel schedule information to customers. With the DCSA CS standard in place, customers can expect to receive high-quality data about their container shipments regardless of which carrier is transporting them. CS expands the scope of the DCSA operational vessel schedule (OVS) standard with three options for accessing schedules from carriers:
    - Point-to-Point Routing: provides single or multiple end-to-end routing options with estimated timestamps during the pre-booking phase.
    - Port Schedule: provides estimated timestamps for all vessels arriving and departing from a defined port/terminal on a given date.
    - Vessel Schedules: provides estimated departure and arrival times for a required service, voyage or vessel, for each port call on the vessel's rotation.
- the Track & Trace standard (T&T) which establishes a technological foundation for continuous visibility into container whereabouts and operational events along the end-to-end container journey. Using interoperable data models, standardised data definitions and APIs, DCSA T&T standards enable the seamless, real-time exchange of digital shipping data between all stakeholders regardless of platform.
- Standards on Cargo Booking and the electronic Bill of Lading.

4.1.4. Terminal Industry Committee (TIC4.0) Standards

The Terminal Industry Committee (TIC4.0) is a worldwide initiative promoted by the port industry to foster the development of unified digital standards. Established in 2018 and endorsed by the Federation of European Private Port Companies and Terminals (FEPORT) and the Port Equipment Manufacturers Association (PEMA), its main focus lies on achieving a common standard that will allow objective comparisons of equipment/systems and define a format for electronic data exchange. Among its members are port operators, digital service providers and suppliers, terminal equipment manufacturers, Terminal Operating Systems (TOS) suppliers and media partners. Furthermore, TIC4.0 maintains regular contact with officially recognised international standardisation bodies with the long-term

goal of achieving the “international standard” status. To this date (September 2024), the association is composed of 58 active members and has published a total of 10 Technical Releases[2].

At the core of the TIC4.0 standard lie a data model and common semantics. Both are regularly updated[3] by the internal Task Forces that discuss, curate and create them based on the contributor’s experience and requirements. The semantics’ format follows a “Subject-Object-Concept-Observed Property-Value” format, closely based on the human language. In order to fully understand the technical possibilities, the TIC4.0 language could bring for JIT port arrivals and the optimisation on port calls, a detailed description of the data model and semantics is provided in the following sections.

4.1.4.1. TIC4.0 Internal Workflow

The daily activities of the association are managed by two decision-making bodies: the Executive Council and the Operations Council. Mainly tasked with upper management and external representation duties, the Executive Council is responsible for decisions affecting the overall goals and targets of the institution. In turn, the more technical tasks are overseen by the Operations Council, which bears the responsibility of the technical development roadmap, the functioning of the various working groups and the Review Board. As explained before, these, called “Task Forces”, are composed by experts sent by the members to discuss and define the various concepts underpinning both TIC4.0’s Data Model and Semantics. Any member is entitled to participate in an existing Task Force or propose and sponsor the creation of a new one on a field of interest with the approval of the Operations Council. Their participation is done on a voluntary basis.

Similar to how an ISO/CEN[4] committee works, these bodies are composed by a Task Force Leader and a group of expert collaborators. These meet on regular intervals to discuss and define the concepts for new releases and revising existing content as required. Once consensus is achieved, the content is sent for reviewing and editing to the Review Board, who then distributes it to the general public.

4.1.4.2. Semantics

The main innovation of TIC4.0 is the common language and semantics, designed to model the physical flow and reality of port operations. This is achieved by using harmonised definitions and an ontology that combines five main elements: a “Subject”, a “Concept”, an “Observed Property”, a “Measurement Point” and a “Value”.

A typical TIC4.0 message is structured as follows:

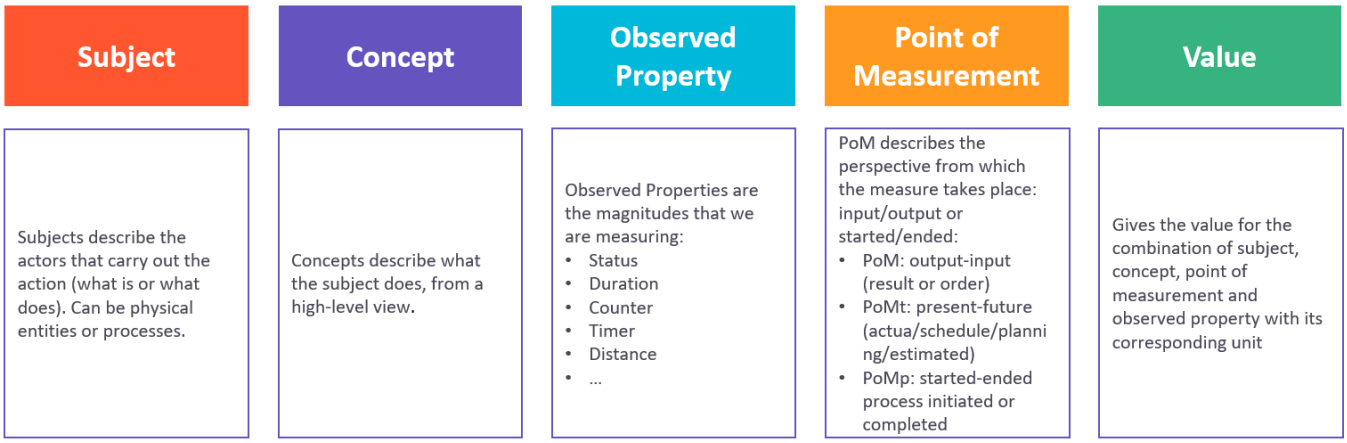
- *Header: It identifies the message in its origin (or destination), time of reference for the message and a unique identifier/reference.*
- *Subject: Who or which entity is executing an object (object as per TIC4.0’s semantics) or embodying a concept.*

[2] Available for download at www.tic40.org
[3] Usually twice per year. Special releases may happen if required (corrections, monographics, etc.).
[4] The European Committee for Standardization (CEN) is a private non-profit organization whose mission is to promote the European economy in the global marketplace, the well-being of European citizens, and the environment by providing an efficient infrastructure for stakeholders to develop, maintain, and distribute consistent specifications and standard systems (Ministerio de Agricultura, Pesca y Alimentación, España., 2024).

- *Concept: Refers always to a particular subject (or subject-subsystem) specifying what the subject is (status) or does (action-event);*
- *Observed Property: How much is the magnitude of the concept (status, pieces, length, volume weight, energy, time, speed, power, duration, acceleration, etc.) represented in the value.*
- *Point of Measurement: Defines where in place and time (past, present and future) the value representing the concept of observed property of the subject is measured and represented.*
- *Value: A "value" in TIC4.0 is defined as "the actual measured result for a specific combination of the TIC4.0 semantic items "time of measurement", "subject, concept and observed property", and "point of measurement. The same value can be represented in several units.*

The figure below shows the structure of TIC4.0's semantics in a graphical way:

Figure 12. Structure of the TIC4.0 semantic. (Terminal Industry Committee 4.0, 2024)



By combining these five elements in a single sentence, it is possible to represent any reality in the port logistics environment. This semantics is currently represented in a digital data format, mostly using JSON, but it is also possible to use other formats such as XML or FLAT.

Figure 13. Example of a TIC4.0 JSON message. (Terminal Industry Committee 4.0, 2024)


```
{
  "msg": {
    "id": "D6wZ6ngBBIsOzhTbxvHG",
    "sender": "",
    "timestamp": "2021-04-19T12:24:26.931Z",
    "topic": "",
    "destinantion": "",
    "creationtimestamp": "2021-04-19T12:24:26.931Z",
    "starttimestamp": "2021-04-19T12:24:26.931Z",
    "endtimestamp": "2021-04-19T12:24:26.931Z"
  },
```

```
"id": "",
"name": "",
"number": 0,
"type": "",
"family": "",
"brand": "",
"model": "",
"location": {
 "logical": [
  {
   "pom": "ioutput",
   "pomt": "actual",
   "timestamp": "2021-04-19T12:24:26.931Z",
   "qualifier": "yard",
   "value": "Y 01A 035 B 3",
   "block": "01A",
   "row": "035",
   "bay": "B",
   "tier": "3"
  }
 ],
```

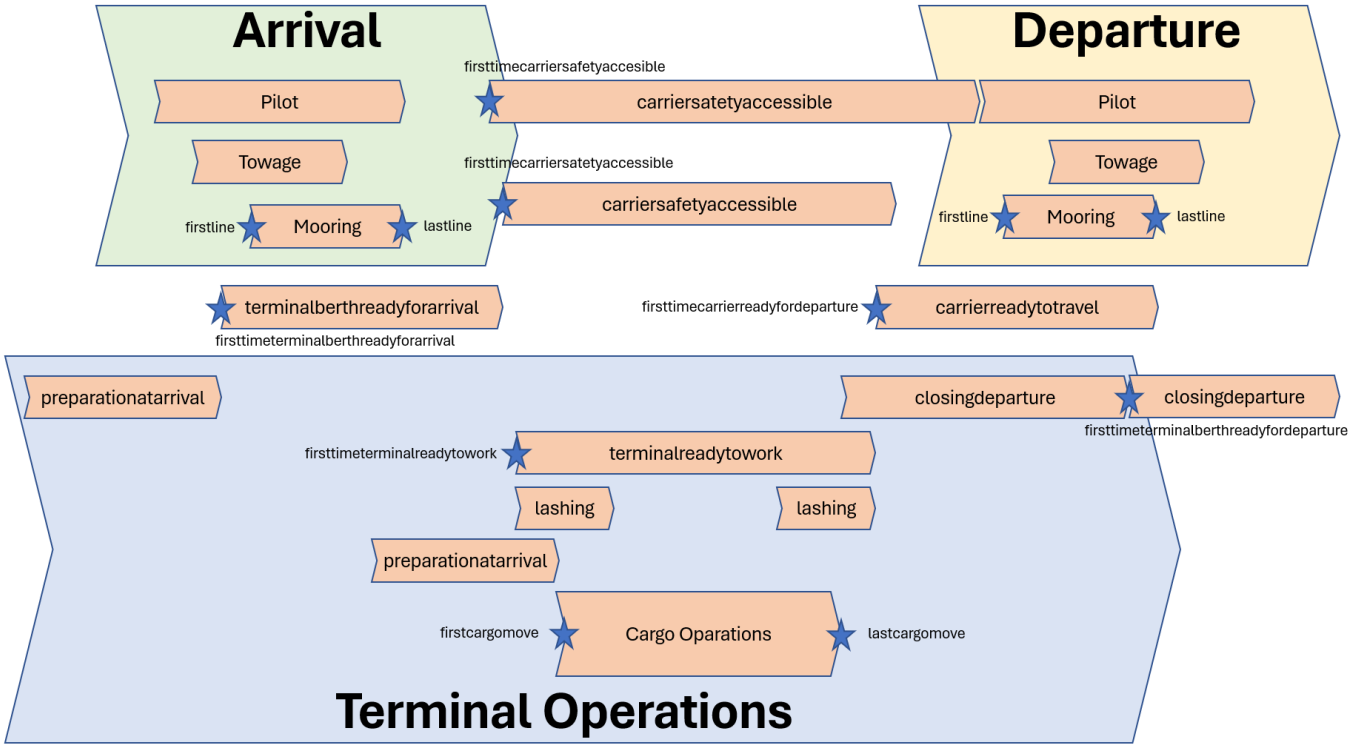
```
"energy": {
 "consumed": [
  {
   "pom": "output",
   "pomt": "actual",
   "name": "electricity",
   "starttimestamp": "2021-04-19T12:24:26.931Z",
   "endtimestamp": "2021-04-19T12:24:26.931Z",
   "timestamp": "2021-04-19T12:24:26.931Z",
   "unit": "kwh",
   "value": 0
  },
```


The figure (Figure 13) shows a message recording the consumption of “0 kWh” of electricity of a Container Handling Equipment (CHE) machine, located at the terminal’s yard, and which is going to pick a container located at the 01a 035, bay B, Tier 3 position:

4.1.4.3. Standards in the Context of the Port Call Process:

As previously mentioned, the TIC4.0 standards focus on the processes and operations that occur in the context of container port terminals. However, due to the adaptability of the semantics to other realities, it is possible to expand the standards to processes and operations of different natures. The technical development of the standards, at the time of writing this report, is primarily divided into the representation of processes controlled by the Terminal Operating System (TOS) and the ability to represent the state of equipment. These two realities are captured in the development of two data models to be transmitted in a digital context. The representation of operational processes corresponds to the TOS Data Model, and the representation of equipment corresponds to the CHE Data Model.

Figure 8. Carrier Visit Events from Terminal Perspective.



Within the standards developed by TIC4.0, those related to port call processes, although designed and developed from the perspective of container port terminals, have considered compatibility with standards such as those of DCSA. Among the processes defined by TIC4.0, those related to port calls are grouped under Carrier Visit and Cargo Visit.

- *Carrier Visit: "Describes the process of a carrier (vessel, truck, barge, train) passing through a terminal (visiting the terminal) to load or unload cargo, or utilize other 3rd party-services (e.g. bunkering, garbage disposal, etc.)". (Terminal Industry Committee 4.0, 2024)*
- *Cargo Visit: "Lifecycle of cargo at a terminal from arrival until departure (both included)". (Terminal Industry Committee 4.0, 2024)The aim in defining Carrier Visit is to identify the most relevant events that must be considered to develop an autonomous operation, capable of representing all possible states of the entities in the process. However, as mentioned earlier, the potential value of TIC4.0 semantics lies in its ability to*

represent not only events but also, and more importantly, the states of all entities and the process itself. This way, the richness of the information allows for more precise identification of how the process has been performed and, crucially, enables processes to be moved to an autonomous environment. Such an environment needs to represent complex realities and all their eventualities, given its inability to spontaneously react to unforeseen situations. In the following figure, all the events and states defined by TIC4.0 to represent the arrival, stay, and departure of a vessel at a terminal are shown. As can be seen, the stars symbols represent events, and the arrow boxes symbols represent the state of the entity and/or process. The Carrier Visit process consists of three main subprocesses, which are Arrival, Terminal Operations, and Departure.

The implementation of Industry TIC4.0 standards is not limited solely to the realm of port terminals, as previously discussed. The applicability of such solutions highlights the importance of interoperable standards to enable greater resilience in operations.

4.1.5. Baltic and International Maritime Council (BIMCO)

The Baltic and International Maritime Council (BIMCO) is an important player in the global maritime industry, providing a wide array of services including standardized contracts, clauses, regulatory guidance, and market analysis. Its initiatives significantly impact the efficiency and sustainability of maritime operations, particularly in the port call process and JIT standardization efforts.

BIMCO and the Port Call Process

The port call process involves several stages, from the vessel's approach to port, cargo operations, and departure. BIMCO plays a crucial role in streamlining this process by:

- *Standardized Contracts and Clauses: BIMCO's standardized contracts and clauses facilitate clear communication and reduce legal disputes among stakeholders. These tools help manage expectations and responsibilities during port calls, ensuring smoother operations.*
- *Digitalization and Efficiency: BIMCO promotes the digitalization of port call procedures, advocating for the use of electronic data interchange (EDI) systems. This reduces paperwork, minimizes delays, and enhances the accuracy of information exchanged between ships and ports.*
- *Collaborative Platforms: BIMCO encourages collaboration among port authorities, shipowners, and agents through platforms that share real-time information. This enables better coordination and reduces waiting times, leading to more efficient port calls.*

JIT Standardization Initiatives

JIT shipping is a strategy aimed at reducing idle time and fuel consumption by ensuring that ships arrive at the port when they are ready to berth. BIMCO supports JIT through:

- *Guidelines and Best Practices: BIMCO develops guidelines that outline best practices for JIT operations. These guidelines help shipowners and operators plan their voyages more effectively, reducing unnecessary fuel consumption and emissions.*

- *Data Sharing and Predictive Analytics: BIMCO advocates for the use of predictive analytics and data sharing among maritime stakeholders. By leveraging data on port congestion, weather conditions, and berth availability, ships can optimize their arrival times and reduce waiting periods.*
- *Regulatory Frameworks: BIMCO works with international regulatory bodies to develop frameworks that support JIT initiatives. This includes advocating for regulations that encourage ports to provide timely and accurate information to incoming vessels.*

Operational-Focused Standards

BIMCO's development operational-focused standards enhances the overall efficiency and safety of maritime operations. Key aspects include:

- *Safety and Compliance: BIMCO provides comprehensive resources on safety standards and regulatory compliance. This ensures that maritime operations adhere to international safety norms, reducing the risk of accidents and environmental incidents.*
- *Training and Education: BIMCO offers training programs and educational resources for maritime professionals. These programs focus on operational best practices, safety protocols, and regulatory updates, fostering a knowledgeable and skilled workforce.*
- *Sustainability Initiatives: BIMCO is actively involved in promoting sustainability within the maritime industry. It provides guidelines on environmentally friendly practices, such as reducing emissions and managing ballast water, contributing to the industry's long-term sustainability goals.*

Regarding the liner sector, owners and operators of container ships typically allow in the contracts the adjustment of the speed of the ship for commercial purposes. Whereas in the bulk shipping sector, ships are required as per their contract to arrive at the discharge port as fast as safely possible via the most direct route without unreasonable delay.

Contracts that incorporate virtual arrival clauses are now in use and are bilateral agreements between the owner(s) and the charters and not with the terminal. There is however a reluctance to charter ships on this basis due to limited applications where the charters are also the terminal operators and cargo owners. That said, if a virtual arrival scheme has been agreed between the owners and the charters, the owners can then issue a Notice of Readiness (NOR) prior to the physical arrival of the vessel and is then able to perform cargo operations.

It is worth mentioning that bulk cargo can be bought and sold numerous times during the ship's voyage, whilst the charters remain the same. As such, all owners are required to be in agreement with the charterparty's terms and ensure there are no disagreements in regard to the obligations towards 3rd party bill of lading holders.

In terms of implementing JIT, the procedure starts with the terminals and/or the receivers of cargo adjusting their terms and conditions by which charterers and/or owners are provided with clarity.

4.1.6. International Association of Ports and Harbours (IAPH)

The International Association of Ports and Harbours (IAPH) was founded in November 1955 as a trade association for port authorities and operators. 177 ports and 147 port-related businesses in 84 countries use the organisation to represent their interests at regulatory level at the International Maritime Organization (IMO), the World Customs Organization, the International Standards Organization and other global alliances such as the Global Maritime Forum and the World Economic Forum. Furthermore, IAPH has consultative status and works on behalf of ports in additional

D1.1. ASSESSMENT AND ALIGNMENT OF ON-GOING JIT / PORT CALL OPTIMISATION STANDARDISATION INITIATIVES INCLUDING LEGAL FRAMEWORKS

United Nations bodies such as the United Nations' Conference on Trade and Development (UNCTAD), United Nations Environmental Program (UNEP) and the UN Global Compact (IAPH, 2023).

Among the ultimate goals of IAPH is the aspiration to become the industry reference for sharing best practices of the more technologically advanced ports worldwide, including the following topics (IAPH, 2023):

- *Climate and Energy: energy transition and innovation, decarbonisation and emissions reduction at ports and in all ship-to-shore interfaces*
- *Data Collaboration: act as an industry leader in collaborating with other industry partners such as ICS, BIMCO and private sector to improve data orchestration between ports and their stakeholders, improving efficiency, creating synergies and reducing emissions by eliminating berth waiting times*
- *Risk and resilience: develop resilience strategies against major disruptive challenges such as the COVID-19 pandemic or the global financial crisis*

The IAPH also promotes the following initiatives (IAPH, 2023):

- *IAPH World Ports Sustainability Program (WPSP): The WPSP was created to assist ports in the practical application of the UN's 17 Sustainable Development goals. Aimed at enhancing and improving future sustainability efforts of ports worldwide, it fosters international cooperation with other partners in the supply chain. Currently, the Program has reached the milestone of 200 registered projects by IAPH members and their partners in the fields of resilient infrastructure, climate and energy, safety and security, community outreach and governance.*
- *Environmental Ship Index: The IAPH port industry incentive scheme – ESI, established in 2011, provides the shipping industry with the measurements on the environmental footprint of merchant vessels. This way, ports can serve as incentive providers to reward vessels demonstrating clear improvements in emissions performance. The index became the industry standard tool: over 6,700 cargo and passenger ships and 60 worldwide incentive providers are registered on the scheme.*
    - *The advancements of the Index have led to its professionalisation, having become a subsidiary of IAPH and externalised to the Green Award Foundation (GAF). Furthermore, a new "at berth" module has been developed to measure the emissions performance of a given vessel at a port call.*
- *IAPH Clean Marine Fuels Working Group: This Working Group strives to offer ship owners a broad spectrum of alternative fuels as possible to improve air quality and reduce GHG emissions in and around ports and harbours. Apart from having achieved a unique compendium of insights into alternative marine clean fuels and the application of standards in practice for bunkering at ports, the Working Group regularly cooperates with standards agencies, industry associations, classification societies, oil majors, terminals, bunker operators and ship owners. The ultimate aim is to develop practical tools for ports that facilitate safe and efficient bunker operations for existing and future low and zero-carbon vessels.*
- *IAPH Women's Forum: The International Association of Ports & Harbors (IAPH) established the Women's Forum on May 22, 2012, to empower women in the maritime industry. The Forum focuses on discussing women's issues, attracting and retaining female talent, and promoting training programs to help women compete for all levels of positions in the industry. It has initiated measures like the IAPH Women's Forum Scholarship and collaborates with organizations such as WISTA and the IMO's Women in Maritime Program. Open to all women, the Forum offers networking, best practice sharing, and professional development opportunities.*

4.2. Digital-Focused Standards

Just as with documented operational and administrative standards, it is crucial to analyze the context of standardization initiatives in the digital domain. This is particularly important because the digital medium is essential for the effective implementation of JIT arrival processes, where overcoming barriers related to information exchange and protocols is vital. In this section, the goal is to identify and define the initiatives, organizations, and entities dedicated to advancing standardization in the realm of digitalization.

4.2.1. IHO International Hydrographic Office

The International Hydrographic Organization (IHO), founded in 1921, is an intergovernmental body that oversees the surveying and charting of the world's seas, oceans, and navigable waters. The IHO works closely with national hydrographic offices to ensure consistency in nautical charts and documentation, and it provides best practices and guidelines to improve the use of hydrographic survey data. Additionally, the organization supports the development of hydrographic skills within its Member States.

Hydrography underpins a wide range of maritime activities, such as safe navigation, marine resource management, environmental protection, and maritime defence. It is essential for understanding and adapting to the ever-changing marine environment, influenced by factors like climate change and tidal movements. For instance, precise depth data can significantly boost economic efficiency by allowing ships to carry more cargo safely. Each Member State of the IHO is represented by its national authority responsible for hydrographic and nautical charting services, with the organization's operations managed by an elected Secretary General and two Directors.

The scope of the IHO encompasses the development and revision of technical standards related to hydrography. These standards, governed by the principles and procedures outlined in the M-3 2/2007 resolution, include product specifications and validation data sets, which are treated as standards. However, these procedures do not apply to non-technical publications, GIS services, or supporting documents. The IHO maintains a categorized list of standards, some of which require an impact study and multiple levels of endorsement, while others only need committee approval and Member States' consent, as detailed in the M-3 2/2007 appendices.

IHO's Products, Standards, and Tools:

Production of Electronic Nautical Charts (IHO, 2024):

The S-57 "Transfer Standard for Digital Hydrographic Data" is the key standard established by the IHO for the exchange of digital hydrographic data among national hydrographic offices and its distribution to manufacturers, mariners, and other users.

The S-57 serves as the essential framework for creating Electronic Nautical Charts (ENCs). It specifies the characteristics of objects, attributes, and data encoding formats, as well as providing a detailed product specification and update protocol. In summary, the S-57 standard outlines the necessary guidelines for producing and maintaining ENCs.

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S-100 Universal Hydrographic Data Model:

To meet the evolving needs for digital products and services, the IHO created the S-100 Universal Hydrographic Data Model. This model supports future requirements by providing a flexible framework. The IHO Geospatial Information Registry houses multiple registers that include carefully managed lists of concepts, feature attributes, metadata, and other essential resources used in the development of product specifications.

A S-100 Product Specification is a blueprint for creating specific nautical data products. Beyond describing the data, itself, it encompasses supplementary components like feature and portrayal catalogues, encoding guides, and data formats. The S-97 guidance document, accessible on the GI registry, provides instructions for developing these specifications. A wide range of S-100 product specifications have been established internationally, each addressing particular maritime requirements.

The following list corresponds to the various standards in the S-100 series (S-101 to S-199) (IHO, 2024):

- *S-101 Electronic Navigational Chart (ENC)*
- *S-102 Bathymetric Surface*
- *S-103 Sub-surface Navigation*
- *S-104 Water Level Information for Surface Navigation*
- *S-111 Surface Currents*
- *S-112 Open - (See Decision HSSC9/38)*
- *S-121 Maritime Limits and Boundaries*
- *S-122 Marine Protected Areas*
- *S-123 Marine Radio Services*
- *S-124 Navigational Warnings*
- *S-125 Marine Aids to Navigation (AtoN)*
- *S-126 Marine Physical Environment*
- *S-127 Marine Traffic Management*
- *S-128 Catalogue of Nautical Products*
- *S-129 Under Keel Clearance Management (UKCM)*
- *S-130 Polygonal Demarcations of Global Sea Areas*
- *S-131 Marine Harbour Infrastructure*
- *S-164 IHO Test Data Sets for S-100 ECDIS*

The Impact of IHO Standards on JIT Arrival:

The IHO and its standards, particularly those in the S-100 series, play a crucial role in enhancing the efficiency of maritime operations, including the implementation of JIT arrival strategies for port calls. The S-100 Universal Hydrographic Data Model provides a flexible framework for integrating various digital hydrographic products, such as ENCs, bathymetric surfaces, and water level information, which are essential for precise navigation and port planning. By adhering to the S-57 standard for data exchange and incorporating the S-100 standards for advanced data integration, maritime operators can achieve highly accurate and timely information on marine conditions. This ensures that vessels can optimize their arrival times, reduce waiting periods at ports, and streamline their docking schedules.

Moreover, the IHO's development of standards like S-101 for Electronic Navigational Charts and S-104 for water level information supports real-time data availability and interoperability among different systems. This facilitates better coordination and decision-making in port operations, which is critical for JIT arrival. The S-97 guidelines for creating product specifications further ensure that the data used in these processes is consistently high-quality and up to date. By leveraging these standards, ports and shipping companies can enhance their operational efficiency, reduce delays, and improve overall supply chain performance, aligning with the principles of JIT arrival and optimizing maritime logistics.

4.2.2. International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Standards

The International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) is a pivotal organization in maritime navigation, established to ensure that vessel movements are safe, efficient, and environmentally sound. IALA's primary focus is on harmonizing marine aids to navigation (AtoN) globally, fostering the efficient and safe movement of vessels.

Role in the Port Call Process

IALA plays important role in the port call process by developing standards and best practices that enhance the predictability and efficiency of maritime operations. The port call process involves several steps, including pre-arrival, arrival, operations, and departure. IALA's guidelines and recommendations help streamline these phases, reducing delays and optimizing resource utilization.

- *Pre-Arrival Phase: IALA's standards for information exchange and communication protocols ensure that all stakeholders have timely access to essential information. This preparation minimizes the risk of last-minute changes and improves scheduling accuracy.*
- *Arrival and Operations: During these phases, IALA's focus on accurate positioning and reliable navigation aids ensures that vessels can safely and efficiently navigate to their berths. This is facilitated through the use of advanced Aid to Navigation (AtoN) and VTS (Vessel Traffic Services).*
- *Departure: IALA's guidelines support the coordination required for timely departures, contributing to the overall efficiency of port operations.*

JIT Standardization Initiatives

- *JIT shipping is a strategic approach aimed at minimizing waiting times and improving the synchronization of vessel arrivals with berth availability. IALA's role in JIT standardization is crucial for enhancing the predictability and efficiency of maritime logistics.*
- *Information Exchange Standards: IALA's standards for digital data exchange, including the S-200 series, enable seamless communication between vessels and port authorities. This real-time information exchange is vital for JIT operations, allowing for precise scheduling and reduced idle times.*
- *Virtual Arrival: IALA supports the concept of virtual arrival, where vessels adjust their speed to arrive at the optimal time, reducing fuel consumption and emissions. By setting standards for communication and data exchange, IALA facilitates the implementation of virtual arrival practices.*

Operational-Focused Standards

IALA's operational standards are designed to ensure that maritime operations are conducted safely and efficiently. These standards cover various aspects of navigation and traffic management, including:

- *Vessel Traffic Services: IALA's VTS standards provide guidelines for the design and operation of traffic management systems. These systems enhance situational awareness and support decision-making, critical for managing port traffic and ensuring safety.*
- *Marine Aids to Navigation: IALA sets standards for the deployment and maintenance of AtoN, such as buoys, beacons, and electronic navigation aids. These standards ensure that vessels can navigate safely, even in challenging conditions.*
- *S-200 Standards Series: The S-200 series, including S-212 for VTS Traffic Clearance Service, provides detailed specifications for data formats and information exchange protocols. These standards are essential for achieving interoperability and enhancing the efficiency of maritime operations.*

S-212 VTS Traffic Clearance Service

The S-212 standard for the VTS Traffic Clearance Service is one specific implementation within the broader S-212 data model. This implementation focuses on the communication of traffic clearance messages, which are essential for managing vessel movements and ensuring navigational safety within VTS areas. The S-212 data model encompasses a wide range of data elements and functionalities, providing a baseline for other functional services as well.

The S-212 Traffic Clearance Service specifies the requirements for traffic clearance messages, ensuring that vessels receive timely and accurate information regarding their navigation status and any restrictions or instructions from VTS centres.

- *Standardized Messages: S-212 defines the structure and content of traffic clearance messages, promoting consistency and clarity in communication.*
- *Interoperability: By adhering to S-212, VTS centres and vessels can ensure that their systems are interoperable, facilitating smooth and efficient information exchange.*
- *Enhanced Safety and Efficiency: The standardization of traffic clearance messages enhances the safety and efficiency of maritime operations, reducing the risk of misunderstandings and delays.*

4.2.3. International Electrotechnical Commission (IEC) Standards

The International Electrotechnical Commission (IEC), a global, non-profit organization, plays a crucial role in promoting quality infrastructure and international trade in electrical and electronic goods. By bringing together experts from over 170 countries, the IEC establishes technical standards and conformity assessment systems that ensure the safety and reliability of products worldwide. These standards, such as IEC 63173-2 SECOM, provide a framework for governments to develop national quality infrastructure and businesses to trade consistently safe products. This work contributes to technological innovation, sustainable energy access, and climate change mitigation, ultimately improving safety and environmental protection.

IEC 63173-2 SECOM Ed. 1 05-2022, SECOM – Secure Communication Between Ship and Shore

The ongoing digitalization in the maritime domain induces the need for secure data transmission. With the exchange of business-critical data or even security relevant data (e.g., routes in term of piracy prevention) via IP-connection (satellite, 4/5G, VDES, or other means) a secure data exchange has to be enabled. To maintain interoperability, the exchange has to be standardized, especially hence the global nature of the maritime domain.

The SECOM standard targets the facilitation of secure communication between ship-to-shore and vice versa. Especially the interface for data exchange between machine-to-machine with an application programming interface (API) is the target for SECOM. The service interface and data exchange model are defined as a REST interface until the interface between SECOM and the end-user application. SECOM is designed for IHO S-100 based products but generally payload agnostic, so any data can be transmitted. Also, the scope includes information security for secure data exchange and an interface for service discoverability. This part of SECOM contains the description of a public key infrastructure (PKI) for authentication and validation of persons, ships, organizations or devices. The public and private key are based on the X.509 PKI standard. In the globalized maritime domain, actors have to exchange information with one another without any previous engagement, or when the information exchanged is confidential for various reasons. Consequently, the need arises to authenticate and authorize actors, so that a secure communication can be established. The PKI can be provided by any recognized provider that complies with the SECOM requirements on PKI. SECOM allows multiple instances of the PKI, e.g., different instances for different regions for the establishment of a decentralized trust system, fitted for the maritime domain. Also, this contributes to the globalized aspect of the maritime domain, that there is no one entity that everyone trusts. So, the intention is, that there are multiple instances parallel that are hosted by multiple providers and actors can transfer between these instances along their journey.

The following clauses are listed in the SECOM Standard:

- *Clause 5 SECOM information service interface.*
- *Clause 6 SECOM communication channel security.*
- *Clause 7 SECOM data protection.*
- *Clause 8 SECOM public key infrastructure.*
- *Clause 9 SECOM service discovery service interface.*
- *Clause 10 SECOM error cases.*
- *Clause 11 Test methods and expected results.*

Relevance of SECOM for MISSION

For the JIT optimization of port calls data exchange in real time is vital. However, many of the exchanged information can be business sensitive or protected by the GDPR, so the information cannot be shared via an open information exchange channel, like VHF nowadays. Also, many of the processes of getting or updating real-time information are done manually. The goal of SECOM is to address these issues by enabling a secure ship-to-shore connection that is designed for the maritime environment and is designed that it can be used for machine-to-machine data transfer to automate communication where no human interaction is really needed.

The SECOM-PKI can contribute to authentication and authorization of information when many different actors have to communicate during the port call process. The authentication can facilitate trust and therefore lowers the barrier that actors communicate in general. A running instance of a SECOM-PKI is the Maritime Connectivity Platform (MCP). A more detailed description of the MCP SECOM-PKI is given in Annex D.6 in SECOM. The two main

components of the MCP is the Maritime Identity Registry (MIR) and the Maritime Service Registry (MSR), that are designed to facilitate secure discovery of maritime services, e.g. navigational warnings (S-124) or ice information (S-411) and valid identification and authorization of actors, so that the information distributed can be verified, e.g. to a national hydrographic office.

One of the most important standards is IEC S-421, as it is a crucial specification for the exchange of route plan information, developed within the framework of the S-100 product specification series. It provides a standardized format and structure for representing route plans, ensuring seamless communication and interoperability between different maritime systems and applications. By adhering to the S-421 standard, organizations can create consistent and comprehensive route plans that can be easily shared and utilized by various stakeholders, including vessel operators, navigation systems, and port authorities. This standardization facilitates efficient voyage planning, enhances safety at sea, and promotes data integration across the maritime industry.

4.2.4. United Nations rules for Electronic Data Interchange for Administration, Commerce and Transport (UN/EDIFACT) Standards

UN/EDIFACT (the United Nations rules for Electronic Data Interchange for Administration, Commerce and Transport) provides a set of rules and guidelines for structuring messages for various business transactions. EDIFACT messages follow a specific syntax or format, defining how segments and data elements are structured within the message. This syntax includes rules for segment and data element delimiters, segment termination, and character encoding. Each segment consists of data elements, and each data element contains specific information about the transaction. Segments are identified by a three-letter code (e.g., UNH for message header, BGM for beginning of message, etc.). Data elements are identified by numerical codes and have predefined formats and lengths. For example, a data element might represent a date, a quantity, a code indicating a specific type of product, etc.

Recommended within the framework of the United Nations, the rules are approved and published by UNECE in the United Nations Trade Data Interchange Directory (UNTDID) and are maintained under agreed procedures. The UNTDID is a repository of data elements, segments, and messages used in UN/EDIFACT. It serves as a reference for developers and businesses implementing EDI systems, ensuring consistency and interoperability across different implementations. By referencing the UNTDID, businesses and software systems can ensure that their EDIFACT messages adhere to the standard, making it easier to exchange data with trading partners and comply with regulatory requirements. The most important UNTDID directories are:

- *Data Element Directory (DED): This directory contains definitions of individual data elements used in EDIFACT messages. It includes the numerical codes, descriptions, formats, and other attributes of each data element.*
- *Segment Directory (SED): The Segment Directory defines the segments used in EDIFACT messages. It provides information about the structure, purpose, and usage of each segment.*
- *Message Type Directory (MTD): This directory defines the structure and composition of specific message types used in EDIFACT. It specifies which segments are included in each message type and their order of appearance.*

UN/EDIFACT messages are typically transmitted over electronic communication protocols like AS2 (Applicability Statement 2), SFTP (Secure File Transfer Protocol), VANs (Value-Added Networks) or using more recent web service protocols such as SOAP (Simple Object Access Protocol) or REST (Representational State Transfer).

UN/EDIFACT messages related to port calls are (UN/EDIFACT, 2024):

- *BERMAN (Berth Management): a message from a carrier, its agent or means of transport to the authority responsible for port and waterway management, requesting a berth, giving details of the call, vessel, berth requirements and expected operations.*
- *IFTSAI (International Forwarding and Transport Shipments and Transport Instructions): a message from/to a liner agent to/from a local authority (e.g., port authority), Container terminals, Schedule Portal or consortia member lines, to inform the parties of the long-term schedule, mid-term schedule, short term schedule or schedule updates, giving information on the actual vessel schedule information and container or cargo operations.*

4.2.5. International Organization for Standardization (ISO) 28005

The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies (ISO member bodies). ISO 28005 defines standards on ships and marine technology related to Electronic Port Clearance and is divided in three parts.

Part 1 (ISO, 2024): defines the general message format, the general message exchange patterns, and the transfer protocols. It also specifies a transport protocol, the basic message exchange patterns and the responsibilities of each party in the message exchange. Furthermore, it specifies how more specific message implementation guides (MIGs) are provided for each type of communication application.

Part 2 (ISO, 2024): contains the definition of core data elements for use in electronic port clearance (EPC) messages. It contains definitions of core data elements for electronic messaging between ships and shore in the areas of safety, security and marine operations. It does not define any structuring of messages or provide any guidance on what information is required for a particular purpose; it is rather a general data dictionary for safety, security or operation-related maritime information.

Part 3 (ISO, 2024): defines basic message exchanges and data elements used in the coordination of actors at sea and land in conjunction with a ship's port call. This will be related to the planning and execution of certain processes related to port calls, e.g., berth allocation, arrival and departure. The scope covers vessel movements, geographical positions, and time stamps. An important part of this is to provide information and proposals to the port and shipping sectors as well as port and maritime administrations on how to facilitate JIT Arrival of ships – with a view to reducing GHG emissions by optimizing the port call business process and providing sustainable solutions to customers in the end-to-end supply chain.

The ISO 28005 standard is directly linked to JIT arrivals. Specifically, Part 3 of the standard addresses the coordination of actors at sea and land during a ship's port call, including planning and executing processes like berth allocation, arrival, and departure. By providing information and proposals to port and shipping sectors, ISO 28005 aims to facilitate JIT arrivals and optimize the port call business process, thereby reducing GHG emissions and offering sustainable solutions to customers throughout the supply chain. This alignment between ISO 28005 and JIT arrivals demonstrates the standard's crucial role in enhancing efficiency and sustainability in the maritime industry.

4.3. Other Standards

In addition to the well-defined roles of standardization and regulatory bodies within the digital and operational spheres, there exist other organizations whose areas of focus are less delineated. Despite this, these organizations play a crucial role in shaping industry practices by setting standards and providing references. These standards and references serve as guiding principles for a wide array of institutions and corporations operating within supply chains. By establishing best practices and facilitating interoperability, these organizations contribute significantly to the efficiency and effectiveness of global logistics operations.

4.3.1. Digital Transport and Logistics Forum (DTLF)

The Digital Transport and Logistics Forum (DTLF) is a collaborative platform formed in 2015 comprising over 100 specialists. Since its inception, DTLF has served as a hub for constructive dialogue, technical assistance, and collaboration between the Commission, Member States, and industry players. The overarching aim of DTLF is to assist the European Commission in designing and implementing various initiatives and programs, particularly those related to digital advancements aimed at improving interoperability and data exchange.

Among other initiatives, a key focus area is supporting the implementation of Regulation (EU) 2020/1056 on Electronic Freight Transport Information (eFTI), as well as fostering Corridor Freight Information Systems to enhance data sharing and facilitate paperless transport (European Union - EUR-Lex, 2020).

Organizational Structure

To effectively address the complex challenges posed by these initiatives, DTLF operates through three distinct subgroups:

Subgroup 1: Digitalization of Transport Documentation

This subgroup endeavours to transition from paper-dependent processes to fully digital systems while maintaining security, transparency, and efficiency. Initially focused on identifying legal and technological hurdles, particularly regarding cross-border digitalization and interoperability, it now consists of four working teams dedicated to implementing the eFTI Regulation (EU) 2020/1056.

Subgroup 2: Corridor Freight Information System

With a focus on enhancing multimodal logistics and reducing reliance on specific transportation modes, this subgroup aims to establish seamless connectivity and data sharing among stakeholders. Similar to Subgroup 1, it operates through four working teams dedicated to technical specifications and fostering interoperability.

Subgroup 3: eFTI Delegated Acts

Established to support the development of regulations governing electronic freight transport information, this subgroup consults experts from Member States and facilitates consultations within DTLF. It ensures compliance with Regulation (EU) 2020/1056 and promotes innovation to overcome technical and procedural barriers.

4.3.2. The Electronic Freight Transport Information Regulation

The core work of DTLF, eFTI regulation in Europe aims to govern electronic information in the freight transport sector, addressing the need for standardized procedures across Member States. Its objectives include enhancing interoperability, operational efficiency, and communication among industry stakeholders. By promoting digitization, eFTI seeks to reduce costs, improve enforcement capabilities, and enhance the sustainability of transportation. Furthermore, this regulation encourages the use of digital technologies to meet regulatory requirements, reduce administrative costs, and ensure acceptance of electronically provided information by competent authorities. It also aims to guarantee consistent implementation of acceptance obligations and ensure interoperability of systems and solutions used.

Data exchange under eFTI will be facilitated through ICT systems and databases designed for document storage. Certification by a Conformity Assessment Body (CAB) is required for both platforms and service providers to ensure secure information exchange.

Lastly, the data model, adopted in June/July 2023, includes all information requirements aligned with legislation. Member States must adopt it by December 2025, though earlier adoption is encouraged if preparedness and certified platforms/providers are available.

5. Legal Aspects Framework

While organizations involved in standardization generally have positive impacts in terms of streamlining these port call optimization processes, they are not the only type of organizations that may pose challenges. The legal framework and organizations dedicated to regulating operational activities and processes have a significant impact on how regulations shape maritime and port operations. Therefore, it is important to describe these regulatory bodies, their scope, and the types of regulations they enforce to understand what needs to be considered to address this scenario, as well as the considerations and potential requirements to overcome any potential barriers.

5.1. International conventions

Description of those aspects of the relevant international conventions that may have a clear relation or could have an impact on JIT operations.

5.1.1. International Convention for the Safety of Life at Sea (SOLAS)

The SOLAS Convention, formally known as the International Convention for the Safety of Life at Sea, stands as a pivotal international treaty in maritime safety. Enacted in 1914 post the Titanic disaster, it has undergone numerous updates and amendments to address evolving safety concerns within the maritime industry. SOLAS mandates minimum safety standards governing ship construction, equipment, and operations.

Encompassing a broad spectrum of safety-related matters, SOLAS spans ship design, fire protection, life-saving apparatus, navigation safety, and maritime security. Its jurisdiction extends to all ships involved in international voyages, and certain domestic voyages based on vessel size and type.

The primary goals of the SOLAS Convention are to ensure the safety of life at sea, safeguard ship integrity, and preserve marine ecosystems. Compliance with SOLAS regulations are compulsory for all vessels under its purview, necessitating regular inspections to validate adherence to these standards. Flag States hold the responsibility of ensuring that vessels flying their flag adhere to the standards outlined in the convention. They utilize certificates as evidence of compliance. Additionally, Contracting Governments have the authority to inspect ships from other Contracting States if there are reasonable suspicions that the ship and its equipment do not meet the Convention's requirements. This process is referred to as Port State Control.

The SOLAS Convention is one of the most important international treaties governing maritime safety and is widely recognized as the most important legal instrument in the field of maritime safety. The structure of the SOLAS Convention is organized into various chapters and annexes, each addressing specific aspects of maritime safety. Here's a brief overview of its structure (IMO, 2024):

- *Chapter I: General Provisions - Sets out the scope and application of the convention.*
- *Chapter II-1: Construction - Covers the ship's structure, stability, subdivision, and watertight integrity.*
- *Chapter II-2: Fire Protection, Fire Detection, and Fire Extinction - Addresses fire safety measures onboard ships.*

- *Chapter III: Life-Saving Appliances and Arrangements - Specifies requirements for lifeboats, life rafts, and other life-saving equipment.*
- *Chapter IV: Radiocommunications - Covers requirements for ship communication equipment.*
- *Chapter V: Safety of Navigation - Focuses on navigational safety, including requirements for navigation equipment, charts, and voyage planning.*
- *Chapter VI: Carriage of Cargoes - Deals with the safe carriage of cargo, including requirements for cargo securing and dangerous goods.*
- *Chapter VII: Carriage of Dangerous Goods - Specific regulations for the carriage of dangerous goods by sea.*
- *Chapter XI-1: Special Measures to Enhance Maritime Safety - Addresses measures to enhance maritime safety, such as ship identification numbers and port state control.*
- *Chapter XI-2: Special Measures to Enhance Maritime Security - Covers requirements for maritime security, including ship security plans and security measures in ports.*
- *Chapter XII: Additional Safety Measures for Bulk Carriers - Specific safety measures for bulk carriers.*
- *Chapter XIII: Verification of Compliance - Outlines procedures for verifying compliance with SOLAS regulations.*
- *Chapter XIV: Safety Measures for High-Speed Craft - Addresses safety measures for high-speed craft.*
- *Chapter XV: Safety Measures for Ships Operating in Polar Waters - Specifies safety measures for ships operating in polar waters.*

The convention also includes various annexes that provide detailed technical specifications and requirements for different aspects of maritime safety. These annexes cover topics such as:

a. *International Safety Management (ISM) Code*
b. *International Ship and Port Facility Security (ISPS) Code*
c. *Global Maritime Distress and Safety System (GMDSS)*
d. *Certificates required under SOLAS*

The main focal area for JIT is Chapter IV regarding requirements for ship communication equipment, V, which regards the safety of navigation, as well as Chapter XI-2 regarding the ISPS Code.

SOLAS Chapter IV focuses on radiocommunications for ensuring maritime safety. The following information summarizes the main keys of this chapter:

- *Scope: This chapter outlines requirements for radio equipment onboard ships to facilitate communication for safety and operational purposes.*
- *Radio Equipment: SOLAS Chapter IV specifies the types of radio equipment ships must have, including distress, safety, and operational communication gear. It covers installation, frequencies, and power levels.*
- *Global Maritime Distress and Safety System (GMDSS): This chapter integrates the GMDSS, a globally recognized system for enhancing maritime distress and safety communications. It mandates that SOLAS-compliant ships be equipped with GMDSS-certified gear and receive appropriate training.*
- *Radio Watchkeeping: Ships are obligated to maintain a continuous radio watch on distress and safety frequencies, ensuring they can receive distress alerts and communicate with other vessels or shore stations during emergencies.*
- *Maintenance and Testing: SOLAS Chapter IV requires that radio equipment be adequately maintained and regularly tested to ensure operational readiness. This includes conducting radio surveys and maintaining detailed records of equipment inspections and tests.*

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Integrating JIT operations in shipping may affect adherence to SOLAS Chapter IV, which oversees radiocommunications and ship communication apparatus. JIT operations demand precise timing for communication exchanges, necessitating dependable and well-maintained equipment. Communication protocols might require adjustments to streamline coordination, while emergency communication capabilities must retain their effectiveness. Upholding regulatory compliance with SOLAS Chapter IV standards remains crucial to ensure seamless and secure communication, thereby supporting safe and efficient maritime operations in JIT scenarios.

SOLAS Chapter V primarily focuses on the safety of navigation. It outlines regulations and standards aimed at ensuring the safe operation of ships at sea. Here's an overview of the key aspects covered in SOLAS Chapter V:

- *Emphasis on Safe Navigation: SOLAS Chapter V underscores the significance of adhering to safe navigation practices, emphasizing the importance of maintaining a vigilant lookout, utilizing navigational aids, and adhering to international collision prevention regulations to mitigate the risk of accidents at sea.*
- *Requirements for Navigational Equipment: This chapter sets forth specific requirements regarding the installation, operation, and upkeep of navigational equipment onboard vessels. This encompasses radar systems, gyrocompasses, echo sounders, and other essential navigational instruments crucial for safe navigation.*
- *Mandate for Charts and Publications: SOLAS Chapter V mandates that vessels carry up-to-date nautical charts and navigational publications pertinent to their intended voyage. This ensures navigators have access to accurate and dependable information essential for effective route planning and navigation safety.*
- *Comprehensive Voyage Planning: Ships are obligated to conduct thorough voyage planning as per SOLAS Chapter V. This entails considering various factors such as weather conditions, navigational hazards, and traffic separation schemes. Adequate voyage planning minimizes the likelihood of accidents and promotes the efficient and secure transit of vessels.*
- *Ship Reporting Systems: The chapter may encompass provisions concerning mandatory ship reporting systems in designated navigational zones. These systems are designed to bolster maritime safety and streamline vessel traffic management for enhanced efficiency.*
- *Bridge Procedures: SOLAS Chapter V may also address bridge procedures, encompassing requirements for watchkeeping arrangements, communication protocols, and the utilization of bridge navigational aids. Adherence to proper bridge procedures is instrumental in maintaining situational awareness and averting navigational errors.*

The implementation of JIT operations in shipping, aimed at optimizing vessel arrival times at ports, can impact various aspects of maritime operations, including compliance with SOLAS Chapter V. This involves adjustments in navigation planning, bridge procedures, voyage planning, traffic management, and communication/reporting practices to align with JIT requirements while maintaining navigational safety standards outlined in SOLAS. Coordination between stakeholders is crucial to ensure that JIT practices enhance efficiency without compromising safety and regulatory compliance.

SOLAS Chapter XI-2 focuses on maritime security measures and incorporates the International Ship and Port Facility Security (ISPS) Code. The ISPS Code was developed in response to the increased threat of terrorism against the maritime industry following the 9/11 attacks.

Key aspects of SOLAS Chapter XI-2 and the ISPS Code include:

- *Security Mandates: The chapter delineates obligatory security standards for ships and port installations to forestall security breaches such as terrorism, piracy, and sabotage.*

- *Ship and Port Security Plans: Vessels must formulate and execute Ship Security Plans (SSPs) to mitigate security risks, encompassing measures like access control and cargo and personnel security. Similarly, Port Facility Security Plans (PFSPs) are imperative for port facilities, covering aspects like perimeter security and personnel training.*
- *Security Assessments and Audits: Both ships and port facilities undergo security evaluations to pinpoint vulnerabilities. Regular audits ensure compliance with ISPS Code requirements.*
- *Security Levels: The ISPS Code categorizes security threats into three levels (1, 2, and 3), each correlating with prescribed security measures for vessels and port installations.*
- *Security Communication: SOLAS Chapter XI-2 mandates seamless communication and collaboration among ships, port facilities, and relevant authorities to disseminate security-related intelligence promptly and mount effective responses to security incidents.*

The adoption of JIT operations in shipping may impact compliance with SOLAS Chapter XI-2, which encompasses the International Ship and Port Facility Security (ISPS) Code. Key considerations include adjustments to security plans, access control procedures, inspection protocols, communication mechanisms, and training efforts to ensure that JIT practices align with ISPS Code requirements without compromising maritime security standards. Coordination among stakeholders is essential to address these challenges effectively and maintain a robust security framework throughout the maritime transportation chain.

Overall, the SOLAS Convention provides a robust framework defining the minimum safety measures essential for protecting both human life at sea and the delicate marine environment. By upholding these standards, it promotes the safe functioning of ships on a global scale.

5.1.2. International Convention for the Prevention of Pollution from Ships (MARPOL)

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the major international convention that focuses on the prevention of pollution as applied to the marine environment by ships during their typical operations and/or from accidental effects. In this respect, the convention incorporates regulations seeking to prevent and reduce pollution emitted from ships. The convention covers 6 annexes (IMO, 2024):

- *Annex I – Regulations for the Prevention of Pollution by Oil. This annex covers the prevention of pollution of the marine environment from ships due to oil from either operational means, e.g., cargo operations or bunkering, or due to discharges from accidents, which may lead to significant environmental disasters. A later amendment to this annex made it obligatory for new oil tankers to be equipped with double hulls as well as the gradual implementation of double hulls to existing tankers, which was an important measure against oil pollution.*
- *Annex II – Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk. This annex covers the management of noxious liquid substances that are carried in bulk, including discharge criteria and the methods for their control. For example, it defines residues discharge specifications and allowances, which mostly refer to reception facilities in certain concentrations and conditions. Emissions from residues of noxious liquid substances is not permitted within 12 miles of the nearest land at no circumstance. In overall, it sets the context for the obligations of the ship operators regarding the management, control and discharge of Noxious Liquid Substances and their residues.*

- *Annex III – Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form. This annex covers the general prerequisites for the issuance of detailed standards covering packing, marking, labelling, documentation, stowage, quantity limitations, exceptions, and notifications. As part of this annex, the harmful substances are considered substances that are recognized as marine pollutants as per the International Maritime Dangerous Goods Code (IMDG Code). The constraints presented by this annex are binding, setting the obligations for managing and discharging harmful substances in packaged form, affecting ship operations.*
- *Annex IV – Prevention of Pollution by Sewage from Ships. This annex focuses on the requirements for the prevention of sea pollution due to sewage. It states in detail the obligations and allowances with respect to sewage discharge into the sea, which is not permitted in overall, unless the vessel has an operational sewage treatment plant, for either when the vessel is discharging sewage that is disinfected and reduced to comminute particles, or not. In more detail, the former is performed at a distance greater than 3 nautical miles from the nearest land, while for sewage that is not disinfected nor reduced to particles is required to be discharged at a distance greater than 12 nautical miles from the nearest land. In any other case, discharge to reception facilities is necessary. In overall, this annex defines the necessary operations for managing and discharging sewage, which affects the overall ship operations.*
- *Annex V – Prevention of Pollution by Garbage from Ships. This annex refers to various types of garbage and indicates the required distance from land and the method of disposal, if allowed. For other cases, garbage should be handled appropriately and discharged to reception facilities. Indicatively, there is a complete ban on the disposal of all types of plastics into the sea. The annex sets the context for management and disposal of garbage, which significantly affects ship operations and logistics.*
- *Annex VI – Prevention of Air Pollution from Ships. This annex sets the threshold for Sulphur oxide (SOx), and nitrogen oxide (NOx) from vessels' exhaust systems and bans the intended emissions of substances that deplete the ozone. Identified areas are set with stricter stands for SOx, NOx and an (PM). The annex also covers the obligatory technical and operational energy efficiency measures seeking to reduce GHG emissions from vessels, including the introduction of the Energy Efficiency Existing Ship Index (EEXI) and the annual operational carbon intensity indicator (CII) and CII rating, which link the GHG emissions to the amount of cargo carried over distance travelled. These work as a stimulus to reduce carbon intensity – gradually for all ships – by 40% by 2030 compared to 2008 baseline.*

The two main aspects that need to be considered with respect to JIT operations are the requirements set for the management and discharge of pollutants (i.e., the ones referring to Annexes II to V), e.g., for garbage or harmful substances in packaged form, and the requirements for compliance with Annex VI, including the limits for local polluting emissions such as SOx, NOx and PM, as well as the context of energy efficiency measures and carbon intensity. For the latter, a JIT integrated digital solution will probably align with energy efficiency requirements and reduction of air pollutants, while for the former, a careful consideration of procedures and possible delays must be considered for ensuring seamless operations and adherence to the MARPOL standards. Thus, management and discharge obligations are presented as a constraint for JIT operations, while compliance with energy efficiency requirements is presented as an enabler for such a port call optimization concept.

5.1.3. COLREG

COLREG, short for "International Regulations for Preventing Collisions at Sea," is a set of rules established by the International Maritime Organization to prevent collisions between vessels at sea and to facilitate safe navigation.

COLREG, established by the IMO, are rules designed to prevent collisions between vessels at sea and promote safe navigation. These regulations provide a standardized framework for vessel manoeuvring, determining right of way, and signalling between ships. By adhering to COLREG, mariners can navigate more effectively and mitigate the risk of accidents or collisions, ensuring the safety of vessels, crews, and passengers while at sea.

The objectives of the International Regulations for Preventing Collisions at Sea (COLREG) are:

- *Safety at Sea: The primary objective of COLREG is to enhance safety at sea by providing a standardized framework for vessel maneuvering and navigation. By defining clear rules for vessel conduct, COLREG aims to minimize the risk of collisions and accidents, thereby protecting the lives of seafarers and passengers and preventing damage to vessels and the marine environment.*
- *Prevention of Collisions: COLREG seeks to prevent collisions between vessels by establishing rights of way, rules for navigating in various situations (such as crossing, overtaking, and navigating in narrow channels), and requirements for displaying lights, shapes, and signals. These rules help vessels avoid misunderstandings and conflicts while navigating in busy waterways and congested areas.*
- *Efficient Traffic Flow: By standardizing vessel behavior and communication, COLREG promotes the efficient flow of maritime traffic. Clear rules for vessel conduct help optimize navigation routes, minimize delays, and facilitate the safe and orderly movement of vessels in ports, harbors, and shipping lanes.*
- *International Uniformity: COLREG aims to achieve international uniformity in the regulations governing vessel navigation and conduct. By establishing common rules that apply to all vessels operating in international waters, COLREG promotes consistency and predictability in maritime operations, regardless of the nationality or flag of the vessel.*
- *Compliance and Enforcement: COLREG encourages compliance with its regulations through education, training, and enforcement measures. By raising awareness of navigational rules and promoting adherence to best practices, COLREG helps improve maritime safety and reduce the incidence of collisions and accidents at sea.*

Here are the key rules outlined in COLREG (IMO, 2024):

- *Rule 1 - Application: Specifies that COLREG applies to all vessels navigating in international waters and establishes the responsibility of vessels to comply with the regulations.*
- *Rule 2 - Responsibility: Emphasizes that all vessels must maintain a proper lookout at all times and take actions to avoid collisions.*
- *Rule 3 - General Definitions: Defines terms used throughout COLREG, such as "vessel," "power-driven vessel," "sailing vessel," and others.*
- *Rules 4-10 - Navigational Rules: These rules govern the conduct of vessels when underway and include regulations for:*
    - *Safe speed (Rule 6)*
    - *Determining the proper course and direction of vessels (Rules 7-8)*
    - *Actions to avoid collisions, including the determination of right of way (Rules 9-10)*
- *Rule 11 - Application of Rules: Specifies that vessels must comply with COLREG regardless of whether they are operating in sight of one another.*

- *Rules 12-18 - Lights and Shapes: These rules outline requirements for the display of lights and shapes by vessels to indicate their status, size, and maneuvering capabilities, including:*
    - *Navigation lights (Rules 20-31)*
    - *Shapes for day signals (Rules 20-31)*
    - *Additional lights and shapes for vessels engaged in fishing, towing, and other special activities (Rules 26-30)*
- *Rules 19-23 - Sound and Light Signals: These rules establish the signals that vessels must use to communicate with each other in various situations, including:*
    - *Sound signals (Rules 32-37)*
    - *Light signals (Rules 34-36)*
- *Rules 24-25 - Exemptions and Special Cases: These rules provide provisions for exemptions from certain COLREG rules under specific circumstances, such as vessels engaged in special operations or vessels constrained by their draft.*

Here are some potential implications of JIT on these rules:

- *Rule 6 - Safe Speed: JIT operations may influence the speeds at which vessels operate. Adjusting speed to meet precise arrival schedules could require careful assessment to maintain a safe and adequate speed considering sea and navigation conditions.*
- *Rules 7-10 - Direction and Right of Way: Under JIT operations, decisions regarding vessel direction and right of way may be influenced by the need to meet specific arrival schedules. This could result in changes to vessel manoeuvres to avoid delays, necessitating a clear understanding and proper application of COLREG rules to avoid conflicts and collision risks. While this scenario may be unlikely, it is important to consider it due to its potential impact.*
- *Compliance and Training: Under JIT, it is crucial for vessel crews to be trained to adapt to operational needs and comply with COLREG rules at all times. Situational awareness and rigorous compliance with navigation rules are essential to avoid conflicts and maintain safety at sea.*

Overall, COLREG is a comprehensive set of rules and regulations aimed at promoting safe navigation and preventing collisions between vessels at sea. Compliance with COLREG is mandatory for all vessels operating in international waters.

5.1.1. FAL Convention

The FAL Convention is an international treaty introducing a unified approach to Facilitation. In more detail, it contains standards, recommended practices and rules for simplifying formalities, documentary requirements and procedures on ship's arrival, stay and departure. The Convention is in force since 1967 and has been continuously amended and updated under the operation of the FAL Committee of IMO, which convenes once a year. The Facilitation Committee (FAL) deals with matters related to the facilitation of international maritime traffic, including the arrival, stay and departure of ships, persons and cargo from ports. The Committee also addresses electronic business, including the single window concept, and aims to ensure that the right balance is struck between regulation and the facilitation of international maritime trade.

Based on the work of the Committee, IMO introduced standardised FAL documentation, also known as FAL Forms, for authorities and Government bodies to use, in accordance with the principles of the FAL Convention. Thus, mandatory requirements are gradually implemented, working towards maritime trade facilitation, and the

implementation of maritime single window environment. In more detail, since April 2019, the FAL Convention makes it mandatory for ships and ports to exchange FAL declarations electronically, and from January 2024, it is attempted to make it mandatory for all ports to adopt the single window approach (IMO, 2024).

Building on the ongoing advancements under the FAL Convention, in 2022, the IMO's Facilitation Committee took a monumental step forward by adopting significant amendments to the Annex of the FAL Convention. These amendments, encapsulated in resolution FAL.14(46) adopted on 13 May 2022 and slated to take effect from 1 January 2024, are poised to make the single window system for data exchange a mandatory requirement for ports globally (IMO, 2022). This initiative is expected to significantly accelerate the digitalization of shipping processes.

The amendments specifically update the FAL Convention to mandate electronic data exchange across ports for the clearance of ships. They require public authorities to establish, maintain, and utilize Single Window (SW) systems to facilitate the electronic transmission of information required for the arrival, stay, and departure of ships. A crucial aspect of these amendments is the requirement for public authorities to ensure that information is not only submitted or provided once but also reused to the maximum extent possible, thereby streamlining processes and reducing redundancies.

To ensure comprehensive compliance and uniformity, the FAL Convention outlines specific declarations that must be electronically submitted through the Single Window system. These include (IMO, 2024):

- *General Declaration (FAL 1): A basic declaration by the ship's master detailing the ship's route and other general information about the voyage.*
- *Cargo Declaration (FAL 2): Details about the ship's cargo, crucial for customs and safety inspections.*
- *Ship's Stores Declaration (FAL 3): Information regarding all stores (e.g., fuel, oil, food, etc.) on board the ship.*
- *Crew's Effects Declaration (FAL 4): Declarations of personal belongings of the crew, important for customs control.*
- *Crew List (FAL 5): A complete list of all crew members aboard the ship.*
- *Passenger List (FAL 6): A list of all passengers aboard, if applicable.*
- *Dangerous Goods Manifest (FAL 7): Detailed information about any hazardous materials on board, essential for handling emergencies and regulatory compliance.*

The aim of these structured declarations is to ensure that all necessary information is available in a standardized format, facilitating quicker processing and enhancing the efficiency of international maritime traffic. By mandating the use of the Single Window approach, the FAL Convention seeks to diminish the administrative burden on ships and ports, contributing to a smoother and more efficient facilitation of global maritime trade.

Potential impact on JIT operations

There is a close link between the FAL conventions, as they establish standardized procedures and data exchange formats, thereby providing a framework for implementing JIT practices in maritime operations. The Convention's focus on electronic data exchange and the Single Window concept aligns with the principles of JIT, which aims to minimize waiting times and optimize resource utilization.

By streamlining communication and information sharing between ships, ports, and authorities, the FAL Convention enables more accurate and timely decision-making. This, in turn, facilitates better planning and coordination, reducing

the likelihood of delays and disruptions. Additionally, the standardized declarations required under the FAL Convention provide a common language for all parties involved, enhancing transparency and efficiency.

Furthermore, the Convention's emphasis on data reuse and the avoidance of redundant information collection contributes to a more streamlined and cost-effective process. This is particularly relevant for JIT, as minimizing administrative burdens and expenses is essential for ensuring its successful implementation. In conclusion, the FAL Convention plays a crucial role in supporting JIT initiatives by providing a standardized and efficient framework for maritime operations.

5.1.2. STCW

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) was established by the IMO in 1978 and has undergone significant amendments, notably in 1995 and 2010, referred to as the Manila amendments. The STCW sets international standards for the training, certification, and watchkeeping of seafarers to ensure safe and efficient maritime operations worldwide.

The convention is structured to detail the responsibilities and required competencies for seafarers at different levels, covering everything from basic safety training to advanced operational skills. Key components of the STCW include:

- *Certification Requirements: It specifies different certification levels for various maritime roles, including masters, officers, and ratings, ensuring that all personnel aboard are adequately trained for their responsibilities.*
- *Watchkeeping Standards: Ensures that all personnel involved in navigational and engine-room watchkeeping are competent, which is crucial for the safe and efficient operation of the ship.*
- *Safety and Emergency Preparedness: Training seafarers in handling emergencies and safety management, which is critical for the protection of life and property at sea.*
- *Resource Management Training: Including Bridge Resource Management (BRM) and Engine-room Resource Management (ERM), which are essential for optimizing the coordination and management of ship operations.*
- *Security Training: Instructing all crew members on security protocols to maintain the safety and security of the ship and its cargo, facilitating smoother operations and compliance with international regulations.*

The STCW Convention is a cornerstone in maritime safety, ensuring that all maritime personnel are proficient and certified to handle their roles effectively, thus contributing to the overall safety and efficiency of maritime operations.

Parts of the STCW that are particularly relevant to JIT operations include:

- *Chapter VIII - Watchkeeping: This section is crucial for JIT as it regulates the standards for watchkeeping practices, ensuring that all navigational and engine-room operations are conducted with precision and awareness, which is vital for JIT operations to synchronize ship arrival and departure times efficiently.*
- *Safety and Emergency Training: Sections dealing with safety and emergency preparedness ensure that crew members are trained to handle unforeseen delays or incidents, which could impact JIT schedules. Such training ensures that operations can return to schedule with minimal disruption.*

- *Bridge Resource Management (BRM) and Engine-room Resource Management (ERM): These competencies are essential for optimizing the coordination and management of ship operations, directly supporting JIT by enhancing the efficiency of ship operations.*

Understanding these parts of the STCW helps in aligning the training and certification of seafarers with the operational needs of JIT systems, ensuring that they have the skills to support timely and efficient ship operations.

5.1.3. SAR

The International Convention on Maritime Search and Rescue (SAR) of 1979, adopted to enhance the global search and rescue system, outlines an international framework for the coordination and execution of SAR operations at sea. It mandates the parties to ensure that proper and efficient arrangements are in place for responding promptly to distress situations. The convention emphasizes cooperation among countries and with the IMO to establish reliable SAR services, covering planning, resources, training, and communication facilities.

The SAR Convention delineates specific responsibilities for contracting states, including the establishment of rescue coordination centres, the organization of SAR regions, and the development of procedures for maritime and aeronautical rescue coordination. It also includes provisions for improving the effectiveness of SAR services through technology and innovation in equipment and operational practices.

Relevance of SAR Convention to JIT Operations:

- *Establishment of SAR Regions: The delineation and clear definition of SAR regions help in managing maritime traffic more efficiently. For JIT operations, where timing and routing are critical, having well-defined SAR support can minimize disruptions caused by maritime emergencies.*
- *Reliable Communication Systems: The SAR Convention's focus on reliable communication systems ensures that in the event of a distress situation, responses can be coordinated swiftly and effectively, minimizing potential delays to shipping schedules, which is critical for JIT operations.*
- *International Cooperation: The emphasis on international cooperation and the sharing of SAR facilities and resources can lead to more streamlined and less congested sea routes, indirectly benefiting JIT operations by reducing potential delays in international waters.*

These aspects of the SAR Convention, while primarily aimed at safety and rescue, can also indirectly support the efficiency and reliability of maritime traffic.

5.1.4. Port Stay Control (PSC) and Regional MoUs

In the context of assuring the compliance of ships with international regulations, the main instrument is Port State Control (PSC) inspections. These are targeting foreign ships in national ports to ensure that their operating condition, equipment and manpower adhere to requirements of international regulations. After all, most of the IMO's technical conventions require inspection for ships that visit foreign ports to verify that they meet their requirements.

In order to enhance cooperation in the matter, IMO adopted resolution A.682(17) on Regional co-operation in the control of ships and discharges promoting the conclusion of regional agreements, which ensures that as many ships as possible are inspected but at the same time prevents ships from being delayed by consequent and unnecessary inspections from one port to the next between a few days or even hours (IMO, 1991). It is noted that the flag State is

primary responsible for assuring the compliance of the ship with international regulations; however, the port State can work as a 'safety net' to identify substandard ships, and thus, increase compliance rate and safety standards across the maritime industry.

In order for ensuring regional cooperation, nine regional agreements on PSC have been signed; the Memoranda of Understanding or MoUs. These cover specific geographical areas and waters, aiming to eliminate the operation of substandard ships through a harmonised system of inspections, through Port State Control. These are the following (IMO, 2024):

- *Europe and the north Atlantic (Paris MoU).*
- *Asia and the Pacific (Tokyo MoU).*
- *Latin America (Acuerdo de Viña del Mar).*
- *Caribbean (Caribbean MoU).*
- *West and Central Africa (Abuja MoU).*
- *the Black Sea region (Black Sea MoU).*
- *the Mediterranean (Mediterranean MoU).*
- *the Indian Ocean (Indian Ocean MoU).*
- *and the Riyadh MoU.*

The United States Coast Guard maintain the tenth PSC regime, which however is not identified as an MoU, in the sense of regional cooperation.

In the context of PSC inspections, for the various MoUs, there are plenty of operational aspect to be considered by ship owners and operators, in order to ensure right scheduling for their vessels and logistics. PCS inspections, as it is assumed also for other inspections, may cause delays, especially if deficiencies with respect to international regulations are identified. Thus, apart from maintaining high standards for ships, adhering to IMO's requirements, operators are carefully considering inspections for scheduling ship operations.

In this sense, PSC inspections should be well considered for JIT operations, as they may pose a threat to port call process optimization due to possible disruptions and delays when ships are – or waiting to be – inspected, as well as if they are identified with deficiencies, which may lead to the detention of the ship. For the latter, an integrated JIT operations system should handle such disruptions when they occur, while ships cannot avoid PSC inspections, which should be considered as a hard constraint.

5.2. EU regulations

Description of those aspects of the relevant EU regulations that may have a clear relation or could have an impact on JIT operations.

5.2.1. Maritime Single Windows

The single window approach has been introduced by the World Customs Organization (WCO), based on which countries are committed by the World Trade Organization Trade Facilitation Agreement to the development and implementation of Single Windows. The most commonly applied definition of the term Single Window is the following:

A single window is defined as a facility that allows parties involved in trade and transport to lodge standardized information and documents with a single-entry point to fulfil all import, export, and transit related-related regulatory requirements.

The single window is clearly a trade facilitative measure. It permits the trader or transporter to submit all the data needed for determining admissibility of the goods in a standardized format only once to the authorities involved in border controls and at a single portal. The single window concept places the onus on the authorities to manage the single window and to ensure that the participating authorities or agencies are either given access to the information or are actually given the information by the managing authority. It eliminates the need for the trader or transporter to submit the same data to several different border authorities or agencies. Implementation of a single window does not necessarily imply the implementation and use of high-tech information and communication technology. The single window concept can be implemented in a manual environment with the co-operation of all border authorities. However, countries may enjoy fuller benefits of a single window by using Information and Communications Technology (ICT) and dataset standards commonly accepted by the relevant public and private stakeholders.

5.2.1.1. **Maritime Single Window by IMO**

The Maritime Single Window (MSW) is a standardized system designed to facilitate a more streamlined process for ships entering and leaving ports. It serves as a single submission point for all the necessary regulatory documents required for the arrival, stay, and departure of ships, their crew, passengers, and cargo.

MSW is an electronic system that integrates all mandatory reporting associated with maritime and port facilities into one single electronic submission gateway. This reduces the need for ship operators to submit the same information multiple times to different government bodies, thus simplifying the administrative processes.

The primary users of MSW are ship operators, port authorities, and national maritime administrations. It's also relevant for other stakeholders involved in maritime transport such as customs authorities, health and quarantine officials, and various port service providers.

The MSW is used during all phases of a maritime journey—prior to arrival, during the stay at a port, and upon departure. All relevant data regarding the vessel, its cargo, crew, and other compliance-related information are submitted through this system.

The MSW operates through an electronic data interchange system that allows the data submitted by ship operators to be distributed automatically to the relevant authorities and service providers. This system ensures that once information is submitted, it is available to all required parties without the need for duplicate submissions. The system supports various data standards and protocols to ensure interoperability across different systems used by the port and national authorities.

The implementation of MSW aims to enhance efficiency, reduce waiting times at ports, improve the predictability of maritime logistics, and reduce the administrative burden on the maritime industry, making it a critical component in modernizing and optimizing maritime and port operations.

Relevance of MSW to JIT Operations:

- *Streamlined Administrative Processes: By consolidating all required reporting into a single-entry point, MSW can significantly decrease the time ships spend on administrative tasks, thus supporting JIT operations which aim for optimal scheduling and reduced port stays.*

- *Improved Data Flow: The MSW facilitates faster and more accurate data exchange between ships, port authorities, and other stakeholders. This efficient data handling can help in planning and executing port calls more precisely, aligning with JIT principles of minimizing idle time at ports.*
- *Enhanced Interoperability: The standardization and interoperability features of MSW can help in smoother coordination across different ports and regions. For JIT operations, where coordination across various jurisdictions is crucial, MSW can ensure that data inconsistencies do not cause delays.*
- *Support for Port Call Optimization: MSW can be integrated with port optimization systems to manage vessel traffic more efficiently. This integration supports JIT by ensuring that vessels receive a berth as soon as they arrive, reducing waiting times.*

Overall, MSW supports the JIT philosophy by enhancing the efficiency of information flow and reducing the administrative workload on shipping companies, which is essential for timely operations and minimizing port stay durations.

5.2.1.2. European Maritime Single Window Environment by EU – EMSWe

Following the establishment of the Maritime Single Window (MSW) by the IMO, the European Union further developed this concept with its own EMSWe, as outlined in Regulation (EU) 2019/1239 (European Union - Euro-Lex, 2019). This regulation aims to streamline the processes related to the reporting obligations of ships arriving at, staying in, and departing from ports within the EU.

EMSWe is designed to reduce the administrative burden on maritime transport by simplifying the information processes through a single electronic submission point. This is intended to enhance efficiency and integration across member states.

Each EU member state is required to maintain or establish a National Single Window (NSW) that functions as the central point for collecting and disseminating data required for port calls. This includes standardized reporting processes and harmonized interfaces, ensuring that the same data sets can be reported in the same manner across all EU ports.

The regulation emphasizes the seamless exchange of information between ships, port authorities, and other relevant entities, supporting real-time data availability which is crucial for operational efficiency.

A key aspect of the EMSWe is its design to be technologically neutral and interoperable, allowing for future adaptations as digital technologies evolve.

Relevance to JIT Operations:

- *Enhanced Predictability and Reduced Delays: By standardizing and simplifying the reporting procedures, EMSWe contributes to reducing delays at ports, which is critical for JIT operations that depend on tight scheduling and minimal port stay times.*
- *Improved Coordination: The regulation facilitates better coordination among various stakeholders, including customs and port authorities, which can expedite processes that otherwise might delay ship operations.*
- *Support for Port Call Optimization: By ensuring efficient information flow and reducing redundancy, EMSWe supports more precise scheduling and resource allocation, which are essential for effective JIT implementation.*

Overall, the EMSWe builds upon the foundational principles of the MSW to enhance maritime efficiency and interoperability across the European Union, providing a robust framework that supports the operational needs of JIT systems in the maritime industry. This contributes to the overall goal of optimizing maritime transport and logistics within the EU's single market framework.

5.2.2. Fit for 55 Package

The Fit for 55 package is a set of legislative proposals by the European Commission aimed at reducing GHG emissions in the EU by at least 55% by 2030 compared to 1990 levels. The package includes proposals to revise and update existing EU legislation and implement new initiatives in various sectors, including energy, transport, buildings, land use, and industry. The Fit for 55 package is a key part of the European Green Deal, which is the EU's roadmap for becoming a climate-neutral economy by 2050.

The Fit for 55 package has the potential to significantly impact maritime and port activity, potentially influencing both port call optimization and JIT practices. All measures aimed at reducing emissions, whether through disincentives or prohibitions, have a more than significant impact on activities related to the port maritime sector due to their emission levels and environmental impact. The following are the measures within this proposal that can impact the project in different ways.

EU emissions trading system

The European Union’s emissions trading system (EU ETS) is a cornerstone of EU climate policy, functioning as a cap-and-trade mechanism designed to limit GHG emissions from energy-intensive industries and the power generation sector (European Commission, 2024). Under this system, a cap is set on the total amount of emissions permitted, with allowances allocated to covered entities. These allowances represent the right to emit a specific amount of GHGs, and they can be traded among participants.

The Fit for 55 package seeks to strengthen and expand the EU ETS as part of the EU's broader efforts to achieve climate neutrality by 2050. By incorporating emissions from maritime transport into the system, the EU aims to address a significant source of emissions that has traditionally been outside its regulatory scope. This expansion will likely impact maritime operations, including port activities, as shipping companies may need to adopt cleaner fuels or technologies to comply with emission limits.

The FuelEU Maritime

This initiative, as a crucial component of the EU’s Fit for 55 package, aims to boost the demand for and consistent use of renewable and low-carbon fuels while reducing GHG emissions from the shipping sector. It seeks to ensure the smooth operation of maritime traffic and avoid market distortions within the internal market. This new legislation sets maritime transport on a path to meet the EU’s climate targets for 2030 and 2050, playing a vital role in fulfilling the European climate law.

Key provisions of the new regulation include measures to gradually reduce the GHG intensity of fuels used by the shipping sector, targeting a 2% reduction by 2025 and up to 80% by 2050 (European Commission, 2024). It also introduces a special incentive regime to promote the adoption of renewable fuels of non-biological origin (RFNBO) with high decarbonization potential and excludes fossil fuels from the regulation’s certification process.

Additionally, there is a requirement for passenger ships and container ships to use on-shore power supply for all electricity needs while moored at major EU ports starting in 2030, aimed at reducing air pollution in ports, which are often located near densely populated areas. The regulation includes a voluntary pooling mechanism that allows ships to pool their compliance balances with one or more other ships, collectively meeting the GHG intensity limits on average.

Time-limited exceptions are provided for the specific treatment of outermost regions, small islands, and areas economically dependent on their connectivity. Revenues generated from the regulation's implementation, referred to as "FuelEU penalties," will be used for projects supporting the maritime sector's decarbonization, with enhanced transparency mechanisms. The regulation's implementation will be monitored through the Commission's reporting and review process.

5.2.3. Trans-European Transport Network

The Trans-European Transport Networks (TEN-T) are a set of strategically important transport infrastructures for the European Union. Their main objective is to create an efficient and sustainable transport network that connects all Member States, facilitating trade, tourism, and the mobility of people. TEN-T emerged in response to the need to overcome the physical and administrative barriers that fragmented the EU's internal market. The lack of interoperability between different transport modes and the shortage of modern infrastructures were significant obstacles to the economic and social development of the EU.

TEN-T aims to eliminate bottlenecks in transport networks, improve interoperability between different transport modes (rail, road, inland waterways, and maritime), and promote the use of more sustainable transport options. Additionally, TEN-T contributes to strengthening the EU's territorial cohesion by connecting less developed regions and reducing inequalities. The maritime and port dimension of TEN-T is essential to ensure the EU's connectivity with the rest of the world. Seaports are key logistical nodes that play a crucial role in international trade. TEN-T promotes the modernization and expansion of ports, as well as the development of efficient and sustainable port infrastructures.

Potential impact on JIT operations

The implementation of JIT arrival is closely related to TEN-T. These projects aim to reduce vessel waiting times in ports, minimize logistical costs, and reduce the environmental impact of port operations. TEN-T facilitates the implementation of these projects by providing an efficient and connected transport infrastructure. For example, a well-developed rail network can enable logistics operators to move goods to and from ports more quickly and efficiently, thus supporting the implementation of JIT Arrival systems.

The integration of TEN-T with JIT Arrival and Port Call Optimization projects offers several benefits, including:

- *Increased efficiency: Reducing waiting times and optimizing port operations enhances supply chain efficiency.*
- *Lower environmental impact: Reducing emissions and noise pollution contributes to greater sustainability in maritime transport.*
- *Increased competitiveness: More efficient and connected ports attract more maritime traffic and help boost regional and national economic competitiveness.*
- *Improved quality of life: Reducing congestion in ports and surrounding areas enhances the quality of life for local communities.*

Challenges and Future Prospects

Despite the progress made, the implementation of TEN-T and the optimization of port operations still face challenges, such as lack of funding, resistance to change, and the complexity of coordinating the interests of multiple stakeholders. However, the outlook is promising. The growing digitalization of the maritime and port sector, along with the development of new technologies like artificial intelligence and the Internet of Things, presents new opportunities to improve the efficiency and sustainability of port operations.

In conclusion, TEN-T plays a fundamental role in optimizing port operations and implementing JIT Arrival projects. By providing an efficient and connected transport infrastructure, TEN-T helps strengthen the European Union's competitiveness and promote more sustainable maritime transport.

5.3. National Regulations

Having covered the regulatory framework at the European and international levels and, due to the international nature of MISSION, it is pertinent to conduct an analysis of potential national regulations that may impact the deployment of JIT operations in the ports where the Use Cases will be conducted. Potential regulations will condition the natural development of the conception, planning, and execution of the Use Cases, so their correct definition will enable these to adapt to the national regulatory framework.

After analysing the countries participating in the project, it has been concluded that there are no national regulations that impose a more restrictive regulatory level than the European regulations already analysed in the previous section. It is important to highlight this reality because it shows that legislation concerning this type of activity does not permeate to the national levels, which is relevant for identifying potential political pressure groups that have interests that could influence national and/or local policies to legislate and regulate the execution of this type of operational processes.

6. Comparative Analysis

This section presents a comprehensive analysis of the available standards, as well as current gaps, overlaps, and improvement opportunities from various perspectives. The information and analyses in this section are based on two workshops conducted with the individuals and organizations involved in this deliverable. The workshops were held using the Miro™ application in June 2023, with the participation of MISSION's consortium partners.

To maximise impact and engagement, the participants were asked to identify and classify gaps, hurdles, difficulties and other barriers that could act as barriers to their implementation. Conversely, they were encouraged to mention any positive aspects and enablers to standards adoption. In turn, standards were classified according to their application area (nautical, operational, process). Lastly, an assessment made based on various factors such as degree of maturity and its impact on business areas (operation, technology, safety…) completes the evaluation.

Operational standards

The results show the varying degree of adoption of standards across all port operation levels and its impact. It is noteworthy that, despite the potential they have to exert impact on business areas, the use of standards remains low overall or on the pilot level. For example, although the DCSA standard has a “high” usage level among its stakeholders, there are only pilots at operational level outside of this sphere. Similar situations were reported of ITPCO and TIC4.0, with ITPCO usage reported as “high at stakeholder level with preliminary deployments” and TIC4.0 as “medium, with existing pilots at operational level”. All other standards were reported as having both “low” maturity and level of adoption.

A certain degree of overlap between standards can be observed in their analysis: for example, the IMO compendium or the JIT arrival guide, DCSA and TIC4.0 cover the nautical services area, while port approach is an area covered by DCSA and ITPCO. However, these standardisation organisations have established communication channels between them to prevent overlaps, ensure compatibility and prevent “double work”. A good example is the compatibility between TIC4.0 and DCSA: TIC4.0’s data model has built-in provisions for DCSA’s definitions and timestamps.

As explained before, these standards have high potential to exert a positive impact on the business areas they are applied to, the sole exception being IAPH, whose impact has been evaluated as “medium/low”:

Operational impact

- *IMO and ITPCO both have an influence on the vessel: IMO in the speed reduction and anchoring time and ITPCO in the Vessel-Port Terminal Berthing Priority.*
- *DCSA and TIC4.0’s biggest potential lies in their ability to reduce the duration of the port visit*
- *BIMCO’s strength lies in its influence on the navigation time and establish agreements between shipping lines and cargo owners*

Technological impact

- *DCSA and TIC4.0 have the strongest technological impact. Both require from adaptations and implementations to make the most of their technology and data models. TIC4.0’s data model is publicly*

available and can be downloaded from its website, while DCSA has a set of APIs and datasets available on the same format. The use of both platforms has potential to significantly change the digitalisation level of a facility or organisation.

- *ITPCO and IMO standards were deemed to have a "medium" impact on the technological applications*
- *Lastly, BIMCO and IAPH have the lowest level of impact on the technological level, since they are more oriented to the contractual obligations and other areas. The contribution IAPH has had on the development of IMO and other standards has been crucial*

Impact on safety

- *Due to their status as international regulations governing the safe passage of vessels and other safety-related areas, the IMO standard was deemed to have the greatest impact on operational safety. All other standards are more oriented to information exchange protocols and, therefore, its overall impact in this area is low. There exists, however, some uncertainty on the possible impact of the ITPCO standards since its regulations do cover terminal operations.*

Impact on GHG emissions

- *Standards tackling the operational and navigation were found as the most important in terms of GHG emissions reduction potential, with IMO and DCSA leading the way. Regulations governing vessel speed, bunker fuel and waste are regulated by the former, while DCSA's potential to reduce anchoring time and enable speed reductions due to the implementation of JIT port calls can be an enabler for greener operations. The same can be said from ITPCO's efforts on regulating JIT. In turn, BIMCO can enforce contracts that enable speed reductions and mandate the usage of green fuels or others.*
- *Purely software standards such as TIC4.0 have the lowest impact. However, the implementation of TIC4.0 may ease the task of monitoring the GHG emissions of the terminal by accurately tracking its movements and cargo operations.*

Impact on specific stakeholders

This section describes the impact the different regulations have on different stakeholders. In order to improve clarity, impacts have been classified according to the corresponding regulation. The analysis has been conducted taking into account the needs, objectives, and roles of the stakeholders in port operations.

IMO

IMO regulations have a significant impact on the daily operations of the identified stakeholders. They influence them by establishing requirements and regulations that must be complied with. In the case of Nautical Service Providers, pilots, tug crews and marine surveyors must comply with safety and training standards, ensuring that all personnel is adequately trained according to them. Furthermore, regulations apply to the maintenance, environmental performance, and operation of the ships. These are regularly inspected to ensure their adherence to the international regulations and any non-conformity might lead to repairs and delays, potentially delaying a JIT operation.

Shipping line operators also have to comply with strict environmental, operational, and maintenance requirements. Consequently, operational costs can increase due to these requirements, potentially including ship replacement and retrofitting to keep them in line with the changing regulations. In addition, crews and operations shall be undertaken according to the international SOLAS convention. All regulations affecting the ship are also of importance to ship owners, which can charge higher charter rates on fully compliant vessels.

Both previous stakeholders might be impacted as well by Port State Control (PSC) inspections. By performing a PSC, port authorities enforce the ships' compliance with IMO safety, security and environmental standards. Ships that are found breaching these might be prevented to leave a port until the detected deficiencies are solved. This can prevent the completion of a JIT operation. On top of this, port authorities develop and oversee other IMO requirements such as operational and emergency policies and pollution control measures.

DCSA

DCSA standards mainly target shipping line operators (especially of the container sector), port terminals, ship owners and shippers/cargo owners.

Apart from the adoption of Electronic Bills of Lading, shipping line operators can enjoy the benefits of real-time data exchange and improved decision-making capabilities when they adopt DCSA standards. In turn, they can adapt their systems to achieve interoperability with other operators and stakeholders in the supply chain, reducing costs and delays that might hinder JIT operations.

Port Terminals might improve their operational efficiency by improving scheduling, reducing turnaround times and optimizing resource allocation thanks to enhanced data exchange. Another benefit of this is the increased transparency achieved by the standardized data sharing protocols, further improving container tracking and movement status. Both of these helps improve the overall efficiency of port operations.

The adoption of better data standards and digitalization technologies can enhance the management of the Ship Owner's assets, leading to more efficient maintenance, better fleet utilization rates and prolonged asset life. The improvement and better planning of maintenance operations leads to reduced call times, allowing for targeted operations at specific ports that can be tied to the overall port call duration.

By aligning data, processes and technology, DCSA standards allow shippers and beneficial cargo owners to automatically exchange critical information in real-time. This not only ensures visibility into the end-to-end cargo journey, it improves operational efficiency and lowers costs by eliminating error-prone manual processes. Ultimately, widespread adoption of DCSA standards will enable logistics managers to make more effective business decisions and improve resource utilisation, which will increase the value and sustainability of all shipping operations.

ITPCO

ITPCO regulations primarily impact port authorities, nautical service providers, and shipping line operators.

Port authorities can enhance operational efficiency through the standardization of data and processes, leading to streamlined operations, reduced congestion, and shorter waiting times. The adoption of advanced IT systems and infrastructure supports real-time data sharing and predictive analytics, fostering better coordination and collaboration with shipping lines and service providers. Additionally, optimized port calls contribute to environmental sustainability by reducing emissions from idling ships.

Nautical service providers benefit from improved scheduling and coordination, which allows for better resource allocation and more reliable operations. Standardized data exchange facilitates better communication with port authorities and shipping lines, reducing delays and enhancing service reliability. The optimization of port calls also helps minimize fuel consumption and emissions, supporting environmental goals.

Lastly, shipping line operators experience reduced port stay times and improved fleet utilization, resulting in cost savings related to fuel consumption, demurrage, and port fees. Standardized data exchange improves the accuracy and reliability of port call information, enhancing operational decision-making and reducing errors. Optimized port operations contribute to a lower carbon footprint and greater environmental compliance. Additionally, improved reliability and efficiency in port operations lead to higher customer satisfaction and stronger competitive positioning.

TIC4.0

TIC4.0 standards primarily affect port authorities, shipping line operators, and port terminals.

Port Authorities benefit from TIC4.0's emphasis on digitalization and integration, which streamlines port operations by improving data exchange and enhancing real-time visibility. This leads to more efficient scheduling, better coordination with shipping lines and terminal operators, and reduced congestion. The adoption of advanced technologies and standardized communication protocols also supports the optimization of port resources and infrastructure, contributing to overall operational efficiency.

Shipping line operators see improvements in operational efficiency and reduced port stay times due to enhanced data sharing and integration facilitated by TIC4.0. Standardized processes and real-time data exchange allow for better planning and scheduling, which minimizes delays and reduces costs associated with fuel consumption and demurrage. Improved coordination with port authorities and terminals also supports more reliable and predictable service, enhancing customer satisfaction.

Port terminals experience increased efficiency through TIC4.0's focus on digital transformation and automation. Improved data exchange and standardized communication lead to optimized scheduling, reduced turnaround times, and better resource allocation. Enhanced visibility into container movements and port operations further streamlines terminal processes, reducing delays and improving overall performance.

BIMCO

BIMCO regulations mainly impact shippers/cargo owners and ship owners.

Shippers/cargo owners benefit from BIMCO's standardized contracts and clauses, which provide greater clarity and consistency in shipping agreements. This reduces the risk of disputes and enhances transparency regarding responsibilities, costs, and liability. Standardized documentation and contract terms streamline the shipping process, making it easier to manage and track shipments while improving predictability and reliability in cargo delivery.

Ship owners experience improved operational efficiency and reduced risk through BIMCO's standardized guidelines and contracts. These regulations help ensure that contractual terms are clear and equitable, reducing the likelihood of disputes and enhancing the overall management of shipping operations. BIMCO's focus on best practices and standardized contracts also facilitates better planning and coordination, leading to more efficient vessel operations and maintenance. Additionally, the adoption of BIMCO's industry standards can contribute to higher asset value and better market positioning.

IAPH

IAPH regulations primarily impact port authorities.

Port authorities benefit significantly from IAPH's focus on enhancing port performance and sustainability. By adopting IAPH's best practices and standards, port authorities can improve operational efficiency, streamline port operations, and better manage resources. The integration of standardized processes and data sharing protocols promotes better coordination with shipping lines and other stakeholders, reducing delays and optimizing port throughput.

IAPH's emphasis on sustainability helps port authorities implement environmentally friendly practices, such as reducing emissions and managing waste more effectively. This aligns with global environmental goals and enhances the port's reputation as a green and efficient facility.

Additionally, IAPH's guidelines support the development of resilient and adaptive port infrastructures, helping authorities respond effectively to changing conditions and emerging challenges. Overall, IAPH regulations contribute to more efficient, sustainable, and well-managed port operations.

Digital-focused standards

The second part of the analysis deals with maritime digital standards and its applications. Four major maritime standards, IALA, SECOM, ISO 28005 and UN/EDIFACT were subjected to the workshop's audience analysis. The conclusions were as follows:

Operational impact

- *Apart from IEC, whose impact was assessed as "low", all other standards were assessed as having a "high" impact on different areas of the operations. IALA and ISO 28005 have significant impact on the port visit duration, while IALA has implications on the overall duration of the port visit. In turn, UN/EDIFACT is the international protocol for the safe transmission of data related to the transportation (cargo, transaction, etc.). As such, it has a big impact on the speed of data exchange and transmission.*

Technological impact

- *Since all of the aforementioned standards are focused on digitalisation, their potential to influence and inspire technological developments is high. IALA and ISO 28005 help in the implementation of integrations between vessels and VTS, integration between vessel and port terminals, the former also achieving better integration with ports.*
- *UN/EDIFACT has based its success in its simplicity and excellent interoperability with other parts of the logistics chain. In fact, the use of the messaging system is widespread among other transportation media such as air transportation. Although it does not require from complex systems, its implementation has fostered the uptake of digital solutions by the logistics industry.*
- *The SECOM standard is more focused on the electrical installations on ships and offshore units and on maritime navigation and radiocommunications equipment and systems. Even if it has undoubtedly helped to establish standards in both of these fields, radiocommunications are nowadays ubiquitous and are not considered a major technological advancement anymore.*

Safety impact

- *IEC, being a radiocommunications and electrical standard, has the most influence on safety, since radio and telecommunications are essential in emergency situations. Maintaining electrical power supply of critical systems is also essential to maintain the ship's manoeuvrability, as the Baltimore bridge accident showed.*
- *The IALA standard focuses on maritime navigation aids (buoys, marks, etc.). The stakeholders involved in the workshop have, however, stated that the impact on safety is "medium". Due to their role in safely guiding ships across the ocean and inland waterways, the impact of IALA's standards on safety should be reassessed.*
- *UN/EDIFACT and ISO 28005 do not have safety as its primary goal and, therefore, have a low overall impact on it.*

Impact on GHG emissions

- *The areas covered by the standards of this sections do not have a significant impact on the GHG emissions. Only IALA's standards might have some impact due to the role navigational aids play in speed reductions and anchoring time. However, a more detailed review of IALA's role might be required to ascertain the real potential impact on this.*

Impact on GHG emissions

- *The effects of EDIFACT on GHG emissions were assessed as "low" by all the participants. This is logical, since EDIFACT is a business-focused approach that was conceived to ease information exchange between business partners and port actors. Thus, it is not a target of EDIFACT. However, some of the information (e.g., container numbers, cargo, etc.) could be extracted and correlated with transport and shipment information to obtain useful GHG emissions metrics.*

Impact on specific stakeholders

IALA

IALA regulations primarily impact Vessel Traffic Services and Nautical Service Providers.

Vessel Traffic Services: IALA's standards and guidelines enhance the efficiency and safety of VTS operations. By adhering to IALA regulations, VTS services can improve their ability to monitor and manage vessel traffic through standardized procedures and technologies. This leads to better communication with vessels, more accurate traffic management, and enhanced safety in navigational areas. IALA's focus on harmonizing VTS practices worldwide also supports interoperability and effective collaboration with other maritime stakeholders, contributing to more reliable and efficient vessel traffic management.

Nautical Service Providers: For nautical service providers, IALA regulations facilitate improved service delivery through standardized practices and training. Compliance with IALA standards ensures that services such as pilotage, towage, and mooring are conducted safely and effectively, enhancing overall maritime safety. The adoption of IALA's best practices helps providers to improve coordination with VTS services and port authorities, leading to more efficient operations and reduced delays. Additionally, standardized procedures promote consistency in service quality and safety, supporting the reliable handling of vessels and cargo.

D1.1. ASSESSMENT AND ALIGNMENT OF ON-GOING JIT / PORT CALL OPTIMISATION STANDARDISATION INITIATIVES INCLUDING LEGAL FRAMEWORKS

IEC

IEC regulations primarily impact Shipping Line Operators, Nautical Service Providers, and Vessel Traffic Services.

Shipping Line Operators: IEC standards play a crucial role in ensuring that shipping lines use reliable and standardized electrical and electronic equipment. Compliance with IEC regulations helps operators enhance the safety and efficiency of their vessels by adopting robust and interoperable technologies. This includes navigation and communication systems that meet global standards, contributing to safer and more reliable operations. IEC standards also support the integration of advanced technologies for better performance and maintenance of shipboard systems.

Nautical Service Providers: For nautical service providers, IEC regulations ensure that the equipment and technologies they use, such as those for pilotage and mooring, are standardized and reliable. This compliance leads to enhanced safety and efficiency in providing nautical services. Standardized equipment and procedures help in maintaining consistent service quality and improving coordination with shipping lines and VTS. Additionally, adherence to IEC standards aids in the effective training of personnel, ensuring that they are proficient in using the latest technologies.

Vessel Traffic Services: VTS operations benefit from IEC regulations through the adoption of standardized and interoperable communication and navigation systems. Compliance with IEC standards ensures that VTS equipment functions reliably and integrates seamlessly with systems used by ships and other maritime stakeholders. This leads to improved monitoring and management of vessel traffic, enhanced safety, and better coordination in navigational areas. IEC standards also support the development and maintenance of effective VTS infrastructure, contributing to overall maritime safety and efficiency.

UN/EDIFACT:

UN/EDIFACT regulations primarily impact Port Terminals, Port Authorities, Logistics Companies, Ship Cargo Owners, and Shipping Line Operators.

Port Terminals: UN/EDIFACT standards improve operational efficiency at port terminals by standardizing electronic data interchange (EDI) for transactions such as booking, shipping instructions, and cargo tracking. This leads to more accurate and timely processing of cargo, streamlined documentation, and reduced paperwork. Enhanced data exchange promotes better coordination with shipping lines and port authorities, optimizing resource allocation and reducing turnaround times.

Port Authorities: For port authorities, UN/EDIFACT standards facilitate seamless integration of data from various stakeholders, improving the management of port operations. Standardized electronic messages enhance communication and coordination, leading to more efficient scheduling, reduced congestion, and improved safety. The adoption of UN/EDIFACT standards also supports better regulatory compliance and data accuracy, contributing to overall port efficiency.

Logistics Companies: Logistics companies benefit from UN/EDIFACT by gaining access to standardized data formats for efficient communication with shipping lines, port authorities, and terminals. This streamlines the management of logistics processes, such as cargo tracking, customs documentation, and inventory management. The standardization reduces errors, speeds up transactions, and enhances visibility across the supply chain, leading to improved operational efficiency and customer satisfaction.

Ship Cargo Owners: For ship cargo owners, UN/EDIFACT simplifies the management of shipping and logistics through standardized electronic documents. This improves transparency and accuracy in cargo tracking, reduces delays associated with manual paperwork, and enhances overall supply chain visibility. Standardized data exchange also facilitates smoother communication with shipping lines and port terminals, leading to more reliable and timely cargo delivery.

Shipping Line Operators: Shipping line operators benefit from UN/EDIFACT through improved efficiency in data exchange with port terminals, logistics companies, and cargo owners. Standardized electronic messages streamline processes such as booking, cargo handling, and documentation, reducing administrative burdens and errors. This leads to faster processing times, cost savings, and improved service reliability. Enhanced data visibility and coordination contribute to better decision-making and operational performance.

ISO 28005

ISO 28005 regulations primarily impact Port Terminals, Port Authorities, Logistics Companies, Ship Cargo Owners, and VTS Services.

Port Terminals: ISO 28005 standards enhance the security of port terminal operations by providing guidelines for secure electronic messaging related to cargo and shipping information. This improves the accuracy and reliability of data exchange between terminals and other stakeholders. The implementation of ISO 28005 helps in managing and mitigating security risks, ensuring that cargo and operational data are protected from unauthorized access or tampering.

Port Authorities: For port authorities, ISO 28005 standards support the development of secure and standardized electronic communication protocols. This ensures that data related to port operations, cargo handling, and security are exchanged securely and efficiently. Compliance with ISO 28005 helps port authorities in maintaining robust security measures, enhancing their ability to respond to security threats, and improving overall port safety and operational integrity.

Logistics Companies: Logistics companies benefit from ISO 28005 by having standardized protocols for secure electronic data exchange. This enhances the security of cargo information and logistics operations, reducing the risk of data breaches or tampering. The standards help logistics companies improve their security management systems and ensure that sensitive information is protected throughout the supply chain, leading to increased trust and reliability in logistics processes.

Ship Cargo Owners: ISO 28005 regulations provide ship cargo owners with enhanced security for electronic data related to their cargo. By adhering to these standards, cargo owners can ensure that their shipment information is securely communicated between various stakeholders, reducing the risk of data breaches and enhancing the overall security of their cargo. This contributes to more reliable and secure management of shipments and improves confidence in the integrity of the supply chain.

VTS Services: For Vessel Traffic Services , ISO 28005 standards ensure the secure exchange of electronic information related to vessel traffic management. Compliance with these standards enhances the security and integrity of communications between VTS centres and vessels, reducing the risk of unauthorized access or data tampering. Improved security protocols contribute to more reliable and efficient vessel traffic management, enhancing overall maritime safety and operational efficiency.

6.1. Standardization Initiatives

As discussed in the previous section, this part addresses the specific case of standardization, particularly related to initiatives aimed at providing operational standards, whether from a digital, process, or administrative perspective. The identification of gaps and overlaps is based on analysing the scope of current standards, which parts of the Port Call process phases they apply to, their level of implementation, and their maturity.

Table 4 Impact of the different standards in the port call process phases. Source: own work

Organization	Type of Standard	Phases of the Process				
		Passage Planning	Port Call Request	Port/berth arrival		Vessel/ Cargo Service
				Internal Navigation	Nautical Services	
DCSA	Digital/Operational	NO	MEDIUM	NO	HIGH	HIGH
TIC4.0	Digital/Operational	NO	NO	NO	MEDIUM	MEDIUM
BIMCO	Operational/Administrative	NO	NO	NO	NO	NO
IHO	Digital	HIGH	NO	HIGH	NO	NO
IALA	Digital	HIGH	HIGH	HIGH	HIGH	NO
IEC	Digital	HIGH	HIGH	HIGH	HIGH	NO
ISO 28005	Administrative/Operational	NO	HIGH	NO	NO	NO
EDIFACT	Administrative	NO	NO	NO	NO	HIGH

In **¡Error! No se encuentra el origen de la referencia.**, the relationship between the standards analysed in the previous sections and the phases they impact is shown. The colour representation indicates the following: green signals that a standard that is widely used, mature, and meets the sector's needs, while orange indicates that while a standard exists, it does not provide the necessary utilities either because it is not widely used by stakeholders, is still in development stages, or does not fully meet the sector's needs. Finally, red indicates that in that phase, the organization or standard has no concrete developments. The analysis will now focus on examining each phase to identify the standards and subsequently establish a map of gaps and overlaps. This will allow us to analyze the barriers that cause these gaps and overlaps that exist.

6.1.1. Passage Planning

Addressing the first phase in the process, we find that regarding deep sea navigation, three organizations have developed different standards with various functions, aimed at facilitating the exchange of vital information for efficient navigation and coordination of activities.

The first and most relevant, being the general framework from which the rest of the standards are developed, is the S-100 standards on the Universal Hydrographic Data Model. These standards establish a framework for the development and implementation of interoperable digital products and services for hydrography, navigation, and related marine data.

On the other hand, the navigation assistance standards (S-201), inter VTS exchange, and format S-212 VTS digital information are standards developed by IALA to facilitate the understanding and transmission of navigation-related information, vessel to vessel, and vessel to shore.

Furthermore, passage planning shall be made in compliance with SOLAS regulations. More specifically, SOLAS Chapter V mandates that ships must undergo detailed voyage planning, covering the appraisal, planning, execution, and monitoring phases. Passage planning must account for navigation hazards, safe speeds, environmental conditions, and vessel characteristics to minimize risk. By doing so, SOLAS aims to prevent accidents and protect life, property, and the marine environment. Compliance with these guidelines is essential for efficient and safe navigation.

Finally, the S-421 standard, whose function is the route plan exchange format, enables the advance transfer of the navigation map, allowing parties to be informed of the route a vessel will take. This facilitates operational planning and enhances navigation safety by enabling the identification of potential collisions. These standards are developed as norms by the IEC, as previously mentioned.

Gap and Overlap

As in the contract refinement phase, regarding the deep-sea navigation phase, the basic needs are correctly covered, as we have seen in the previous paragraphs, so there are no significant gaps. Some standards may still be in development phases and may not yet have practical applications, but they are being developed based on solid standards. The developments by IHO and IALA are complementary and even have a certain level of coordination, so their efforts are currently aligned, and no overlaps exist.

Barriers

- Low level of implementation
- Political (due to the IMO processes)
- Low level of digitalization
- Interoperability Issues
- Cybersecurity Concerns
- Cost of Compliance

In the context of deep-sea navigation, the implementation of JIT arrival encounters significant barriers that hinder its effective deployment. Despite standards like the S-100 for the Universal Hydrographic Data Model and S-201 for navigation assistance, a pervasive challenge persists with the low level of implementation. Many maritime entities have yet to fully adopt these standards, impeding seamless coordination and efficient information exchange critical for JIT operations.

Political barriers add complexity, influenced by processes within the IMO that can delay standardization efforts. Diverse national policies and regulatory frameworks further complicate the harmonization of digital navigation standards across regions, impacting the smooth adoption of JIT practices.

Moreover, the maritime industry's overall low level of digitalization presents a fundamental hurdle. Outdated systems and manual processes prevalent in many organizations are insufficient for the real-time data exchange needed for JIT arrival. This technological gap not only affects operational efficiency but also increases the complexity and cost of integrating advanced navigation technologies and systems.

Additionally, interoperability issues between different technologies and systems, cybersecurity concerns related to digital systems, the high cost of compliance with new standards, and organizational resistance to change pose significant challenges. Overcoming these barriers requires collaborative efforts among maritime authorities, industry stakeholders, and regulatory bodies to promote standardization, enhance digitalization efforts, and provide support for the effective implementation of JIT arrival practices across global maritime networks.

6.1.2. Port Call Request

Regarding the scenario of standardization in the processes concerning the port call request, it is noteworthy the number of organizations that have dedicated themselves to addressing the various challenges to harmonize them from an operational standpoint and also in terms of the digitization of processes. We see that organizations such as DCSA, IHO, IEC, IALA, and ISO with the ISO 28005 standard have established some level of standardization.

Analyzing the operational standards, the JIT implementation framework from DCSA stands out. It includes open-source API definitions, an interface standard, message format, and business process, ensuring interoperability among all stakeholders. It covers all important port call events, allowing users to exchange 112 event timestamp messages with their stakeholders. ISO 28005 and S-211 are both electronic communication standards in the maritime industry but address different aspects. It is important to highlight the fact that nowadays, no organisation is officially maintaining and supporting S-211. Therefore, support and updates for it might cease in the future and, as a consequence, the standard might fall into disuse. ISO 28005 focuses on streamlining data exchange during port clearance (think exchanging standardized information about ships, cargo, crew for customs and port authorities). It defines message formats and core data elements (ISO 28005-1 & -2). S-211 concentrates on communication and coordination between ships and shore authorities regarding entire port calls (think planned arrival, services needed, cargo operations). It emphasizes situational awareness and smooth execution of port activities. While ISO 28005 standardizes data exchange for clearance, S-211 provides a data model for broader port call communication, allowing some flexibility. Together, they can create a more efficient and seamless maritime environment.

Building on the communication standards (ISO 28005) and port call coordination (S-211), S-131 (Marine Harbour Infrastructure) acts as a digital port map. While not directly involved in the initial port call request, the ship can leverage S-131 data to tailor their request, e.g., specifying berth depth needs based on port layout. Similarly, the port authority uses this data to assess requests and allocate resources efficiently. In short, S-131 provides the groundwork for smoother communication and planning throughout the port call process, as identified by the focus on the ship's perspective.

We can also link the DCSA's Operational Vessel Schedule (OVS) standard, as it plays the role in improving communication and efficiency within the port call process. This standardized approach uses APIs to facilitate the automatic exchange of vessel schedule data and exception information between carriers, operational stakeholders (terminals), and solution providers.

Gap and Overlap

While no gaps are observed, in the specific case of the port call request phase, certain overlaps were found. These come from various factors: the existence of process definitions in multiple standards and the availability and increased usage of various tools for the standard’s application. These overlaps affect mainly the standards developed by DCSA and ISO 28005, as both have definitions of the same events and processes. Additionally, the

implementation of EMSWe and its own regulations, aimed at harmonizing the port call and port call request process from a primarily administrative perspective, represents another overlap.

In the ongoing analysis of gaps and overlaps related to standardization, it's essential to address certain aspects that significantly impact the definition of processes and present challenges that can be effectively managed through standardization efforts.

Firstly, various workshops conducted have revealed that the reference event for a vessel's arrival at the port, as defined in FAL 5, may not be clearly established. According to this IMO convention, the reference point for a vessel's arrival is the Pilot Boarding Place. This location is typically viewed as the initial contact point between the vessel and the port concerning operations. This event is crucial, as it signifies the beginning of the vessel's oversight by port authorities regarding its stay in port; processes such as pilotage, towage, and mooring rely heavily on this point.

However, in most ports, the physical location of the Pilot Boarding Place falls within the waters under the port's control and jurisdiction. Defining this point as the reference overlooks the possibility of common occurrences such as vessel drifting or anchoring. These two scenarios, being quite routine, significantly impact the metrics related to the vessel's turnaround time in port. If these factors are not considered, there could be unaccounted time between when the vessel approaches the port and when it reaches the Pilot Boarding Place, especially if it has been drifting or anchored beforehand.

One way to address this omission is to include the ETA for vessels entering the port's jurisdictional waters. This would involve adding an event prior to reaching the Pilot Boarding Place to determine whether the vessel arrived at the port and was directly directed by the authorities to access the PBP, or if, due to operational needs, the vessel was diverted to the anchorage area or instructed to drift between the time it arrived in the port control waters and when it was authorized to proceed to the PBP.

By implementing this modification, the port would enhance its statistics and measurements, allowing for a more accurate representation of the turnaround time for port calls.

Another important aspect that is overlooked in the processes suggested by the various standards is the necessity for a vessel to change berths once it is within the port. Such a requirement frequently arises for several reasons, including operations by different terminals, adverse weather conditions, or maintenance needs that necessitate a berth change. Unfortunately, this reality is not adequately reflected in the existing processes, leading to the omission of critical events that are essential for effective operational management.

Incorporating this information is vital for accurately assessing a vessel's turnaround time in port, as it would provide a comprehensive overview of the vessel's activities during its stay. A complete understanding of these events will significantly enhance operational efficiency and improve overall port performance.

Barriers

- Low level of coordination.
- Political.
- Low level of digitalization.
- Low level of implementation.

- High level of investment required.

Implementing JIT arrival in port call request processes faces significant administrative barriers that hinder its effective deployment. Insufficient coordination among shipping lines, port authorities, and terminal operators impedes real-time data exchange necessary for JIT arrival, potentially leading to operational inefficiencies and delays. Political complexities stemming from varying regulatory frameworks and priorities across jurisdictions further complicate standardization efforts, essential for JIT practices to achieve global adoption.

Digitalization presents a substantial administrative obstacle as many ports and maritime entities rely on outdated administrative systems, limiting their capacity to integrate JIT practices effectively. The transition to digital administrative systems requires substantial investment in infrastructure and technology upgrades, posing financial challenges for stakeholders. Additionally, the low adoption and implementation maturity of JIT practices across ports undermine potential benefits such as enhanced administrative efficiency and reduced environmental impact.

Further administrative barriers include technological compatibility issues between different IT systems and administrative resistance within traditional maritime practices. Addressing these administrative challenges demands collaborative efforts among international organizations, regulatory bodies, port authorities, and stakeholders to invest in digital administrative infrastructure, streamline administrative regulations, enhance administrative coordination, and promote widespread adoption of JIT arrival practices. This integrated administrative approach is key for advancing administrative efficiency and sustainability in global port call operations.

6.1.3. Port and Berth Arrival

For the analysis of this phase, the process has been divided into two sub-processes: internal navigation and nautical technical services. This approach is taken because, although the two sub-processes are interconnected, there may be specific characteristics that apply exclusively to one of them. Analysing them separately enhances the clarity of the analysis and allows for a more precise focus on the expected outcomes.

6.1.3.1. Internal Navigation

Regarding the remaining standards, the S-210's data exchange capabilities can be adapted to create a standardized format for sharing real-time vessel information within the port, thereby enhancing situational awareness and coordination. Meanwhile, the focus of S-212 on VTS services offers potential port-specific benefits such as real-time traffic updates, route recommendations, and virtual berthing assistance. Both standards fulfil functions related to operations conducted within the port’s operational scope.

For internal navigation phases, similar standards as those used in deep-sea navigation can be applied. This is because the exchanged information pertains to navigation conditions. Thus, standards like the S-100 for the Universal Hydrographic Data Model and the S-200 series, particularly S-210 Inter VTS Exchange Format and S-212 VTS Digital Information, remain relevant. Specifically, S-100 covers hydrographic conditions of the port, including seabed updates on depths, underwater features, and sediment types.

Just as with the S-421 related to the deep-sea navigation phase, in the context of internal navigation, this standard facilitates the communication of route exchanges. It should be noted that there are ports where the distance between the port entry area and the terminal locations can be several nautical miles. In these contexts, this type of information is very relevant as it allows all parties to know in detail what the route of a vessel will be, and therefore it can be shared by all stakeholders.

Gaps and Overlaps

Regarding gaps and overlaps in this phase, no significant issues are identified. Existing standards serve distinct purposes, coordinating stakeholders involved in the process and providing tools for the use and transfer of relevant information in internal navigation.

Barriers

- Technological barrier
- Low level of implementation
- Infrastructure Limitations

Regarding internal navigation within ports, the implementation of JIT arrival faces significant barriers that impede its effective deployment. Standards such as the S-100 for the Universal Hydrographic Data Model, S-210 Inter VTS Exchange Format, and S-212 VTS Digital Information are critical for sharing real-time vessel information and enhancing situational awareness and coordination. However, persistent technological barriers exist due to varying degrees of digitalization among port facilities and stakeholders. Many ports still rely on outdated systems and manual processes, hindering the seamless integration of JIT arrival practices and real-time data exchange necessary for efficient port operations.

Moreover, the low level of implementation of these standards poses a fundamental hurdle. Despite their potential benefits, many ports have yet to fully adopt and implement these standards uniformly across different regions and facilities. This inconsistency in implementation undermines the effectiveness of JIT arrival strategies, leading to inefficiencies in port operations and coordination.

Expanding on the list of barriers, additional challenges include infrastructure limitations, such as outdated communication systems and inadequate port facilities, which can impede the effective exchange of real-time vessel information. Regulatory complexities and compliance requirements across different jurisdictions also create barriers to the standardized implementation of digital navigation standards. Harmonizing regulatory frameworks is crucial to facilitate the seamless adoption of JIT practices.

Furthermore, the digitalization of internal navigation processes raises concerns about data privacy and cybersecurity. Ensuring secure transmission and storage of sensitive vessel information is essential to gain trust among stakeholders and facilitate the adoption of JIT arrival practices. Addressing these barriers requires collaborative efforts among port authorities, maritime stakeholders, and regulatory bodies to invest in digital infrastructure, streamline regulatory frameworks, enhance cybersecurity measures, and promote standardized implementation of digital navigation standards. This comprehensive approach will support the effective integration of JIT arrival practices and improve operational efficiency within port environments.

6.1.3.2. Nautical Services

In the phase of nautical services, the importance of having standards becomes more relevant due to the fact that several stakeholders (vessel, pilot, towage, VTS, and mooring services) operate simultaneously, requiring precise and frequently updated information. The IHO standards S-124, S-125, and S-131 work together to enhance nautical services during port calls. S-124 (Navigational Warnings) provides real-time updates on hazards and changes to navigation aids, crucial for pilots and tug operators when manoeuvring ships. S-125 (Marine Aids to Navigation) offers

detailed information on buoys, lighthouses, and other physical aids within the port, allowing for precise navigation and safe berthing. Additionally, the S-421 once again have applications in this instance as they allow communication between all participants in this phase, thus facilitating the coordination of operations by having a common standard for route exchange.

The most direct link to services comes from S-131 (Marine Harbour Infrastructure). This standard acts as a digital port map, detailing berth locations, service areas (bunkering, repairs), and service availability (towing, pilotage, mooring). By knowing which berths require tug assistance, for example, ships can request this service efficiently. Additionally, S-131 can include contact information for service providers, facilitating communication and optimizing port call experiences for all stakeholders.

In addition to navigation assistance and nautical technical information, there are standards that harmonize the process itself, focusing on defining the key events that trigger the participation of nautical services. In this regard, as we have seen previously, the DCSA standards on JIT and its API specification facilitate the exchange of information about these processes. We also find the developments of TIC4.0, which have created the definition of the terminal arrival process from the perspective of the most important events, considering the information needs of terminals for the correct development of their activities and operational processes. These processes are captured in a data model called the TOS Data Model, which has been previously mentioned. Finally, the S-211 standard also contains information on the definition of various events.

Gaps and Overlaps

The situation of standardization in this section of the port call and JIT process is considered appropriate with respect to possible gaps. This is because communications about traffic, navigation conditions, and intercommunication between vessels, towages, and pilots are supported by IHO standards in their S-100 series, among which S-131 on infrastructure conditions could be highlighted. However, an overlap is observed, especially regarding process definition, since, as seen in the port call request phase, initiatives such as DCSA, TIC4.0, ISO 28005, and S-211 have created standards in this regard. Particularly between DCSA and TIC4.0, although there are attempts to achieve interoperability, the necessary progress has not yet been made.

Barriers

- Technological barrier
- Low level of implementation

Regarding the barriers related to the implementation of JIT in nautical services processes, we find technological limitations, such as outdated systems in many ports that hinder real-time data exchange, crucial for efficient operations. Additionally, the low implementation of JIT practices in ports limits potential improvements in efficiency and operations.

Operational resistance within traditional maritime practices also poses a barrier, slowing down the adoption of JIT practices. Varied regulatory complexities across jurisdictions further complicate standardized implementation, while infrastructure limitations impede efficient data exchange necessary for JIT arrival.

Addressing these challenges requires collaborative efforts to modernize infrastructure, harmonize regulations, and promote universal adoption of JIT practices. Such initiatives are necessary for optimizing nautical services, enhancing port efficiency, and realizing the benefits of JIT arrival in maritime operations.

6.1.4. Vessel and Cargo Service

The final stage of the process is related to terminal operations and their impact on JIT. One of the main characteristics is the absence of standards beyond maritime container logistics, as the main initiatives come from DCSA and TIC4.0, both fully focused on these operations. DCSA promotes the work of the Ship Message Design Group (SMDG) on the Load List and Bay Plan, a set of UN/EDIFACT based message standards for the digital communication of information about container cargo and stowage on container ships. This aims to improve the efficiency and predictability of port operations. With precise information about container cargo and stowage, port terminals can better plan their resources and operations, such as crane allocation, container movements, and stowage on the vessel. This can reduce the waiting time of ships in port. On the other hand, DCSA has published its API-based Container Track & Trace standards, which provide real-time visibility into container movements and status, allowing for accurate arrival time predictions and better coordination between vessels, ports, and terminal operators.

On the other hand, TIC4.0 and its process definition, combined with the data model, provide a series of standards through which interoperability between sea-side and land-side interfaces can be achieved. By using the same data format, communication between terminals is more homogeneous. Additionally, we can observe that the widely used UN/EDIFACT standards, which facilitate the exchange of operational and administrative information between terminals and vessels, are compatible with TIC4.0. This compatibility arises from the alignment being developed by TIC4.0 to incorporate the most relevant EDIFACT information within its standard.

Gaps and Overlaps

Finally, in the final phase of the process, we encounter a clear gap, which is the absence of ensuring full Track & Trace of the cargo throughout the process. From the terminal's perspective, especially from TIC4.0, there is no specific standard that tracks cargo and is interoperable with DCSA developments. On this issue, extending the analysis to other types of non-containerized operations, there also appears to be a lack of available standards to guarantee this tracking. Regarding overlaps, currently, the processes developed by TIC4.0 and DCSA for arrival and departure are not compatible, thus representing an overlap in this respect.

Following a summary of the different standards and their impact on the various phases of port call operations, this section will address the different gaps, overlaps, and barriers that hinder the implementation of these standards and the enhancement of operational efficiency. These conclusions will serve as inputs to identify potential requirements and recommendations in the next chapter, aiming to address some of these inefficiencies. The goal is to make the standardization map more comprehensive, thereby achieving new levels of interoperability in operations such as JIT, which involve a wide range of stakeholders.

Barriers

- Low level of implementation
- Low level of coordination
- Technological barrier

Terminal operations in the context of implementing JIT practices face several barriers that impact their efficiency and interoperability. One significant challenge is the low level of implementation of standardized processes, particularly beyond maritime container logistics. While initiatives like DCSA and TIC4.0 provide standards for container cargo and stowage information, there is a notable absence of comprehensive standards for non-containerized cargo and

full Track & Trace capabilities. This limitation hinders the seamless coordination of operations between terminals, vessels, and other stakeholders.

Another barrier is the low level of coordination among terminals and maritime entities. The lack of standardized processes and interoperable systems between seaside and land-side interfaces complicates data exchange and operational planning. This fragmentation not only affects efficiency but also delays in port operations, such as crane allocation and cargo movements, thereby impacting vessel turnaround times and JIT practices.

Technological barriers also pose a challenge. Many terminals still rely on outdated systems that do not support real-time data exchange effectively. This limitation prevents terminals from achieving optimal efficiency in managing cargo flows and coordinating with vessel schedules. Moreover, the compatibility issues between existing standards (e.g., UN/EDIFACT and TIC4.0) further exacerbate these technological challenges, creating overlaps and inconsistencies in data handling and communication protocols.

6.1.5. Standardisation landscape

Once the landscape has been reviewed and the initiatives compared, it can be concluded that there are no significant gaps in the sector regarding the availability of standards to be applied. There are initiatives covering all phases, with standards of varying types. The only area where a lack of standards or, at the very least, a low level of interoperability can be observed is in the phase associated with cargo loading and unloading operations. Regarding overlaps, the situation is similar, with overlaps only present in the port call request process and the port/berth arrival phase, specifically within nautical services. In both cases, these overlaps are related to the duplication of standards aimed at harmonizing the same processes. Therefore, it can be concluded that applicable developments exist throughout the process considered for the implementation of JIT port call arrival and port call optimization initiatives, with no major difficulties arising from these dimensions.

Table 5 Standardisation landscape related to the main phases of the port call process.

Phase of the process		Gaps	Overlaps	Barriers
Passage Planning		No gaps	No overlaps	• Low level of implementation • Political (due to the IMO processes) • Low level of digitalization
Port Call Request		No gaps	Process duplication	• Low level of coordination • Political • Low level of digitalization • Low level of implementation • High level of investment required
Port/Berth Arrival	Internal Navigation	No gaps	No overlaps	• Technological barrier • Low level of implementation
	Nautical Services	No gaps	Process duplication	• Technological barrier • Low level of implementation
Vessel/Cargo service		Absence of T&T of the cargo	No overlaps	• Low level of implementation • Technological barrier • Low level of coordination • High level of investment required

As for the barriers and constraints analysed, different types of barriers can be identified across all phases of the process. One notable characteristic is the repetition of barriers across various phases, such as the low level of digitalization and the low level of standard implementation, which are closely linked. Later in this study, these issues will be examined in more detail to identify best practices and actions to address the situation. In conclusion, the general landscape of standardization in the sector is largely determined by the low level of standard implementation. This is primarily due to the need for stakeholders to implement changes in their activities, driven by investment requirements, operational needs, or resistance to sharing information that is considered commercially sensitive and strategic by each organization.

6.2. Legal Aspects

The approach to understand the legal and regulatory framework within which the project for implementing a Port Call JIT operation is situated will be analysed differently from the standardization section due to the differing nature of these dimensions. For this analysis, it has been determined that the most appropriate way to understand how the legal and regulatory framework impacts the process is through the identification of enablers and their impact on the various phases of the port call process. On the other hand, the constraints that hinder the deployment of a JIT operation in ports will also be examined, as specific regulations may discourage parties from making the necessary changes to achieve the required interoperability.

Table 6 The impact of different regulations on the port call process

Initiative	Type of regulation	Phases of the Process				
				Port/Berth Arrival		
		Passage Planning	Port Call Request	Internal Navigation	Nautical Services	Vessel/Cargo Service
SOLAS	**SAFETY** Safety of Life at Sea	x		x	x	
MARPOL	**ENVIROMENTAL** Prevention of Pollution from Ships	x				x
COLREG	**SAFETY** Prevention of Collisions at Sea	x		x	x	
FAL	**ADMINISTRATIVE** Facilitation of International Maritime Traffic		x			x
STCW	**SAFETY** Standards of Training, Certification and Watchkeeping for Seafarers	x		x		
SAR	**SAFETY** Stands for Search and Rescue	x		x	x	

EMSWe	**ADMINISTRATIVE** Port call process		x			
Fit for 55	**ENVIROMENTAL** Reduction of GHG.	x		x		

To provide contextual insight, Table 6**¡Error! No se encuentra el origen de la referencia.** shows all regulatory bodies and organizations that represent the interests of different groups within the maritime port sector, as well as the agreements that seek to regulate the industry. As seen in the table, the Type of Regulation column details the specific field that each regulation aims to cover. Similarly, to the comparative analysis of standards, we have included in the table the parts of the port call process that are impacted by the different regulations. This allows for an appreciation of how well-covered the sector is, enabling the identification of any potential over-regulation. This last point is important as it facilitates the understanding of possible enablers and barriers, since depending on the affected phase, the enablers and barriers may differ.

To facilitate the comparison between different regulations, a categorization will be made based on the type of regulation being referred to. This categorization will be divided into sets of initiatives from the perspective of Safety, Environmental, Administrative, Operative, and Operational. Within each category, the scope of each regulation will be detailed to differentiate them and identify the points at which and the ways in which they affect JIT operations.

6.2.1. Safety

Safety is a paramount concern in the maritime industry, given the inherent risks associated with sea navigation and port operations. This essay delves into the critical international regulations and conventions that govern maritime safety, focusing on their impact on JIT arrival operations at ports. The key regulations and conventions discussed include the International Regulations for Preventing Collisions at Sea (COLREG), the International Convention for the Safety of Life at Sea (SOLAS), the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW), and the International Convention on Maritime Search and Rescue (SAR).

Navigation and Collision Avoidance

One of the fundamental aspects of maritime safety is navigation and collision avoidance, governed by the COLREG and supported by SOLAS and STCW. The COLREG convention provides a framework of rules to prevent collisions at sea, defining the responsibilities of vessels to avoid accidents and ensure safe navigation. By ensuring that vessels follow these standardized rules, COLREG minimizes the risk of collisions, which can cause significant delays and disruptions to JIT schedules.

SOLAS complements COLREG by setting minimum safety standards for navigation equipment and practices. Provisions under SOLAS mandate modern navigation equipment, such as Automatic Identification Systems (AIS) and Electronic Chart Display and Information Systems (ECDIS), which enhance situational awareness and help prevent collisions. Moreover, STCW ensures that seafarers are adequately trained in navigation and watchkeeping,

further reducing the risk of human error that could lead to accidents. Together, these regulations form a robust framework for safe navigation, crucial for maintaining the precision required in JIT arrival operations.

Emergency Preparedness and Response

Emergency preparedness and response are critical to maintaining safety and efficiency in maritime operations, governed primarily by SOLAS and SAR, with support from STCW. SOLAS encompasses various safety measures, including fire protection, life-saving appliances, and emergency procedures. These measures ensure that ships are adequately prepared for emergencies, reducing the likelihood of incidents that could disrupt JIT schedules.

The SAR convention provides a framework for coordinating search and rescue operations at sea, ensuring that vessels in distress receive timely and effective assistance. Effective implementation of SAR is crucial for minimizing disruptions to JIT operations. If a vessel encounters a distress situation en route to a port, the availability of SAR resources ensures that the situation can be resolved quickly, allowing the ship to resume its journey with minimal delay. STCW supports this by mandating training in emergency response and survival techniques for seafarers, ensuring that crews can effectively handle emergencies and mitigate their impact on operations.

Competency and Training of Seafarers

The competence and training of seafarers are vital to ensuring safe and efficient maritime operations, governed by the STCW convention. STCW sets minimum standards for the training and certification of seafarers, ensuring that crew members are adequately skilled and competent to perform their duties safely. Effective implementation of STCW is crucial for the safety and efficiency of maritime operations, directly impacting the reliability of JIT arrival schedules.

STCW covers various aspects of seafarer training, including safety training, watchkeeping, and emergency procedures. By ensuring that crew members are well-trained and capable of handling complex maritime operations, STCW reduces the risk of human error, which is a significant factor in maritime accidents. For JIT operations, having a competent crew means that ships can navigate and operate efficiently, reducing the likelihood of delays caused by safety incidents or non-compliance with safety protocols. Therefore, STCW compliance enhances the overall safety and efficiency of maritime operations, supporting the timely execution of JIT strategies.

When mapping out the landscape of these regulations, it is evident that each has a distinct scope but collectively contributes to comprehensive maritime safety. COLREG focuses on navigation rules to prevent collisions, SOLAS sets broad safety standards for ship construction and operation, STCW ensures the competence and training of seafarers, and SAR provides a framework for effective search and rescue operations. Together, these regulations form a cohesive safety net that supports the seamless and safe execution of JIT arrival operations in the maritime industry.

6.2.2. Environmental

One of the main focuses currently being addressed by international and regional regulators is environmental impact. This section of the deliverable explores the impact of the major regulations and conventions described in previous sections, such as MARPOL and the European Union's "Fit for 55" package, on JIT arrival operations at ports.

Voyage Planning and Emissions Reduction

A key component of environmental compliance in maritime operations is the meticulous planning of voyages to reduce emissions and fuel consumption. MARPOL Annex VI and Fit for 55 significantly influence this aspect. MARPOL Annex VI sets strict limits on sulfur content in marine fuels, driving the adoption of low-sulfur fuels and technologies like scrubbers. Fit for 55 complements this by extending the EU Emissions Trading System (ETS) to the maritime sector, requiring ship operators to purchase allowances for their CO2 emissions.

To align with these regulations, shipping companies must optimize their routes and speeds to minimize fuel consumption and emissions. For JIT arrival operations, this means integrating environmental considerations into the scheduling process. Advanced voyage planning tools can help find the optimal balance between speed, fuel efficiency, and timely arrivals. By reducing fuel consumption, ships not only comply with emissions regulations but also contribute to cost savings and environmental sustainability, which are essential for maintaining efficient and precise JIT operations.

Adoption of Cleaner Fuels and Technologies

The shift towards cleaner fuels and technologies is a central aspect of both MARPOL and Fit for 55. MARPOL Annex VI encourages the use of low-sulfur fuels and mandates the reduction of nitrogen oxides (NOx) emissions from ship engines. Fit for 55 goes further by setting GHG intensity limits for the energy used by ships and promoting the use of alternative fuels through the FuelEU Maritime initiative.

For JIT operations, the adoption of cleaner fuels and technologies can pose logistical challenges. The availability and logistics of alternative fuels, such as LNG or biofuels, must be factored into voyage planning. Ships may need to coordinate refueling stops more carefully to ensure compliance without disrupting their schedules. Additionally, the adoption of technologies like exhaust gas cleaning systems (scrubbers) and energy-efficient hull designs can support compliance while maintaining operational efficiency. These measures can help ships reduce their environmental impact, ensuring that JIT arrivals are both timely and sustainable.

Port Infrastructure and Services

The Fit for 55 package emphasizes the development of infrastructure for alternative fuels and shore-side electricity at EU ports. This infrastructure is crucial for supporting JIT operations by enabling ships to comply with environmental regulations without significant delays. Ports equipped with facilities for alternative fuels and shore-side power can accommodate the needs of environmentally compliant vessels, ensuring smooth and efficient port calls.

For JIT operations, coordination between ports and shipping companies is essential to ensure that necessary services are available when needed. Ports must invest in the necessary infrastructure to support the transition to cleaner fuels and technologies. This includes expanding bunkering facilities for alternative fuels and providing shore-side electricity to reduce emissions while ships are docked. By facilitating compliance with environmental regulations, ports can enhance the efficiency and sustainability of JIT operations, ensuring that ships can adhere to their schedules without compromising on environmental standards.

Environmental Training and Compliance

Ensuring that crews are adequately trained in environmental regulations and compliance is a critical factor in achieving the objectives of MARPOL and Fit for 55. The STCW mandates training in environmental protection and pollution prevention, ensuring that seafarers are well-versed in the necessary practices and procedures.

For JIT operations, having a well-trained crew means that ships can efficiently handle the requirements of environmental regulations, minimizing the risk of non-compliance and associated delays. Training in areas such as waste management, fuel handling, and emissions reduction ensures that crews can implement best practices effectively. This competence is vital for maintaining the precision and reliability of JIT arrival schedules, as it reduces the likelihood of incidents or delays caused by environmental non-compliance.

In focusing on the scope of both MARPOL and the EU's Fit for 55 package, maritime operations are compelled to enhance their environmental stewardship while maintaining operational efficiency. By rigorously planning voyages to minimize emissions and embracing cleaner fuels and technologies, shipping companies align with stringent regulatory standards. The development of port infrastructure and comprehensive crew training in environmental compliance further fortify the industry's capacity to seamlessly adhere to JIT schedules, thus advancing sustainable practices across maritime operations.

6.2.3. Administrative

From different perspectives, there are various regulations, agreements, and norms aimed at harmonizing and disciplining the administrative processes carried out in ports to ensure the proper development of a port call. This section aims to explore the implications of two key administrative frameworks, FAL and EMSWe, on JIT processes during port calls.

Operational Efficiency

The FAL Convention aims to harmonize administrative procedures across international ports. By setting standards for customs clearance, immigration procedures, and port services, it reduces bureaucratic complexities and delays. This standardization is crucial for JIT operations, as it ensures that ships can efficiently navigate administrative processes and adhere to precise arrival schedules.

Information Exchange

The EMSWe represents a significant advancement in administrative efficiency by integrating multiple administrative procedures into a single electronic platform. This platform facilitates the submission and processing of standardized information related to maritime trade and port operations, including customs declarations, security clearances, and port entry formalities. For JIT arrival projects, EMSWe enables proactive data exchange between ship operators and port authorities, allowing for pre-clearance of vessels and efficient berth allocation. By reducing paperwork and eliminating redundant processes, EMSWe enhances decision-making speed and operational flexibility, ensuring that ports can accommodate vessels precisely when required under JIT strategies.

The FAL Convention focuses on harmonizing administrative procedures such as customs clearance and port services across international ports, aiming to reduce bureaucratic barriers and enhance operational efficiency. In contrast, the EMSWe centralizes administrative processes through an integrated electronic platform. EMSWe facilitates seamless data exchange for customs declarations, security clearances, and port entry formalities, optimizing information flow to expedite vessel clearance and port operations. While FAL emphasizes standardization and procedural harmonization, EMSWe leverages technology to streamline administrative processes and enhance operational flexibility in JIT arrival projects at ports.

6.2.4. Enablers and Constraints

Regulations and conventions established for governance and cooperation among participants in an activity often have diverse impacts beyond the specific field they aim to regulate or discipline. Among these effects, we can identify two clear ones: incentives for agents to take advantage of the new regulations, thereby improving their processes and discovering new levels of productivity, while simultaneously reducing the negative impacts that previously existed in that activity. We categorize these effects as enablers. On the other hand, effects that pose difficulties for stakeholders in complying with regulations will be considered constraints. These initially negative effects discourage parties from supporting initiatives. In the specific case of developing JIT operations in port calls, international regulations and conventions will have significant impacts on the feasibility and commitment of parties to support them, depending on how high the implementation costs are compared to potential benefits.

6.2.4.1. Enablers

For both the analysis of enablers and constraints, we will adhere to the same subdivision used in the comparative analysis, categorizing various groups of conventions and regulations based on their nature. Beginning with enablers, our objective is to identify how regulations or international conventions facilitate the deployment of JIT operations in ports. Implementing new requirements often stimulates opportunities for creating innovative solutions that may not otherwise exist under different circumstances.

Safety

SOLAS and COLREG:

Predictable and stable operating environment:

- *Navigation accuracy and reduced collision risks, allowing ships to adhere more closely to JIT schedules.*
- *Emergency response plans and equipment, which means that ships can quickly recover from incidents and resume their journey without significant delays.*
- *Global acceptance ensures that vessels from different countries follow the same rules, facilitating smoother and more predictable maritime traffic, crucial for JIT operations.*
- *Clear guidelines and responsibilities outlined in COLREG create a predictable and stable operating environment.*

STCW:

- *Ensures that seafarers are adequately trained and certified, reducing the likelihood of human error and supporting the precise execution of JIT schedules.*
- *Ensure a consistent level of competence among seafarers worldwide.*

SAR:

- *Provides a framework for efficient search and rescue operations.*

Environmental

MARPOL and Fit for 55:

- *Enforces strict limits on sulfur content in marine fuels, It incentivizes the development of JIT operations because it would facilitate compliance with the required reduction.*
- *It forces route optimization.*
- *Promotes the use of planning tools.*
- *Implementing the ETS in the maritime system necessitates emissions reduction, making collaboration in a JIT environment appealing.*
- *Promotes technological changes that would not otherwise be carried out, thereby facilitating the implementation of JIT.*

Administrative

FAL and EMSWe:

- *Standardises customs clearance, immigration procedures, and port services across international ports, reducing bureaucratic complexities and delays.*
- *Consolidates multiple administrative tasks into a single electronic platform, enhancing efficiency in maritime trade and port operations.*
- *Facilitates pre-clearance of vessels and efficient berth allocation through proactive data exchange between ship operators and port authorities.*
- *Streamlines customs declarations, security clearances, and port entry formalities, minimizing paperwork and redundant processes.*
- *Improves decision-making speed and operational flexibility, ensuring ports can accommodate vessels precisely as needed for JIT strategies.*

6.2.4.2. Constraints

Regarding possible constraints, the aim is to identify how the obligation and/or necessity to comply with the regulations and conventions mentioned earlier could hinder or discourage parties from collaborating in achieving JIT operations, because the drawbacks would outweigh the potential benefits of implementing such a scheme.

Safety

SOLAS and COLREG:

- ***S.1 - Regulatory Compliance Limits:*** *Compliance with SOLAS and COLREG may require procedures and practices that do not allow for quick adjustments to arrival schedules, especially in high traffic or unexpected weather conditions.*
- ***S.2 - Compliance Challenges:*** *Compliance may necessitate additional resources for crew training and ongoing compliance monitoring, posing logistical and financial challenges.*
- ***S.3 - Compliance Penalties:*** *Safety-related incidents or failure to comply with COLREG may result in lengthy investigations and penalties, disrupting JIT operational planning and execution.*
- ***S.4 - Incident Management Demands:*** *Effective incident management requires additional resources and coordination among stakeholders, potentially affecting JIT operational efficiency.*

STCW:

- ***S.5 - Training Requirements:*** *Meeting these requirements can be time-consuming and may require additional training sessions or certifications.*
- ***S.6 - Crew Flexibility Constraints:*** *Ensuring compliance with STCW standards may restrict the flexibility needed to adjust crew schedules and tasks to accommodate JIT arrival schedule.*
- ***S.7 - Training Costs:*** *Adhering to STCW training standards involves costs associated.*
- ***S.8 - Certification Demands:*** *Maintaining a crew that is consistently trained and certified according to STCW standards requires careful planning and management.*
- ***S.9 - Regulatory Integration:*** *STCW compliance must be integrated with other regulatory frameworks, such as SOLAS and COLREG, which may have overlapped or complementary requirements.*

SAR:

- ***S.10 - Search and Rescue Framework:*** *Provides a framework for efficient search and rescue operations.*
- ***S.11 - Emergency Preparedness:*** *Requires ships to be equipped and crewes to handle emergency situations effectively. While this ensures safety, stringent requirements for emergency preparedness may impact the flexibility needed for JIT operations.*
- ***S.12 - SAR Regulation Impact:*** *Compliance with SAR regulations may necessitate specific procedures and protocols that could potentially delay JIT arrival schedules if emergency situations arise.*
- ***S.13 - SAR Coordination Challenges:*** *Effective implementation of SAR requires seamless coordination and communication between ships, coastal authorities, and SAR services. Delays or gaps in communication could impact the ability to maintain JIT schedules during emergency situations.*

PSC:

- ***S.14 - PSC Audit Impacts:*** *Possible lack of coordination between the audit of PSC requirements may lead to delays in the planning of the port call turnaround of the vessel.*

Environmental

MARPOL and Fit for 55:

- ***E.1 - Emission Regulations Impact:*** *MARPOL and Fit for 55 regulations may require ships to operate at reduced speeds or with more fuel-efficient practices to meet emission limits. This can affect ships' ability to maintain precise JIT arrival schedules as they balance energy efficiency with time constraints.*
- ***E.2 - Fuel Supply Coordination:*** *Coordinating the availability and supply of these fuels at ports, as well as refueling logistics, is crucial for JIT operations.*
- ***E.3 - Reporting Requirements:*** *Shipping companies must adhere to strict reporting and monitoring requirements under MARPOL and Fit for 55, including emission data submission and compliance certificates. Managing these requirements may require significant resources and impact attention to JIT arrival schedules.*
- ***E.4 - Waste management and disposal:*** *Possible scenarios where the different stakeholders involved in the management of waste and disposals do not have a sufficient level of communication and coordination, which could jeopardize the vessel's stay time in port.*

Administrative

FAL Convention and EMSWe:

- ***A.1 - Procedure Efficiency:*** *While standardizing these procedures can reduce bureaucratic delays, the need for thorough documentation and compliance with FAL requirements can affect the efficiency of JIT arrival schedules.*
- ***A.2 - EMSWe Integration:*** *Adherence to EMSWe requirements may require shipping companies to integrate their systems and ensure data accuracy, impacting JIT scheduling and operational flow.*
- ***A.3 - Jurisdictional Challenges:*** *Differences in interpretation or implementation across jurisdictions may still pose challenges for seamless JIT arrival operations, requiring careful coordination and compliance management.*
- ***A.4 - EMSWe Data Alignment:*** *Integration with EMSWe requires shipping companies to align their data systems with port authorities for timely submission and clearance of required documentation.*
- ***A.5 - Training for Compliance:*** *Compliance with FAL and EMSWe necessitates adequate training and preparation of personnel involved in administrative tasks and data management.*

This numbered list is designed to streamline the process of identifying the specific constraint to be analyzed in the subsequent chapter. It will help in establishing the potential requirements or actions needed to address and overcome the identified constraints effectively. By organizing constraints in this manner, we aim to provide a clear framework for developing targeted strategies to address each constraint in line with our goals.

6.2.5. Regulatory Landscape

As demonstrated throughout this section, the European maritime and port sector is governed by a diverse set of regulations impacting various levels of the vessel call process. However, it is not definitively clear whether these regulations hinder the development of port call optimization activities or, conversely, if the existence of these measures compels stakeholders to enhance operational efficiency to realize the benefits of the regulations.

What can be established is that there are negative and discouraging aspects associated with measures that reduce flexibility in the process, forcing stakeholders to duplicate processes or complicate activities that were previously simpler. This applies to all types of regulations, whether related to safety, environmental concerns, or administrative matters.

Nevertheless, measures that drive operational efficiencies, such as those from programs like FIT for 55 or similar initiatives, can encourage companies to adopt more efficient practices. However, it is important to note that such measures are not always accessible to everyone. Often, they require investments that may be beyond the reach of companies and organizations without substantial financial backing.

7. Preliminary Requirements

The purpose of this section is to outline various requirements that will help overcome the gaps, overlaps, and barriers identified in the previous section. Since the development of this deliverable coincides with the start of the project, the conclusions and possible requirements will serve as support and guidance for the different work packages and tasks whose development relies on the various concepts developed in this section.

Before starting with the presentation of the different requirements, actions, and initiatives, a brief explanation will be given on the most appropriate way to present the information. Due to the large amount of data that has been compiled throughout the work, the barriers and constraints of the standardization initiatives and the regulatory framework will be analyzed separately to improve readability and structure sustainable and efficient development over time.

7.1. Standardisation Perspective

Out of the various methods to approach this section, it was decided to focus on potential solutions for the most significant challenges faced by initiatives aimed at driving change. To identify the most critical constraints, common challenges were analyzed across different stages of the process and among various initiatives. Thus, this section will focus on proposing potential solutions to mitigate the impact of these challenges. The list below shows the main constraints identified:

- *Low level of digitalisation & Technological barriers*
- *Low level of implementation*
- *Political*
- *Low level of coordination*
- *High level of investment required & Infrastructure limitations*

The main challenges facing the sector are related to the low adoption of existing standards, the limited level of digitalization, and the disparity in digitalization among stakeholders based on their size. These issues contribute to a third major barrier: the lack of coordination between initiatives and stakeholders, which is crucial for achieving an efficient and synchronized scaling process. Finally, high investment requirements and insufficient infrastructure are barriers present at multiple stages, preventing the sector from having the necessary tools to support its needs.

Since this section will focus only on the most relevant constraints, the complete list of constraints and requirements developed by the participants of this document can be found in the Annex 1 Preliminary Requirements.

The initiatives and actions proposed in this standards section are organized based on the barriers, gaps, and overlaps identified as priorities in the previous section. The analysis will include the relevant phases and standards referenced, as well as the stakeholders involved in these actions, which are recommended for implementation. All requirements identified by the partners of Task 1.1 to address the gaps, overlaps, and constraints uncovered during the workshops have been organized into tables to improve information clarity and structure.

Low Level of Digitalisation and Technological Barriers

To address the low level of digitalisation in a project aimed at optimizing port call operations and JIT arrival, various initiatives are required, particularly focusing on digitalization and modernization. Key stakeholders, such as national governments, technology providers, maritime industry associations, port authorities, and standardization bodies, play an essential role across different phases of the port call process. Efforts should be directed toward modernizing maritime operations by implementing real-time data exchange capabilities and retrofitting existing equipment with digital technologies. Digital standards such as TIC4.0 could help to speed up the uptake process and increase market acceptance, since they are aimed at harmonizing the data exchange. Additionally, partnerships with technology providers can help offer affordable solutions to small and mid-sized maritime entities, especially in crucial phases like passage planning, port call request, port/berth arrival, and vessel cargo service.

Financial incentives also serve as a powerful tool to encourage the adoption of new technologies. Establishing financial instruments will help support the digitalization of the maritime sector. National governments, European Commission (through its “Digital Europe Programme, DIGITAL” and EU4Digital programmes), and relevant industry stakeholders should work together to incentivize the use of these technologies, facilitating the modernization of ports and terminals. Offering these incentives during the passage planning and vessel cargo service phases will help remove financial barriers to the implementation of advanced digital solutions. Encouraging investment in port infrastructure will further enhance the integration of navigation systems and data exchange capabilities.

Promoting digital solutions and fostering the development of digital communities within the EU's maritime sector is another key initiative. This effort could involve incentivizing the use of digital solutions within ports, eventually mandating their use to ensure consistency across EU harbours. Here, the EMSWe could play a significant role, though more effort is needed for its implementation. Building digital port communities and fostering open logistics platforms, particularly for SMEs, will support greater interoperability. Establishing common platforms will promote the seamless integration of systems across stakeholders, including port authorities, technology providers, and standardization bodies, particularly in phases like port call requests and port/berth. Finally, the implementation of standards aimed at easing communication, data collection and port process modelling, like the TIC4.0, can act as drivers for digitalisation. By harnessing the benefits of standardised data, TIC4.0 may act as a showcase for digital standards and, therefore, act as a catalyst for their use.

Table 7 Requirement for overcome the low level of low level of digitalisation & Technological barriers.

Requirement	Stakeholder involved	Process Phase
Digitalization & modernization		
DM.1 - Establish programs to modernize and digitalize maritime operations, with a focus on integrating real-time data exchange capabilities.	-National Governments -Technology providers -Maritime industry associations -Port Authorities -Technology providers -Maritime technology -Standardization bodies -Port Terminals -European Commission	-Passage planning -Port call request -Port/Berth arrival -Vessel cargo service
DM.2 - Invest in modernizing port infrastructure to support digital navigation systems.		
DM.3 - Programmes to retrofit existing equipment with digital technologies.		
DM.4 - Create partnerships with technology providers to offer affordable digital solutions tailored for small to mid-sized maritime entities		
DM.5 - Incentivize the use of digital solutions in the maritime community in the EU.		

DM.6 - Eventually, mandate the offering of services in a digital manner in EU-Harbours.		
DM.7 - Foster the creation of “digital communities” in the logistics sector.		
DM.8 - Facilitate the building of digital port communities in the EU.		
Financial Incentives		
FI.1 - Set up financial instruments to help the digitalization of the sector.	-National Governments -Technology providers -Maritime industry associations -European Commission -Port Authorities -Technology providers -Maritime technology -Standardization bodies -Port Terminals	-Passage planning -Port/Berth arrival -Vessel cargo service
FI.2 - Incentivize the adoption of new technologies through financial instruments.		
Interoperability and technological standardization		
IO.1 - Establish programmes to make terminal systems interoperable (also between Port Authority systems and them).	-European Commission -National governments -Port Authorities -Technology providers -Maritime technology -Standardization bodies.	-Port call request -Port/Berth arrival
IO.2 - Create common open logistics platforms for everyone to use and promote, especially for SMEs.		
IO.3 - Develop a standardized technology framework that ports can adopt to ensure compatibility and interoperability across different systems.		
Training and development		
TR.1 - Train personnel in the usage and adoption of new technologies.	-Port Terminals -Port Authorities -European Commission	-Vessel cargo service
Strategic importance of digitalization		
SD.1 - Stress the importance of digitalization for orchestration.	-National Governments -Technology providers -Maritime industry associations -Maritime technology -Standardization bodies.	-Passage planning -Port/Berth arrival
SD.2 - The integration of advanced navigation technologies within internal port areas is hindered by varying levels of technological sophistication among ports.		

Low level of implementation

To tackle the challenge of low implementation levels in port call optimization, a multifaceted approach is necessary. First, targeted outreach efforts should be launched to raise awareness about the adoption of international standards and advanced technologies. These campaigns, spearheaded by organizations such as the IMO and IHO, alongside national maritime authorities and technology providers, should highlight the long-term benefits of adopting standards like S-100. This awareness drive should cover various aspects of port operations, from passage planning to vessel cargo services.

In parallel, offering financial incentives is crucial for encouraging the adoption of these new technologies. By providing subsidies and financial support to early adopters, the sector can be motivated to implement advanced solutions across all phases of port operations, including passage planning and port/berth arrival. Effective collaboration among national governments, financial institutions, and technology providers will be key to facilitating this financial support.

Furthermore, advancing standardization and technology adoption is vital for improving implementation levels. Efforts should focus on speeding up the integration of S-100 products in national hydrographic offices and transitioning industry standards such as TIC4.0 or DCSA to ISO or EN standards. This will enhance the interoperability and acceptance of new technologies in port operations. Key stakeholders, including international organizations and port authorities, need to work together to drive these changes.

Finally, establishing a robust monitoring and reporting framework will be essential for tracking the progress of standard adoption and identifying areas where additional support is needed. Port authorities and national governments should lead this initiative, with the backing of financial institutions, to ensure effective oversight and support. This comprehensive approach will help address barriers to implementation and improve overall efficiency in port call processes.

Table 8. Requirements to overcome the low level of implementation. Source: own work

Requirement	Stakeholder involved	Process Phase
Campaigns and Promotion		
CP.1 - Launch targeted campaigns to promote the adoption of these standards, emphasizing their long-term benefits in efficiency and safety.	-IMO -IHO -National maritime authorities -Shipping companies -Port Authorities -National Governments -Financial institutions -Technology providers -SDOs	-Passage planning -Port/Berth arrival -Vessel/Cargo service
CP.2 - Promote the use of the S-100 products (S-421) within EU shipping		
CP.3 - Promote the S-100 products through the national representatives of the EU Member States in the IMO/IALA.		
CP.4 - Increase awareness on the benefits of digitalization for the different stakeholders through focused studies and informative campaigns.		
CP.5 - Launch initiatives aimed at promoting the benefits of JIT and the necessary technologies among port operators and stakeholders.		
CP.6 - Promote the adoption of standards through institutions		
Financial Incentives		
FI.3 - Provide financial incentives or subsidies to early adopters to encourage widespread implementation.	-IMO -IHO -National maritime authorities -Shipping companies -Port Authorities -National Governments -Financial institutions -Technology providers -SDOs	-Passage planning -Port/Berth arrival -Vessel/Cargo service
FI.4 - Provide financial incentives or subsidies to ports and operators that implement these standards and technologies.		
FI.5 - Incentivize the adoption of new technologies through financial instruments.		
Standardization and Adoption		
SA.1 - Accelerate the adoption process of S-100 products in national hydrographic offices.	-IMO -IHO -National maritime authorities -Shipping companies -Port Authorities -Port Authorities -National Governments -Financial institutions -Technology providers	-Passage planning -Port/Berth arrival -Vessel/Cargo service
SA.2 - Promote the formal transition of industry standards into ISO or EN standards to maximize acceptance and usage.		

	-SDOs	
Monitoring and Reporting		
MR.1 - Establish a monitoring and reporting framework to track the adoption of these standards and identify areas needing additional support.	-Port Authorities -National Governments -Financial institutions -Technology providers	-Port/Berth arrival

Political

To reduce political barriers in the development of port call optimization, it is essential first to streamline the standardization process at the IMO. This involves creating expedited pathways for critical standards that have a direct impact on port arrival operations. Key stakeholders, including the IMO, national governments, regional maritime organizations, the European Commission, and SDOs, especially ISO, must collaborate to facilitate this process. By doing so, we can ensure that essential standards are adopted quickly and effectively during both passage planning and port arrival requests.

Beyond streamlining standards, promoting the adoption of the EMSWe through harmonization and consensus is crucial. This requires support from a wide range of actors, including national governments, regional maritime organizations, and international bodies such as the IMO and ISO. Harmonization will help unify procedures and improve coordination across different jurisdictions, thereby enhancing efficiency in various phases of port operations.

Encouraging bilateral or regional agreements is also a critical action. These agreements can act as precursors to broader international consensus, helping align standards and practices across different regions. National governments, regional maritime organizations, and the IMO should work together to advance these agreements, which will support the integration and optimization of port arrival processes during passage planning.

Lastly, advocating for the adoption of sector-promoted standards is vital for advancing these initiatives. Engaging with the European Commission and other key stakeholders, including the IMO, DCSA, sectorial (TIC4.0 and DCSA, for example) and general SDOs like ISO, and national and regional maritime organizations, will emphasize the importance of these standards. Effective advocacy will ensure that proposed standards receive the attention they deserve, leading to smoother port arrival processes and enhanced operational efficiency.

Table 9. Requirements to overcome the political constraints. Source: own work

Requirement	Stakeholder involved	Process Phase
Standardization Process		
SP.1 - Streamline the IMO's standardization process by creating expedited pathways for critical standards that impact JIT operations.	-IMO -National governments -Regional maritime organizations -European Commission -SDOs -ISO	-Passage planning -Port call request
SP.2 - Foster the adoption of the EMSWe via harmonization and consensus.		

Requirement	Stakeholder involved	Process Phase
International and Regional Agreements		
IA.1 - Encourage bilateral or regional agreements that can serve as stepping stones towards broader international consensus.	-IMO -National governments -Regional maritime organizations	-Passage planning
Advocacy		
AD.1 - Address the European Commission with the importance of adopting sector-promoted standards.	-IMO -DCSA -SDOs -ISO -European Commission -National governments -Regional maritime organizations.	-Port call request

Low level of coordination

Improving coordination among maritime stakeholders is crucial as it is a key factor for achieving interoperability and synchronization of port calls. A critical strategy involves strengthening collaboration between the DCSA, TIC4.0, the EMSWe, and the ISO Technical Committees (TCs). The same applies for digitalisation and port processes, where TIC4.0 shall align with similar initiatives backed by ISO and/or CEN. By facilitating cross-attendance of experts from these organizations, we can ensure that their efforts are aligned, fostering a more cohesive approach in the development of standards and operational practices during port call requests.

Furthermore, establishing a coordination group that includes representatives from DCSA, EMSWe, TIC4.0 and the ISO TCs can significantly enhance the synchronization of their activities. This group would focus on ensuring that the guidelines and publications from each organization are compatible and complementary, reducing duplication and streamlining the implementation of standards. Such coordination is essential for creating a unified framework that supports effective and efficient operational practices and standards.

On the operational level, it is crucial to strengthen the role of Port Authorities. This involves enhancing their ability to coordinate terminal operations and work closely with terminal operators and nautical service providers. Effective management of these relationships is vital for providing smooth vessel and cargo services and contributes to overall operational efficiency.

Developing platforms like Port Collaborative Decision Making systems (PortCDM) is also a significant step. These platforms enable real-time, event-based communication among the various stakeholders involved in port operations, improving coordination and information exchange. By providing tools that facilitate timely and effective communication, we can enhance the efficiency of port operations and support better integration among the different parties involved in vessel and cargo services.

Table 10 Requirements to overcome the existing low level of coordination. Source: own work

Requirement	Stakeholder involved	Process Phase
Coordination and Collaboration		
CC.1 - Promote the cross-attendance of experts of DCSA, EMSWe, TIC4.0 and ISO TCs.	-DCSA -ISO -TIC4.0 -European Commission -EMSWe promoters	-Port call request -Vessel/cargo service
CC.2 - Create a coordination group between DCSA, EMSWe, TIC4.0 and the ISO TCs.		
CC.3 - Ensure that the publications of all four bodies take each of them into account respectively		
Port Operations and Stakeholder Communication		
PO.1 - Reinforce the Port Authority's role in coordinating terminal operations.	-Terminal operators -Nautical services providers -Port Authorities	-Vessel/Cargo service
PO.2 - Develop platforms like PortCDM that enable real-time event-based communication among the various stakeholders involved in the process.		

High level of investment required & Infrastructure limitations

Navigating the complexities of high investment requirements and infrastructure limitations necessitates establishing robust financial instruments to support the digitalization of the maritime sector. The involvement of the European Commission, national governments, and SDOs (as promoters and keepers of the standards) is crucial for facilitating these investments. This financial support will be essential for replacing outdated equipment with modern digital technologies and updating existing infrastructure, impacting both port call requests and vessel/cargo services.

Additionally, promoting open platforms and digital tools designed for SMEs is critical. Programs aimed at fostering the adoption of these tools can help overcome infrastructure limitations and ensure that SMEs can effectively integrate new technologies. Collaboration between the European Commission, national governments, and SDOs is key to expanding the accessibility and functionality of these digital solutions.

Furthermore, initiatives focused on encouraging the adoption of digital software technologies are essential. These programs will address existing infrastructure challenges and drive the transition toward more efficient port operations. Coordinated efforts among all stakeholders are needed to successfully implement these technologies and enhance overall port operational efficiency.

Table 11 Requirements to overcome the high level of investment required & Infrastructure limitations. Source: own work

Requirement	Stakeholder involved	Process Phase
Financial Support and Incentives		
FI.6 - Set up financial instruments to help the digitalization of the sector.	-SDOs	-Port call request

Requirement	Stakeholder involved	Process Phase
FI.7 - Programmes to replace old equipment with digitalized equipment.	-European Commission -National governments	-Vessel/Cargo service
FI.8 - Programmes to retrofit existing equipment with digital technologies.		
Promotion of Digital Tools and Platforms		
PR.1 - Promote open platforms and open tools for SMEs.	-SDOs -European Commission -National governments	-Port call request -Vessel/Cargo service
PR.2 - Programmes to foster the adoption of digital software technologies.		

This analysis has identified critical barriers to effective port call optimization, including low digitalization, insufficient implementation, political obstacles, poor coordination, and high investment requirements. Addressing these issues requires a multifaceted approach: modernizing maritime operations through digital standards like TIC4.0, DCSA, and others enhancing stakeholder collaboration, and leveraging financial incentives to support technology adoption. Key initiatives include promoting real-time data exchange and establishing robust monitoring frameworks.

To overcome political and coordination challenges, streamlining the standardization process at the IMO and fostering harmonization through EMSWe are essential. Additionally, improving port infrastructure and providing financial support for digital tools, particularly for SMEs, will help address investment constraints and infrastructure limitations. By implementing these strategies, stakeholders can enhance operational efficiency, achieve better synchronization of port calls, and drive the sector toward greater digital integration.

7.2. Regulation perspective:

Following a similar logic to the previous section, the approach here focuses on grouping the various constraints arising from the implementation of the regulations presented in this document based on the type of impact they generate in the sector, regardless of the area or type of regulation. As it will be seen later, impacts on costs, challenges in meeting requirements, and operational impacts, among others, are the result of having to comply with a set of new, stringent rules. The following is the list of impacts under which these barriers will be analysed:

- *Costs and Resources*
- *Operational Flexibility*
- *Coordination and Communication*
- *Compliance and Documentation*

As mentioned, these four areas are affected regardless of the nature of the regulation. For instance, a safety-focused regulation like SAR can lead to increased operational costs or reduce operational flexibility, making it harder to coordinate or implement JIT activities effectively.

In contrast to the previous section, where the analysis was structured around the most relevant constraints, gaps, and overlaps within the set of standards across different phases of the project, this section will focus on defining potential measures and actions to be taken within the various types of regulations considered in this study (Safety, Environmental, and Administrative). This structure will make it easier to link problems to solutions, enabling the identification of specific initiatives within each type of regulation.

Costs and Resources

Just as with the implementation of standards, complying with regulations imposed on the maritime port sector often involves addressing various costs associated with acquiring equipment. To optimize port call operations and JIT scheduling, effective regulatory compliance and stakeholder coordination are crucial. Incentivizing and mandating the use of AIS and ECDIS systems on ships will enhance safety and efficiency, aligning with SOLAS and COLREG regulations. This initiative requires collaboration from the European Commission, the IMO, national governments, and international institutions. Additionally, establishing local academies for crew training and developing formal programs based on IMO requirements are essential. Financial support mechanisms, such as subsidies and grants, should be created to aid in training crew and port personnel. Key stakeholders in this effort include port authorities, port terminals, the European Commission, the IMO, and UNCTAD.

Although these barriers are not insurmountable, they do affect the involved stakeholders, making it important to consider potential negative impacts. However, by enforcing regulations that require the adoption of equipment improving communication and coordination among agents, the sector's ability to achieve efficiency and adhere to expected port call times will increase, ultimately enhancing predictability within the industry.

Table 12 Requirements to overcome the cost and resource constraints. Source: own work

Constraint	Requirement	Regulation	Stakeholders involved
S.2 - Compliance Challenges	Develop financial instruments to promote, subsidize, and incentivize training for crews and port personnel beyond existing instruments in order to facilitate knowledge generation.	SOLAS COLREG	Port authorities Port terminals European Commission, IMO, UNCTAD.
S.7 - Training Costs	Explore grant opportunities or funding programs to offset STCW compliance costs, consider digital or remote training solutions to reduce expenses, and encourage collaboration between shipping companies to share training resources and achieve cost savings.	STWC	European Commission IMO UNCTAD Port Authorities Port terminals Universities Other academic institutions
E.2 - Fuel Supply Coordination	Optimized reporting systems by the IMO and EU could streamline emission data and compliance certificate reporting through unified digital platforms, reducing the administrative burden on shipping companies and aiding JIT scheduling. Additionally, integrate compliance with operational planning tools to combine environmental requirements with scheduling.	MARPOL FIT for 55	IMO European Commission National governments Port Authorities Port terminals Ship owners Customers
E.3 - Reporting Requirements	The IMO and the European Commission could promote strategies for balancing MARPOL and Fit for 55 regulations with JIT requirements, offering guidelines for planning. International and regional organizations might provide incentives, like grants or recognition, for innovative solutions that improve both environmental compliance and operational efficiency.	MARPOL FIT for 55	IMO European Commission National governments Regional governments SDOs

Operational Flexibility

Operational flexibility is crucial for optimized port call operations. However, regulations often restrict this flexibility, leading to operational inefficiencies. Specific measures are necessary to mitigate these effects. To address strict collision regulations, the mandatory use of AIS and ECDIS systems on vessels is essential, as previously discussed. Establishing an international VTS body can further enhance navigation coordination and efficiency. Supported by the European Commission, the IMO, and other key stakeholders, these initiatives aim to balance safety with the need for timely port operations.

It is also vital to tackle crew flexibility and emergency preparedness within JIT operations. Implementing automated crew rotation systems can align crew schedules with JIT arrivals while complying with STCW regulations. Additionally, developing flexible SAR protocols and enhancing regional SAR centers' response capabilities can minimize delays. Close coordination with SAR services and optimizing protocols for low-risk emergencies ensure that critical JIT vessels stay on schedule without compromising safety. These measures require collaboration between port authorities, vessel operators, and national governments to enhance overall operational efficiency.

Table 13 Requirements to overcome the cost and resource constraints. Source: own work

Constraint	Requirement	Regulation	Stakeholders involved
S.6 - Crew Flexibility Constraints.	The use of automated crew rotation systems could be explored to align crew schedules with JIT arrivals, ensuring compliance with STCW work and rest hour requirements while maintaining operational flexibility.	STWC	STWC Ship owner Vessel operators Shipping lines Port terminals European Commission (for labour regulations) National governments (for labour regulations)
S.11 - Emergency Preparedness	Develop flexible SAR protocols for different risk profiles and JIT needs, adapt emergency response with port authorities to avoid disrupting JIT schedules, and enhance regional SAR centres for faster response to minimize delays.	SAR	IMO National governments Port Authorities SAR operators
S.12 - SAR Regulation Impact	Port authorities should coordinate closely with SAR services to adjust JIT schedules in real time. Optimize SAR protocols for low-risk emergencies to reduce delays and introduce prioritization frameworks to keep critical JIT vessels on schedule while balancing safety.	SAR	Port Authorities Vessel operators Ship owners National governments SAR operators
E.1 - Emission Regulations Impact	Multilateral and regional organizations could create coordination networks among fuel suppliers, shipping companies, and port operators to streamline fuel logistics and synchronize refuelling.	MARPOL FIT for 55	IMO European Commission National governments Port Authorities Shipping lines

Coordination and Communication

Optimizing JIT operations in port management requires effective coordination among various stakeholders, despite the complexities introduced by regulations such as SOLAS and COLREG. While these regulations can complicate operations with their stringent requirements, they also provide an opportunity to establish standardized methods for vessel interaction, which can enhance operational coordination and efficiency.

To tackle coordination challenges, it is crucial to develop a unified approach to incident management and communication. This involves working closely with shipping lines, vessel operators, port authorities, and local training academies to prevent incidents and streamline operations. Establishing real-time coordination platforms and conducting cross-border drills are also essential steps in improving communication and minimizing delays. By implementing these strategies, the sector can better navigate regulatory constraints and enhance the effectiveness of JIT operations.

Table 14 Requirements to overcome the coordination and communication constraints. Source: own work

Constraint	Requirement	Regulation	Stakeholders involved
S.4 - Incident Management Demands	Coordinate among stakeholders to prevent incidents and provide training for crews and personnel in safety-related areas.	SOLAS COLREG	IMO Shipping lines Vessel operators Vessel owners Local academies Port Authorities
S.10 - Search and Rescue Framework	Develop global guidelines integrating SAR frameworks with JIT practices to balance safety and minimize delays. The European Commission could harmonize SAR procedures across EU states for consistent emergency management, supporting efficient JIT schedules. Promote next-gen SAR technology, like automated systems and drones, to speed up operations and reduce JIT disruptions.	SAR	IMO Shipping lines Vessel operators SAR operators European Commission Port Authorities National governments
S.13 - SAR Coordination Challenges	Upgrade communication infrastructure for seamless coordination between ships, coastal authorities, and SAR services. Develop real-time SAR coordination platforms linking SAR services, port authorities, and vessels. Conduct joint cross-border SAR drills to improve communication and reduce delays.	SAR	SAR operators IMO Port Authorities European Commission National governments Ship owners Vessel operators
S.14 – PSC Audit Impacts	Efforts in the audit scheduling efficiency may facilitate the implementation of JIT optimization.	PSC	Ship operators Ship managers Ship agents Port Authorities National Authorities
E.2 - Fuel Supply Coordination	Ship agents ensuring prior port call the availability of proper fuels and relevant quantities. Effective communication among stakeholders is necessary to enhance JIT operations and further arrangements.	-	Vessel operators Ship owners Ship agents Ship manager
E.4 – Waste management and disposal	Involved stakeholders in the waste management and disposal could enhance the efficiency of their operations, in order not to introduce any delays and enable JIT scheduling.	MARPOL	Ship owners Ship operators Ship agents Ship managers Service providers
A.3 - Jurisdictional Challenges	Establish formal agreements or MoUs between jurisdictions to align EMSWe implementation practices and responsibilities. Conduct impact assessments to understand how jurisdictional differences affect JIT operations and adjust strategies as needed. Launch pilot projects across various jurisdictions to test EMSWe implementation and gather data on managing these differences	FAL EMSW	European Commission National governments Port Authorities

Compliance and Documentation

Equally important for the success of a JIT implementation is the compliance and documentation according to current regulations. Incorporating current procedures into port call planning is crucial to ensure this; for example, by integrating real-time information (e.g., weather, traffic, etc.) and novel technologies such as berth usage models. Training and crew certification will ensure the full integration of the human factor; these should be regularly updated to keep them informed on the latest regulatory developments. Port authorities, local academies and national and supranational authorities, must work in a coordinated way. A key enabler for the coordination could be a centralized crew certification platform to track STCW compliance and renewals. In this area, the support of the European Maritime Agency (EMA) could act as a cornerstone, since it may act as possible overseer and issuer of the trainings and certificates just like the European Railway Agency (ERA) does for railways.

In addition to these measures, the integration of multiple regulatory documents such as STCW, SOLAS and COLREG should be explored to achieve a unified approach. Simultaneously, this combined effort could facilitate regulatory relaxation of the regulations to aid compliance. However, this should happen only after a significant consensus is reached. Furthermore, authorities must ensure that regulatory easements do not lead to complacency amongst the port actors.

Lastly, the implementation of the EMSWe could be fostered by cost-sharing models and the implementation of trainings and business cases that show ports its benefits. Especially, the main beneficiaries of such a training might be smaller ports, since they usually do not have the same financial or personnel strength as large ports do.

Table 15. Requirements to overcome compliance and documentation constraints.

Constraint	Requirement	Regulation	Stakeholders involved
S.1 - Regulatory Compliance Limits	Incorporate SOLAS and COLREG procedures into port call planning and integrate real-time weather forecasts with berth usage models based on historical conditions and operations.	SOLAS COLREG	IMO Port Authorities
S.3 - Compliance Penalties	Ensure strict enforcement of safety regulations and procedures, conduct COLREG inspections before vessel departures and during port calls, focusing on essential equipment. Retire non-compliant or aging vessels.	SOLAS COLREG	Ship owners IMO European Commission, National governments
S.5 - Training Requirements	Establish local academies for crew training and develop formal training courses and programs based on IMO requirements.	STWC	Local academies National governments IMO Port Authorities (as enablers) Shipping lines (as enablers)
S.8 - Certification Demands	Create centralized platforms for automating crew certification and renewals for STCW compliance. Implement refresher training aligned with operational schedules and appoint dedicated personnel to manage compliance and address issues.	STWC	SDOs European Commission National governments Port Authorities Local academies European Maritime Agency (EMA)

Constraint	Requirement	Regulation	Stakeholders involved
S.9 - Regulatory Integration	Develop a system integrating STCW, SOLAS, and COLREG compliance for a unified approach. Create training programs covering multiple frameworks to streamline compliance and conduct regular internal audits to ensure adherence and alignment with JIT practices.	STWC	SDOs European Commission EMA National governments Local academies Port Authorities
A.1 - Procedure Efficiency	Relaxing requirements to aid compliance is crucial but should be coordinated through working groups to prevent disparities among ports and maintain consistent standards.	FAL EMSWe	European Commission IMO National governments Port Authorities (as stakeholders)
A.2 - EMSWe Integration	The European Commission's Reporting Interface Module (RIM) uses eDelivery for secure data exchange and is currently in testing. International organizations like the IMO could adopt this model and establish global working groups for a similar platform.	FAL EMSWe	European Commission IMO Port Authorities Shipping lines Vessel operators Ship owners
A.4 - EMSWe Data Alignment	Develop cost-sharing models and subsidies to help smaller ports and companies with EMSWe implementation. Offer financial assistance and scalable solutions tailored to their needs. Conduct cost-benefit analyses to show the long-term value of EMSWe investment.	FAL EMSWe	Port Authorities European Commission National governments Shipping lines Port terminals
A.5 - Training for Compliance	Organize regular training sessions and workshops to educate stakeholders on EMSWe requirements and best practices and offer certification and accreditation for personnel who complete these programs.	FAL EMSWe	IMO European Commission Local academies Port Authorities Port terminals Shipping lines

In conclusion, to address the identified challenges, several effective strategies are proposed. Firstly, to mitigate associated costs, it is crucial to promote the mandatory use of advanced technologies such as AIS and ECDIS, establish training centers for personnel, and provide financial incentives. These measures will facilitate regulatory compliance and optimize operations without sacrificing efficiency.

Furthermore, to improve operational flexibility and coordination, it is recommended to implement automated crew rotation systems and strengthen rescue coordination centers with enhanced protocols. Creating real-time communication platforms and standardizing incident management procedures are also essential. Finally, integrating regulatory documents and promoting cost-sharing models for the implementation of systems like EMSWe will help simplify compliance. These initiatives will lead to more efficient port management and ensure a more agile response to regulatory challenges.

8. Conclusions

After conducting a comprehensive analysis of the standardization landscape and the regulatory framework applied to the port call process, it can be preliminarily observed that there is a wide range of initiatives that adequately cover the entire process, providing different tools to achieve the necessary harmonization to attain the required interoperability if we expect to have the minimum coordination needed to deploy JIT arrival operations. Standards for the exchange of data and nautical information, such as those developed by the IHO (S-1xx series), IALA (S-2xx series), and IEC with S-421, administrative standards like ISO28005 and S-211, and operational standards such as DCSA and TIC4.0, are examples that demonstrate the existence of sufficient developments carried out by large international organizations. However, if we observe in more detail, it can be seen that even with this scenario, the sector has not managed to incorporate the available standards in a generalized manner. Barriers such as a low level of digitalization, implementation costs, and internal political barriers of different countries conspire to deploy all the potential that these types of tools offer.

Additionally, the regulatory framework is seen with advantages and disadvantages in the context of the project. An assessment of the potential impact that different regulations would have on JIT arrival operations reveals that those that intend to motivate, through certain benefits, the reduction of emissions through operational optimizations will generate the necessary incentives for stakeholders to support port call optimization initiatives. However, those regulations that impose rigidity on the operations of vessels, ports, terminals, nautical services, etc. Regulations such as SOLAS, MARPOL, and FIT for 55 are examples of measures that, in their intention to reduce emissions in the sector, incentivize the different actors to introduce operational efficiencies, within which JIT arrival is one of the most important. However, other groups of regulations such as SAR, COLREG, or the STWC tend to introduce regulations that potentially impact the reduction of flexibility by reducing reaction times to unexpected events, restricting the possibilities of complying with JIT schedules.

Based on these findings, different requirements have been proposed that would potentially reduce the negative impact on the sector and increase the chances of success of projects like MISSION in the search to optimize port calls. Some of these initiatives are aimed at increasing the implementation of standards by supporting stakeholders to facilitate their access to funding sources for the incorporation of technological equipment that increases the level of digitalization of the sector, a key factor for the deployment of the different standards. Actions such as the development of information exchange platforms like single windows, port CDMs, and Port Community systems are key for the different systems to interoperate.

Regarding the impact of the regulatory framework, the initiatives will be oriented to incentivize through regulations the reduction of operational inefficiencies, incentivize the incorporation of ECDIS compatible with SOLAS and MARPOL regulations, provide flexibility to regulations by considering exceptions according to the possibilities of the different stakeholders, without this generating a wide range of ad-hoc regulations that generate heterogeneity and therefore hinder standardization. For this, it is important that, in addition to multilateral organizations, there are regional coordination bodies that discipline the activities, such as the EMSWe, designed to generate the same regulatory framework regardless of the location of the port or the institution that regulates it.

As a final reflection, the analyses carried out in this work and the findings that have been found should serve this project to identify the measures that best adapt to the tools to be developed to achieve the defined objectives of the project. This information base shows what the general and particular panorama of standardization is in the sector and what actions improve that panorama. Without neglecting the regulatory impacts, the regulations that may have the greatest impact on the project and how stakeholders should act to overcome these difficulties should be considered.

9. References

[1] DCSA. (June 2022). *DCSA Interface Standard for Just In*. Available in: https://dcsa-website.cdn.prismic.io/dcsa-website/65a7a8d77a5e8b1120d59b23_202206_DCSA_Just-in-TimePortCallOptimisation1.2Beta1_InterfaceStandard.pdf

[2] European Commission. (2024). *CO2 emissions from shipping – encouraging the use of low-carbon fuels*. Available in: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12312-CO2-emissions-from-shipping-encouraging-the-use-of-low-carbon-fuels_en

[3] European Commission. (2024). *EU Emissions Trading System (EU ETS)*. Available in: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en

[4] European Union - EUR-Lex. (2020). *Regulation (EU) 2020/1056 of the European Parliament and of the Council of 15 July 2020 on electronic freight transport information* . Available in: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32020R1056&qid=1725280193915

[5] European Union - Euro-Lex. (2019). *Regulation (EU) 2019/1239 of the European Parliament and of the Council of 20 June 2019 establishing a European maritime single window environment and repealing Directive 2010/65/EU*. Available in: https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX%3A32019R1239

[6] European Union. (2022). *Commission Delegated Regulation (EU) 2023/205 of 7 November 2022 supplementing Regulation (EU) 2019/1239 of the European Parliament and of the Council as regards the establishment of the European Maritime Single Window environment data set and amending it.* Brussels, Belgium.

[7] IAPH. (2023). *IAPH official website*. Retrieved on 30th May 2024, Available in: https://www.iaphworldports.org

[8] IAPH, IHMA, IHO, ITPCO. (2023). *Guide for Nautical Data.* Available in: https://portcalloptimization.org/images/Guide%20for%20Nautical%20Data%201.3.pdf

[9] IHO. (2024). *ENC Production* . Available in: https://iho.int/en/enc-production

[10] IHO. (2024). *S-100 based Product Specifications* . Available in: https://iho.int/en/s-100-based-product-specifications

[11] IHO. (2024). *SECOM overview - IEC 63173-2 MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DATA INTERFACE* – Available in: https://iho.int/uploads/user/Inter-Regional%20Coordination/WWNWS/S-124PT/S-124%20PT1/S124PT1_2020_2.7_EN_SECOM_overview_v1.0.pdf

[12] IMO . (2024). *International Convention for the Safety of Life at Sea (SOLAS)*. Available in: https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-(SOLAS),-1974.aspx

[13] IMO. (1991). *REGIONAL CO-OPERATION IN THE CONTROL OF SHIPS AND DISCHARGES.* Available in: https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.682(17).pdf

[14] IMO. (1999). *GUIDELINES FOR VOYAGE PLANNING.* Available in: https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.893(21).pdf

[15] IMO. (2020). *Just In Time Arrival Guide.* Available in: https://greenvoyage2050.imo.org/wp-content/uploads/2021/01/GIA-just-in-time-hires.pdf

[16] IMO. (13 de 5 de 2022). *AMENDMENTS TO THE ANNEX TO THE CONVENTION ON FACILITATION OF*. Available in: https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/FALDocuments/FAL.14%2846%29.pdf

[17] IMO. (2024). *COLREG - Preventing collisions at sea*. Available in: https://www.imo.org/en/OurWork/Safety/Pages/Preventing-Collisions.aspx

[18] IMO. (2024). *FAL CONVENTION*. Obtenido de https://www.imo.org/en/OurWork/Facilitation/Pages/FALConvention-Default.aspx

[19] IMO. (2024). *FAL declarations and certificates*. Available in: https://www.imo.org/en/OurWork/Facilitation/Pages/DeclarationsCertificates-default.aspx

[20] IMO. (2024). *IMO Compendium on Facilitation and Electronic Business. Just In Time Concept, Data structure report*. Available in: https://imocompendium.imo.org/public/IMO-Compendium/Current/Submodels/JIT/s11.htm

[21] IMO. (2024). *International Convention for the Prevention of Pollution from Ships (MARPOL)*. Available in: https://www.imo.org/en/about/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx

[22] IMO. (2024). *Port State Control*. Available in: https://www.imo.org/en/ourwork/msas/pages/portstatecontrol.aspx

[23] IMO. (2024). *The IMO Compendium on Facilitation and Electronic Business*. Available in: https://www.imo.org/en/ourwork/facilitation/pages/imocompendium.aspx

[24] International Maritime Organization. (31 de March de 2023). *GUIDELINES FOR HARMONIZED COMMUNICATION AND ELECTRONIC EXCHANGE.* Available in: https://wwwcdn.imo.org/localresources/en/OurWork/Facilitation/FAL%20related%20nonmandatory%20documents/FAL.5-CIRC.52.pdf

[25] International Task Force for Port Call Optimisation (ITPCO). (2024). *Business process.* Available in: https://portcalloptimization.org/images/Business%20process%20220222.pdf

[26] ISO. (2024). *ISO 28005-2:2021*. Available in: https://www.iso.org/standard/74059.html

[27] ISO. (2024). *ISO/PRF 28005-1*. Available in: https://www.iso.org/es/contents/data/standard/08/38/83881.html

[28] ISO. (2024). *ISO/PRF 28005-3*. Available in https://www.iso.org/standard/83631.html

[29] Terminal Industry Committee 4.0. (2023). *CarrierVisit Events*. Available in: https://tic40.atlassian.net/wiki/spaces/TIC40Definitions/pages/999718925/CarrierVisit+Events

[30] Terminal Industry Committee 4.0. (2024). *Cargo Visit.* Available in: https://tic40.atlassian.net/wiki/spaces/TIC40Definitions/pages/877232284/CargoVisit

[31] Terminal Industry Committee 4.0. (2024). *Carrier Visit.* Available in: https://tic40.atlassian.net/wiki/spaces/TIC40Definitions/pages/878641169/CarrierVisit

[32] Terminal Industry Committee 4.0. (2024). *Carrier Visit Events.* Available in: https://tic40.atlassian.net/wiki/spaces/TIC40Definitions/pages/999718925/CarrierVisit+Events

[33] Terminal Industry Committee 4.0. (2024). *TIC4.0 Semantic*. Available in: https://tic40.atlassian.net/wiki/spaces/TIC40Definitions/pages/8618041/TIC4.0+Semantic

[34] UN/EDIFACT. (2024). *UN/EDIFACT*. Available in: https://unece.org/fileadmin/DAM/trade/untdid/d16b/trsd/trsdeqn.htm

[35] UNCTAD. (2020). *TRANSPORT AND TRADE FACILITATION, Serie No 13.* Available in: https://unctad.org/system/files/official-document/dtltlb2019d2_en.pdf

[36] World Bank Group. (2023). *Port Community Systems: Lesson From Global Experience.*

Annex 1 Preliminary Requirements

The following tables outline the requirements identified by the partners of Task 1.1 to address the gaps, overlaps, and constraints uncovered during the workshops conducted.

Operational Perspective

Table 16 Constraints and incentives in the Passage Planning phase

Constraints Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
Low level of implementation	Many maritime entities have yet to fully adopt existing standards, which impedes the seamless coordination and efficient information exchange that are critical for Just-In-Time operations. 1. *Launch targeted campaigns to promote the adoption of these standards, emphasizing their long-term benefits in efficiency and safety.* 2. *Provide financial incentives or subsidies to early adopters to encourage widespread implementation.* Stakeholders involved: IMO, IHO, national maritime authorities, shipping companies.
Political (due to the IMO processes)	Political barriers, influenced by the lengthy processes within the IMO, can delay standardization efforts. This includes the harmonization of diverse national policies and regulatory frameworks. 1. *Streamline the IMO's standardization process by creating expedited pathways for critical standards that impact JIT operations.* 2. *Encourage bilateral or regional agreements that can serve as steppingstones towards broader international consensus.* Stakeholders involved: IMO, national governments, regional maritime organizations.
Low level of digitalization	Many maritime organizations still rely on outdated systems and manual processes, which are insufficient for the real-time data exchange required for JIT arrival. This technological gap increases the complexity and cost of integrating advanced navigation technologies and systems.

	1. *Establish programs to modernize and digitalize maritime operations, with a focus on integrating real-time data exchange capabilities.* 2. *Create partnerships with technology providers to offer affordable digital solutions tailored for small to mid-sized maritime entities.* Stakeholders involved: National governments, technology providers, maritime industry associations.
Interoperability Issues	The lack of interoperability between different navigation technologies and systems creates barriers to the seamless implementation of JIT practices. 1. *Develop and enforce interoperability standards across different systems to ensure smooth data exchange.* 2. *Encourage collaborative development of technology solutions that prioritize compatibility with existing systems*. Stakeholders involved: IALA, IEC, technology developers, maritime industry stakeholders.
Cybersecurity Concerns	The digitalization of deep-sea navigation raises significant concerns about data security, particularly regarding the transmission and storage of sensitive navigation data. 1. *Implement robust cybersecurity frameworks and standards tailored specifically for the maritime industry.* 2. *Regularly conduct cybersecurity training and awareness programs for maritime personnel.* Stakeholders involved: IMO, IALA, cybersecurity experts, maritime organizations.
Cost of Compliance	The high cost associated with complying with new standards and upgrading systems to meet these requirements can be a significant barrier, especially for smaller operators. 1. *Offer financial assistance programs or tax incentives to offset the costs of compliance.* 2. *Provide a phased implementation plan that allows operators to spread out the costs over time*. Stakeholders involved: National governments, international financial institutions, shipping associations.

Port Call Request

Overlaps:

Table 17 Overlaps and initiatives in the Port Request phase

Overlap Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
Harmonizing Efforts Between DCSA, ISO 28005, and EMSWe	1. *Coordinate with European institutions to compare DCSA, ISO 28005 and EMSWe coverage and areas (Stakeholders: DCSA, ISO, European Commission, EMSWe promoters)* 2. *Identify overlapping areas and adapt the standards to prevent these (Stakeholders: DCSA, ISO, European Commission, EMSWe promoters)* 3. *Adoption of the most accepted solution as standard when an overlap occurs (Stakeholders: DCSA, ISO, European Commission, EMSWe promoters)* 4. *Incorporate DCSA's and ISO 28005 systems and procedures into the EMSWe (Stakeholders: DCSA, ISO, European Commission, EMSWe promoters)*

Table 18 Constraints and initiatives in the Port Request phase

Constraints Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
Low level of coordination	3. *Promote the cross-attendance of experts of DCSA, EMSWe and ISO TCs (Stakeholders: DCSA, ISO, European Commission, EMSWe promoters)* 4. *Create a coordination group between DCSA, EMSWe and the ISO TCs (Stakeholders: DCSA, ISO, European Commission, EMSWe promoters)* 5. *Ensure that the publications of all three bodies take each of them into account respectively (Stakeholders: DCSA, ISO, European Commission, EMSWe promoters)*
Political	1. *Address the European Commission with the importance of adopting sector-promoted standards (Stakeholders: DCSA, ISO, European Commission)* 2. *Foster the adoption of the EMSWe via harmonization and consensus.*
Different size of organizations	1. *Actively ensure that representatives of the small organizations can be represented at committees and forums of the European Commission and ISO Stakeholders: DCSA, ISO, European Commission)*
Low level of digitalization	1. *Set up financial instruments to help the digitalization of the sector (Stakeholder: European Commission)* 2. *Foster the creation of "digital communities" in the logistics sector (Stakeholders: European Commission, national governments, potential support actions by TIC4.0, DCSA, ISO and other associations or bodies)* 3. *Create common open logistics platforms for everyone to use and promote, especially for SMEs (Stakeholders: European Commission, national governments, potential support actions by TIC4.0, DCSA, ISO and other associations or bodies)*

High level of investment required	1. *Set up financial instruments to help the digitalization of the sector (Stakeholder: European Commission)* 2. *Promote open platforms and open tools for SMEs (Stakeholders: European Commission, national governments, potential support actions by TIC4.0, DCSA, ISO and other associations or bodies)*

Internal Navigation

Table 19 Constraints and initiatives in the Internal Navigation phase

Constraints Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
Technological barrier	1. *Set up financial instruments to help the digitalization of the sector* 2. *Incentivize the use of digital solutions in the maritime community in the EU* 3. *Eventually mandate the offering of services in a digital manner in EU-Harbours* 4. *Facilitate the building of digital port communities in the EU* 5. *Stress the importance of digitalization for orchestration* The integration of advanced navigation technologies within internal port areas is hindered by varying levels of technological sophistication among ports. Many ports still utilize outdated systems that are not compatible with newer, more efficient digital navigation tools. 1. *Invest in modernizing port infrastructure to support digital navigation systems. This includes upgrading communication networks and installing advanced navigational aids.* 2. *Develop a standardized technology framework that ports can adopt to ensure compatibility and interoperability across different systems.* Stakeholders Involved: Port Authorities, national governments, technology providers, maritime technology standardization bodies.

Low level of implementation	1. *Promote the use of the s-100 products (S-210/212) within EU-shipping.* 2. *Promote the S-100 products through the national representatives of the EU-Member states in the IMO/IALA* 3. *Accelerate the adoption process of S-100 products in national hydrographic offices.* 4. *Despite the availability of standards and technological solutions for internal navigation, there is a significant lag in their adoption and implementation across different ports. This inconsistency hampers the effectiveness of Just-In-Time operations.* 5. *Launch initiatives aimed at promoting the benefits of JIT and the necessary technologies among port operators and stakeholders.* 6. *Provide financial incentives or subsidies to ports and operators that implement these standards and technologies.* 7. *Establish a monitoring and reporting framework to track the adoption of these standards and identify areas needing additional support.* Stakeholders Involved: IMO, national maritime authorities, port authorities, shipping companies. central VTS
Infrastructure Limitations	Some ports may lack the physical infrastructure required to support efficient internal navigation. This includes insufficient berthing space, inadequate communication systems, and lack of real-time data exchange capabilities. 1. *Allocate resources for the physical expansion and upgrading of port infrastructure, particularly in high-traffic ports.* 2. *Implement smart port technologies that allow for the efficient use of existing infrastructure through better data management and real-time communication systems.* Stakeholders Involved: Port Authorities, national governments, international financial institutions, technology providers
Cybersecurity Concerns	The increasing digitalization of internal navigation processes exposes ports to cybersecurity risks, including potential data breaches and system disruptions. 1. *Develop and implement robust cybersecurity protocols specifically tailored for port operations.* 2. *Conduct regular cybersecurity training for port staff and ensure that all systems are regularly updated to protect against emerging threats.* Stakeholders Involved: Port Authorities, cybersecurity experts, national maritime authorities, technology providers.

Nautical Services

Table 20 Overlaps and initiatives in the Nautical Service phase

Overlap Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
Overlap in Port Call and JIT Standards: DCSA and TIC4.0 Interoperability Issues	1. *Establish working groups to collaborate on common standards.* 2. *Develop platforms or translation interface programs to enhance interoperability.* 3. *Jointly participate in international organizations and create a network of sector associations for coordination.*

Table 21 Constraints and initiatives in the Nautical Services phase

Operational Resistance	Traditional practices in maritime operations often resist changes, including the adoption of JIT practices. This resistance can slow down the implementation of more efficient processes. 1. *Conduct workshops and training sessions to demonstrate the operational and economic benefits of JIT practices.* 2. *Involve key stakeholders in the planning and implementation stages to ensure buy-in and reduce resistance.* Stakeholders Involved: Port Authorities, Nautical Service Providers, Shipping Companies, Maritime Training Institutions.
Regulatory Complexities	The variation in regulatory requirements across different jurisdictions complicates the standardization and implementation of JIT practices in nautical services. 1. *Work towards harmonizing regulations across jurisdictions through international agreements and cooperation.* 2. *Promote the adoption of international standards that facilitate the seamless integration of JIT practices.* Stakeholders Involved: IMO, National Governments, Regulatory Bodies, Port Authorities.

Infrastructure Limitations	Some ports may lack the necessary infrastructure to support advanced nautical services and the implementation of JIT operations. This includes insufficient communication systems and inadequate physical infrastructure. 1. *Invest in upgrading port infrastructure, focusing on improving communication networks and building facilities that support JIT operations.* 2. *Encourage public-private partnerships to fund and accelerate infrastructure development.* Stakeholders Involved: National Governments, Port Authorities, Private Investors, International Financial Institutions.

Vessel/Cargo service

Table 22 Gap and initiatives in the Vessel/Cargo Service phase

Gap Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
Absence of Comprehensive Track & Trace Standards in Cargo Operations	1. *Monitor current and future Track and Trace technologies.* 2. *Identify existing common standards and potential areas for further standardization. Standards might include those of other areas (e.g. air transport, GS1 barcodes, etc.) to use as an example or basis* 3. *Establish guidelines for the adoption of track and trace standards.* 4. *Develop new standards based on the results of the monitoring and guidelines.*

Table 23 Overlaps and initiatives in the Vessel/Cargo phase

Overlap Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
Incompatibility Between TIC4.0 and DCSA Standards for Arrival and Departure Processes	1. *Establishment of a joint TIC4.0 – DCSA Task Force to coordinate the incompatibilities between both standards and reach a consensus (Stakeholders: TIC4.0, DCSA)*

Table 24 Constraints and initiatives in the Vessel/Cargo Service phase

Constraints Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
Low level of implementation	1. *Promote the adoption of standards through institutions (Stakeholders: European Commission + standardization organizations)* 2. *Promote the formal transition of industry standards into ISO or EN standards to maximize acceptance and usage (Stakeholders: SDOs)* 3. *Incentivize the adoption of standards (Stakeholders: SDOs, European Commission)* 4. *Incentivize the adoption of new technologies through financial instruments (Stakeholders: European Commission)*
Technological barrier	1. *Train personnel in the usage and adoption of new technologies* 2. *Incentivize the adoption of new technologies through financial instruments (Stakeholders: European Commission)* 3. *Programmes to replace old equipment with digitalized equipment (Stakeholders: European Commission)* 4. *Programmes to retrofit existing equipment with digital technologies (Stakeholders: European Commission)* 5. *Establish programmes to make terminal systems interoperable (also between Port Authority systems and them) (Stakeholders: Port Authorities, Port Terminals)*
Low level of coordination	1. *Reinforce the Port Authority's role in coordinating terminal operations (Stakeholders: Port Authority)*
High level of investment required	1. *Programmes to replace old equipment with digitalized equipment (Stakeholders: European Commission)* 2. *Programmes to retrofit existing equipment with digital technologies (Stakeholders: European Commission)* 3. *Programmes to foster the adoption of digital software technologies (Stakeholders: European Commission)*

Regulation Perspective

Safety

SOLAS and COLREG:

Table 25 Constraints and initiatives in the Safety Regulations, applied to SOLAS & COLREG

Constraints Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
S.1 Compliance with SOLAS and COLREG may require procedures and practices that do not allow for quick adjustments to arrival schedules, especially in high traffic or unexpected weather conditions.	1. *Introduction of SOLAS and COLREG procedures into port call planning* 2. *Introduce real-time weather forecasts and conditions into port planning. Create berth usage models based on past conditions and operations*
S.2 Compliance may need additional resources for crew training and ongoing compliance monitoring, posing logistical and financial challenges.	1. *Creation of local academies for crew training (Stakeholders: Port Authorities, Port Terminals)* 2. *Creation of formal training courses and programmes based on IMO requirements (Stakeholders: Port Authorities, Port Terminals)* 3. *Financial instruments to promote, subsidize and incentivize training actions for crews and port personnel (Stakeholders: European Commission, IMO, UNCTAD)*
S.3 Safety-related incidents or failure to comply with COLREG may result in lengthy investigations and penalties, disrupting JIT operational planning and execution.	1. *Adequate enforcement of safety regulations and procedures* 2. *Enforce COLREG inspections prior to the departure of vessels and integrate them into port calls, especially of essential equipment (radar, radio, AIS systems, GPS positioning…)* 3. *Retirement of non-compliant vessels or vessels nearing the end of its service life (Stakeholders: ship owner, IMO, European Commission, national authorities)*
S.4 Effective incident management requires additional resources and coordination among stakeholders, potentially affecting JIT operational efficiency	1. *Coordination between stakeholders to prevent incidents (Stakeholders: port terminal, ship operator, shipping line, VTS services, mooring personnel, port authority)* 2. *Training of crews and personnel in safety-related areas to prevent incidents*

STCW:

Table 26 Constraints and initiatives in the Safety Regulations, applied to STCW

Constraints Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
S.5 Meeting these requirements can be time-consuming and may require additional training sessions or certifications.	3. *Creation of local academies for crew training* 4. *Creation of formal training courses and programmes based on IMO requirements*
S.6 Ensuring compliance with STCW standards may restrict the flexibility needed to adjust crew schedules and tasks to accommodate JIT arrival schedule.	1. *The use of automated crew rotation systems could be explored to align crew schedules with JIT arrivals, ensuring compliance with STCW work and rest hour requirements while maintaining operational flexibility.* 2. *Cross-functional training programs might offer a way to allow crew members to perform multiple roles, potentially easing task redistribution when arrival times fluctuate due to JIT schedules.* 3. *Another option could be developing "Just-In-Time" shifts within the STCW framework to better accommodate JIT operations without disrupting necessary rest periods.*
S.7 Adhering to STCW training standards involves costs associated.	1. *Looking into grant opportunities or funding programs could help offset the costs associated with STCW compliance, particularly when tied to innovations like JIT arrivals and port call optimization.* 2. *A potential cost-saver might be implementing digital or remote training solutions that meet STCW requirements while reducing the financial burden of in-person training.* 3. *Collaboration between shipping companies could also help reduce costs, for example, by sharing training facilities and programs to achieve economies of scale.*

S.8 Maintaining a crew that is consistently trained and certified according to STCW standards requires careful planning and management.	1. *Centralized platforms for managing crew certifications could help automate the process of tracking expiry dates and renewals, ensuring continuous compliance with STCW standards.* 2. *Implementing regular refresher training aligned with operational schedules may also help ensure that crew certifications remain up to date without disrupting JIT operations.* 3. *It might also be worth considering the appointment of personnel dedicated to managing STCW compliance, who can oversee certification planning and address potential issues before they impact operations.*
S.9 STCW compliance must be integrated with other regulatory frameworks, such as SOLAS and COLREG, which may have overlapped or complementary requirements	1. *A system that integrates STCW, SOLAS, and COLREG compliance could provide a unified approach, making it easier to manage overlapping requirements and ensuring smooth operations.* 2. *Training programs that address multiple regulatory frameworks in a single course may help reduce redundancy and streamline the process of maintaining compliance across all relevant standards.* 3. *Regular internal audits could be useful to ensure that compliance with STCW, SOLAS, and COLREG is maintained, allowing organizations to align these requirements with JIT arrival practices.*

SAR:

Table 27 Constraints and initiatives in the Safety Regulations, applied to SAR

Constraints Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
S.10 Provides a framework for efficient search and rescue operations.	1. *Develop global guidelines that integrate both Search and Rescue frameworks and Just-In-Time arrival practices. This would ensure that safety is maintained while minimizing operational delays in non-emergency situations.* 2. *Entities such as the European Commission could promote the harmonization of SAR procedures across EU member states, ensuring consistency in emergency management. This reduces variability in SAR operations and enables JIT schedules to be maintained more efficiently in European waters.* 3. *Promote next-generation SAR technology, such as automated emergency response systems, drones, and enhanced satellite communication tools, to accelerate SAR operations and reduce disruptions to JIT schedules.*
S.11 Requires ships to be equipped and crewed to handle emergency situations effectively. While this ensures safety, stringent requirements for emergency preparedness may impact the flexibility needed for JIT operations.	1. *Develop flexible SAR compliance protocols that take into account the vessel's operational risk profile and JIT needs. These could allow for variations in emergency drills and preparedness measures, especially for vessels on low-risk voyages.* 2. *Collaborate between port authorities and shipping companies to adapt emergency response protocols, ensuring safety and compliance without affecting port call schedules for JIT operations. This could include tailored drills based on the risk assessment of individual voyages.* 3. *Multilateral bodies, such as the European Maritime Safety Agency (EMSA), could enhance regional SAR coordination centers, allowing for faster response times. This could reduce the need for vessels to delay their operations, ensuring they can maintain JIT schedules during non-critical incidents.*

S.12 Compliance with SAR regulations may necessitate specific procedures and protocols that could potentially delay JIT arrival schedules if emergency situations arise.	1. *Port authorities could establish closer working relationships with SAR services, allowing for pre-emptive coordination of arrival schedules and emergency protocols. This would enable ports to adjust JIT schedules based on real-time information without significant delays.* 2. *SAR protocols optimized for low-risk or quickly resolved emergencies. By creating procedures that minimize disruptions in such scenarios, JIT operations could proceed with fewer delays.* 3. *The European Commission and similar organizations could introduce prioritization frameworks, allowing vessels with critical JIT operations to receive clearance to continue their schedules when appropriate, balancing safety with the need for operational efficiency.*
S.13 Effective implementation of SAR requires seamless coordination and communication between ships, coastal authorities, and SAR services. Delays or gaps in communication could impact the ability to maintain JIT schedules during emergency situations.	1. *Communication infrastructure upgrades to improve communication between ships, coastal authorities, and SAR services, ensuring that coordination is seamless.* 2. *Creation of real-time SAR coordination platforms by international bodies: Multilateral organizations could develop real-time digital platforms that link SAR services, port authorities, and vessels. This would facilitate more efficient responses.* 3. *Joint cross-border SAR drills in different jurisdictions. This would ensure smooth communication and coordination between multiple SAR services, reducing the likelihood of delays.*

PSC:

Table 28 Constraints and initiatives in the Safety Regulations, applied to PSC

Constraints Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
S.14 Possible lack of coordination between the audit of PSC requirements may lead to delays in the planning of the port call turnaround of the vessel.	1. *Efforts in the audit scheduling efficiency may facilitate the implementation of JIT optimization.*

Environmental

MARPOL and Fit for 55:

Table 29 Constraints and initiatives in the Environmental Regulations, applied to MARPOL and FIT for 55.

Constraints Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
E.1 Coordinating the availability and supply of these fuels at ports, as well as refueling logistics, is crucial for JIT operations.	1. *Multilateral and regional organizations could potentially facilitate the creation of coordination networks between fuel suppliers, shipping companies, and port operators. These networks would help streamline fuel supply logistics and ensure that refueling is synchronized.*
E.2 Shipping companies must adhere to strict reporting and monitoring requirements under MARPOL and Fit for 55, including emission data submission and compliance certificates. Managing these requirements may require significant resources and impact attention to JIT arrival schedules.	1. *Optimized reporting systems by the IMO and EU would streamline the reporting of emission data and compliance certificates. Developing unified digital platforms for data submission and monitoring could reduce the administrative burden on shipping companies and allow them to focus on maintaining JIT schedules.* 2. *Integration of compliance with operational planning tools. Encourage the development of integrated planning tools that combine environmental compliance with operational scheduling.*
E.3 To comply with JIT arrival under MARPOL and Fit for 55 regulations, shipping companies need to develop operational and planning strategies that balance environmental requirements with the need for precise schedule adherence.	1. *The IMO and the European Commission could promote the creation of dual-compliance strategies that help shipping companies balance MARPOL and Fit for 55 regulations with JIT requirements. This could involve guidelines on how to plan voyages and operations to meet both environmental and scheduling objectives.* 2. *To support shipping companies in developing effective strategies, international bodies and regional organizations could offer incentives for innovative solutions that address both environmental compliance and operational efficiency. This could include grants or recognition programs for companies that successfully implement such strategies.*

E.4 Possible scenarios where the different stakeholders involved in the management of waste and disposals do not have a sufficient level of communication and coordination, which could jeopardize the vessel's stay time in port.	1. *Involved stakeholders in the waste management and disposal could enhance the efficiency of their operations, in order not to introduce any delays and enable JIT scheduling.*

Administrative

FAL Convention and EMSWe:

Table 30 Constraints and initiatives in the Administrative Regulations, applied to FAL Convention and EMSWe

Constraints Description	Measure, initiative, or statement to overcome the situation & Stakeholders involved
A.1 While standardizing these procedures can reduce bureaucratic delays, the need for thorough documentation and compliance with FAL requirements can affect the efficiency of JIT arrival schedules.	1. *Relaxing requirements to favor compliance by the different parties: It is important to establish this flexibility in a coordinated manner through working groups to avoid a scenario where this flexibility creates disparities in requirements among ports applying the EMSWe.*

A.2 Adherence to EMSWe requirements may require shipping companies to integrate their systems with port authorities to ensure data accuracy and the timely submission and clearance of required documentation, impacting JIT scheduling and operational flow.	1. *Requirements for interfaces between systems: As part of the adoption projects by the European Commission, the development of the Reporting Interface Module (RIM) is underway. This is a technical infrastructure on which this data exchange is to take place. It utilizes eDelivery, the secure data exchange platform. It is currently in the testing phase.The development of such tools is necessary for the correct and secure exchange of information between the various stakeholders. This would reduce the resistance of the parties to share information, due to the ease of implementing these solutions.* 2. *International organizations such as the IMO could adopt the best practices of the European Commission regarding the RIM and establish working groups for the development of a similar platform with a global reach.*
A.3 Differences in interpretation or implementation across jurisdictions may still pose challenges for seamless JIT arrival operations, requiring careful coordination and compliance management.	1. *Establish formal agreements or Memorandums of Understanding (MoUs) between jurisdictions to align on EMSWe implementation practices and responsibilities.* 2. *Perform impact assessments to understand how jurisdictional differences affect JIT operations and adjust strategies accordingly.* 3. *Launch pilot projects in different jurisdictions to test EMSWe implementation and gather data on how to manage jurisdictional differences effectively.* 4. *Organize policy dialogues and forums where stakeholders from different jurisdictions can discuss challenges, share solutions, and collaborate on EMSWe implementation.*
A.4 The costs for the different parties may favor larger ports and private companies at the expense of those ports and companies that are unable to afford the necessary investment.	1. *Develop cost-sharing models or subsidies to help smaller ports and companies cover the investment required for EMSWe implementation.* 2. *Provide financial assistance or grants to smaller ports and companies to support their investment in EMSWe-related infrastructure and technology.* 3. *Create scalable EMSWe solutions that can be adapted to the size and needs of different ports and companies, allowing smaller entities to invest incrementally.* 4. *Perform cost-benefit analyses to identify and highlight the long-term advantages of EMSWe investment for smaller ports and companies, demonstrating the value of the initial expenditure.*

A.5 Compliance with FAL and EMSWe necessitates adequate training and preparation of personnel involved in administrative tasks and data management	1. *Organize regular training sessions and workshops for stakeholders to educate them on EMSWe requirements and standard practices.* 2. *Provide certification and accreditation opportunities for personnel who complete training programs on FAL and EMSWe compliance.*