

Why are most ports still not ready for Just-in-Time Arrivals?

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Port logistics

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In general, the optimisation of port call processes is approached as a technological challenge when, in reality, the main obstacle is not the availability of systems or the level of digitalization, but the ability of the port community to trust shared data and make joint decisions based on them.

Many port communities already have Port Community Systems (PCS), sophisticated port call planning systems have been developed, bridges can be established to connect different systems through APIs, and standards such as IALA S-211, TIC4.0 and DCSA enable different stakeholders to share key port call information using a common language.

However, few port communities, if any, have reached the level of coordination, trust and governance required to turn this data into collaborative decisions that enable operations based on Just-in-Time Arrivals (JIT Arrivals) principles and optimise the sequence of vessel arrivals and departures through Port Call Optimisation (PCO) concept.

It is therefore clear that port communities need to complement their technology strategies with initiatives aimed at strengthening cohesion. The implementation of digital platforms, standards and services is a necessary, but not sufficient, condition. Only when it is understood that optimising the port community as a whole creates more value than optimising each organisation individually do data stop being an end in themselves and become drivers of efficiency.

In response to growing regulatory requirements to reduce emissions while also improving the efficiency of port calls, the maritime-port sector have developed a range of initiatives based on digitalisation, information sharing and improved coordination among the different stakeholders. Among these is the initiative promoted by the International Maritime Organization (IMO) to facilitate **JIT Arrivals**.

This concept aims to enable **vessels to adjust their speed so that they arrive at the port exactly when the required resources are available**, avoiding unnecessary waiting times and reducing fuel consumption and emissions (GloMEEP, 2020). The logic seems straightforward: if all stakeholders involved in the processes have access to accurate information and share it in real time, operations will be more efficient.

Illustration 1| Comparison of Conventional Operations and JIT Arrivals.



Source: *JIT Arrivals Guide – Barriers and Potential Solutions (GloMEEP Project (2020))*.

In this context, **planning a Just-in-Time arrival consists of an iterative coordination process between the port and the vessel**. Based on knowledge of the port's operational situation, i.e. the availability of berths, pilots, tugs, mooring services and other critical resources, the port's traffic management service proposes a Requested Time of Arrival (RTA) that optimises the planned sequence of vessel arrivals and departures and the utilisation of available resources. In return, the vessel approaching responds with a Planned Time of Arrival (PTA), calculated according to its operational capabilities and the speed required to meet that time. This exchange can be repeated iteratively until both parties **reach a mutually agreed schedule**.

For this process to be viable, the **port must have collaborative systems** capable of integrating and sharing operational information in real time (Pahl, 2024). Up-to-date knowledge of terminal status, the availability of nautical services, as well as developments in other scheduled port calls, provide the basis for calculating and updating the RTA with sufficient advance notice and reliability.

As a result, many ports have invested in information systems, Port Community Systems, PortCDM-type collaborative platforms, planning tools and data-sharing solutions. Nevertheless, reality shows that **having the technology does not necessarily mean operating according to Just-in-Time principles**.

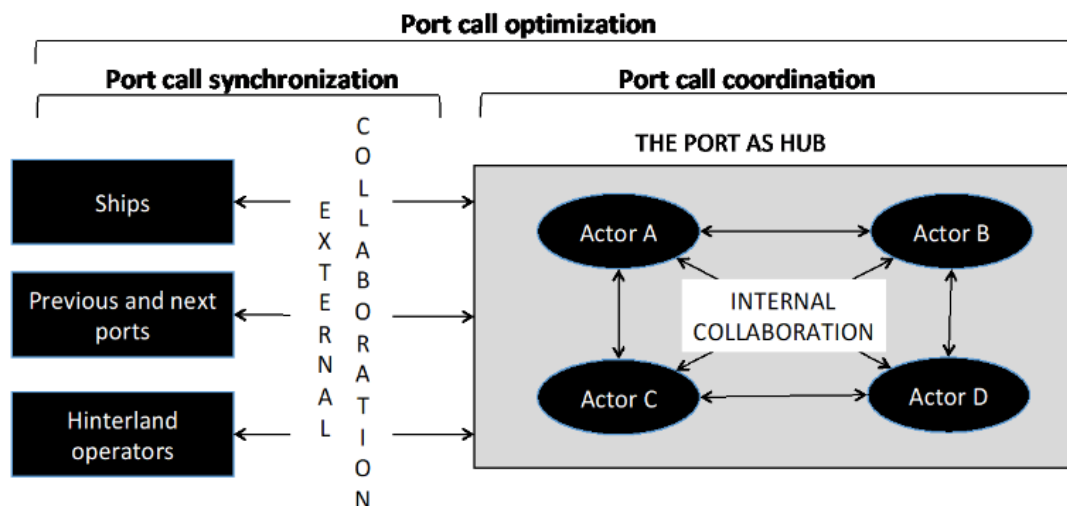
In fact, a challenging question is beginning to emerge in many port forums: **why, after years of digitising processes, do waiting times, last-minute changes to plans and underutilised resources still persist?** The answer is rarely to be found in the absence of data, but rather the **difficulty of overcoming the traditional lack of transparency** in processes and **turning that data into coordinated decisions** among all the stakeholders involved in the port call process.

The main challenge for JIT Arrivals is not technological, but collaborative

Unlike other digital transformation processes, the success of a **JIT** port call **does not depend on a single organisation**. It requires shipping lines, agents, terminals, pilots, tug operators, mooring services, port authorities and vessel traffic services to share a common view of the operation, sharing key events in real time, accurately updating forecasts and **acting on them in a coordinated manner**. A terminal may be highly digitalised and have the most advanced Terminal Operating System (TOS) on the market and yet still be unable to operate in JIT mode if the other stakeholders continue to work with fragmented information or if procedures are not synchronised.

For this reason, the key question is no longer whether a port has advanced digital tools. The real **question is** whether a **port community has reached the level of maturity needed to use these tools collectively**, move beyond information silos and one-to-one integrations, and create collective value.

Illustration 2 | Collaborative processes among stakeholders related to port call processes.



Source: Lind, M. et al. (2018). *Port collaborative decision making (PortCDM): An enabler for port call optimization empowered by international harmonization*.

The experience accumulated over the past decade confirms that the **implementation of JIT Arrivals is**, above all, **a progressive process of building trust, standardising data, aligning procedures and establishing shared governance mechanisms**. The concept of Port Collaborative Decision Making (**PortCDM**), developed as one of the key pillars of the Sea Traffic Management (**STM**) paradigm, was validated through pilot projects in nine

European ports, demonstrating that the benefits of operational synchronisation depend less on the technology available than on the ability of stakeholders to share information in a structured way and act on a common situational awareness. Similarly, subsequent **Port Call Optimisation (PCO)** initiatives promoted by the International Association of Ports and Harbours (IAPH), including demonstrations carried out in ports such as Rotterdam and Singapore, have reinforced the same conclusion: before a port call can be optimised, it is **essential that all participants share a consistent and reliable view of the operational reality**, as well as a common understanding of the processes that underpin it.

Today, the main **standards** for information exchange in port calls **are no longer evolving in divergent directions**, but towards a common vision based on **standardised events, harmonised semantics and collaborative planning**. This convergence is also reflected in European projects currently under development, such as **MISSION** and **DYNAPORT**, which are validating interoperable approaches to the optimisation of port calls and voyage planning through secure information exchange, improved situational awareness and the synchronisation of operational decisions between vessels, ports and service providers.

The real **challenge** is no longer to develop new technologies, but to ensure that **organisations with different objectives**, responsibilities and cultures **are able to use them in a co-ordinated manner**.

The technology illusion

There is a tendency to believe that introducing new digital tools automatically leads to operational improvements. However, experience shows that the mere **availability of technology does not guarantee its effective use**. A system may be successfully implemented from a technical perspective and yet remain underused by potential users if processes, incentives or decision-making mechanisms do not evolve at the same pace. Digital transformation is not simply about digitising information, but about **transforming the way organisations use it to create value** (Westerman et al., 2014).

This limitation is particularly relevant in the port environment, where the efficiency of a port call does not depend on a single organisation, but on the ability of multiple stakeholders to coordinate decisions concerning shared resources. A vessel's departure affects the future availability of berths, pilots, tugs and mooring services; the simultaneous arrival of several vessels requires priorities to be established based on factors such as traffic type, vessel size, required services and existing operational commitments. **Decisions made during one specific port call therefore constrain the options available for subsequent calls, creating a network of operational dependencies that extends across the entire port system**. In this context, optimising an individual port call is not enough; **the port's port calls and resources must be optimised as a whole**. All stakeholders involved need to be brought on board, otherwise biases will arise. As Arjona et al. (2020) point out, the potential of **JIT Arrivals depends on the ability of the different participants to share information and collaborate in decision-making**, rather than simply on the availability of technology.

The literature on organisational transformation consistently points out that the main **obstacles are rarely technological**: resistance to change, difficulties in aligning interests, and a lack of shared governance mechanisms (Kotter, 1995; Weill & Ross, 2004). But the JIT challenge goes one step further, because it is not about transforming a single organisation, but coordinating several independent organisations, such as shipping lines, terminals, nautical service providers and port authorities, operating under different governance structures, incentives and objectives. **The issue**, then, **is** not technology adoption, but the ability **to share** reliable **information** and make coordinated decisions **among parties that do not report to the same chain of command**.

This has been one of the key conclusions drawn from PortCDM pilot projects and subsequent work on Maritime Informatics, a discipline that systematises many of these findings (Lind et al., 2020). The **benefits of information sharing do not derive solely from greater data availability, but from the ability** of stakeholders **to build a shared situational awareness** and coordinate their actions accordingly (Lind et al., 2018). From this perspective, JIT Arrivals is not simply a digitalisation project, but an exercise in **collaborative governance between organisations**.

Consequently, the key question is no longer whether the port community has the technology required to exchange information in real time. The real **question is** whether **there is sufficient organisational maturity to trust that information, incorporate it into decision-making processes and act in a coordinated manner** on the basis of it.

From sharing information to sharing decisions

Most port digitalisation initiatives have focused on the first half of the equation: sharing information. The **real qualitative leap**, however, occurs **when the port community is able to share decisions**.

Sharing information means that a pilot has access to a vessel's updated ETA. **Sharing decisions means that the shipping line, pilot, terminal and port authority use that same ETA to jointly adjust the port call plan and the processes associated with it**. Sharing information provides visibility. **Sharing decisions creates coordination and transparency**. And it is precisely at this second stage that the difference emerges between a digitalised community and one that is genuinely prepared to operate according to JIT Arrivals principles and achieve optimal port call sequences that minimise idle time and align the actions of all parties around the common goal of maximising the efficiency of the port call sequence as a whole.

The real bottleneck: building a mature community

It is important to **distinguish** between a port's **digital maturity** and its **collaborative maturity**. The first is reflected in the systems it integrates, the data it exchanges and the APIs it exposes. The second lies in its ability to share reliable information, trust third-party data, use common definitions, align operational decisions and optimise the port call as a whole, rather than each individual stage separately.

A port can be digitally sophisticated and technologically advanced while remaining poorly cohesive as a community. It may have a state-of-the-art PCS and, at the same time, lack formal information-sharing agreements or mechanisms that enable operational decisions to be made jointly rather than sequentially, with each link in the chain reacting too late to what the previous one has already decided and communicated through another channel.

It is an uncomfortable distinction because it shifts responsibility. It is easier to request funding for a new software module than to set up a working group involving the port authority, pilots, tug operators, terminals and shipping lines or agents to agree on how they will share information and, above all, how they will trust it. **While technology can be purchased, trust must be built.**

How can a port determine its level of maturity?

Answering this question requires more than measuring the number of systems implemented or the volume of information exchanged between organisations. It requires assessing the extent to which the port community has developed the capabilities needed to share reliable information, build trust in data, coordinate decisions and operate as a single system.

To this end, we have developed the **Port Community Maturity Model (PCMM)** (Ferrús et al., 2026). The model **draws on more than a decade of experience accumulated at the Port of Valencia and through European projects** such as **Monalisa 2.0, STM Validation and MISSION**.

Its purpose is not to classify ports or establish rankings. Rather, it **provides a common language for identifying where a port community stands, the barriers limiting its progress, and the steps that should be taken** to continue advancing towards collaborative operations based on the principles of JIT Arrivals.

The PCMM defines five levels of maturity, ranging from the most reactive to the fully collaborative:

Level 1 – Reactive. Each organisation involved in the port call process makes decisions independently. Information is typically exchanged by telephone, email or VHF radio, and decisions are made with very limited visibility of the other involved parties' operations.

Level 2 – Local Optimisation. Organisations begin to digitalise their own processes, but continue to operate in isolation within silos. Improvements are achieved internally, but co-ordination between stakeholders remains limited and confidence in estimated events is still low.

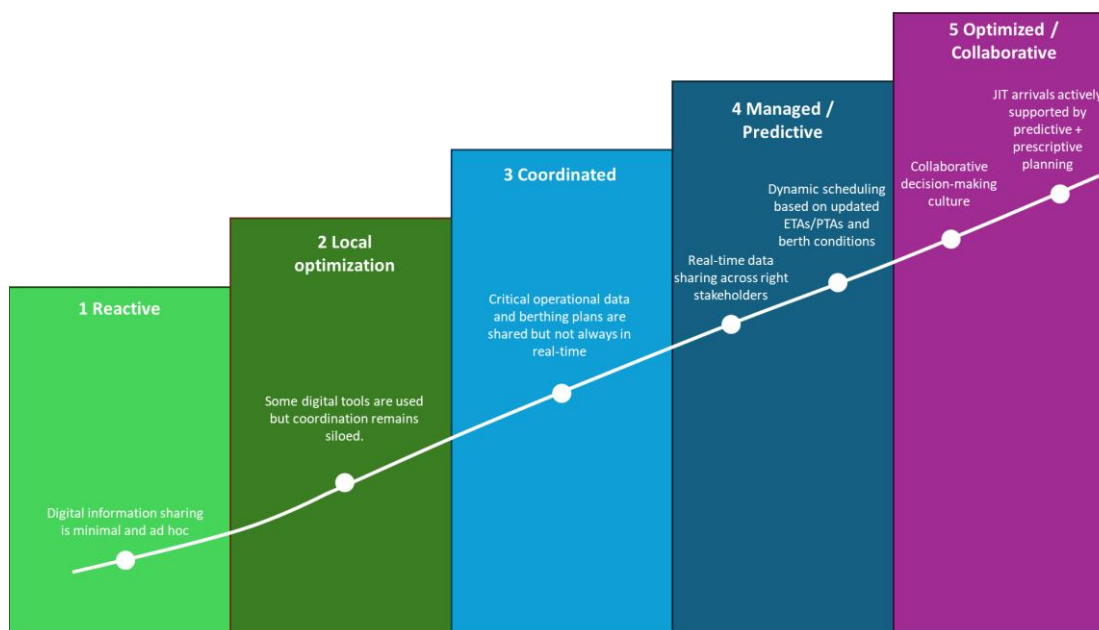
Level 3 – Coordinated. The community begins to share events and data through common standards and platforms. Shared situational awareness is established, although many decisions still require manual validation and rely on personal trust.

Level 4 – Predictive. Shared information makes it possible to anticipate conflicts, optimise resources and plan port calls more accurately. However, governance and collaborative

decision-making mechanisms are still evolving at this stage: who has access to what, under which conditions, and with what guarantees of reliability.

Level 5 – Collaborative. The community operates as a true ecosystem. Data are no longer simply shared; they underpin joint decisions, enable operations based on JIT Arrivals principles and allow the complete sequence of port calls to be optimised for the benefit of the port as a whole.

Illustration 3 | Port Community Maturity Model.



Source: Ferrús Clari, G., et al (2026). *Enabling Just-In-Time Port Arrivals through Port Community Maturity Models*.

How can a port improve its maturity level?

Once the maturity levels have been established to assess the current state, the next question is how to move up to the next level. To do so, it is useful to understand what it takes to cross each of the three barriers separating a reactive port from a truly collaborative one.

The self-assessment presented below is not intended to produce an exact score based on the questions. Rather, it is designed to encourage reflection and identify the factors that make it difficult to move from one level to the next.

Data and visibility – The typical barrier between Levels 1 and 2.

This barrier simply involves taking information out of telephone calls, emails and each stakeholder's individual software systems and putting it into a system that everyone can access at the same time. No sophisticated standard is required to cross this barrier: it is enough for port call milestones (key events) to be recorded digitally and in real time.

- Are the main port call events (such as anchorage commenced, pilot on board, first-line, start and completion of cargo operations, etc.) shared digitally among all relevant stakeholders?
- Is this information available in real time, or does it arrive with a delay and require telephone confirmation?
- Is the accuracy of declared ETAs and RTAs systematically monitored against what actually occurs?

Standards and trust — The typical barrier between Levels 2 and 3.

At this stage, the issue is no longer having the data, but ensuring that it means the same thing to everyone. If each stakeholder interprets events differently, or no one verifies the quality of the information being shared, the information ceases to be reliable, even if it already exists in a common system.

- Do all stakeholders use common definitions for the same events, or does each interpret them differently?
- Is the quality of the data being exchanged explicitly measured, or is it simply assumed to be correct?
- Are there formal information-sharing agreements in place, with defined roles and access levels?

Governance and decision-making — The final leap, from technical coordination (Levels 3–4) to collaborative decision-making (Level 5).

This is the most difficult barrier to overcome because it no longer depends on technology or technical agreements, but on giving up some degree of decision-making autonomy. It means accepting that the optimal sequence for a port call will rarely coincide with what is best for each stakeholder individually, and that someone, or some collective mechanism, must be able to make decisions on behalf of the whole.

- Are relevant operational decisions, such as port call sequencing, resource allocation, speed adjustments, etc., made collaboratively by the stakeholders involved, or does each stakeholder decide independently and the others adapt afterwards?
- Is the complete port call sequence optimised as a joint process, or does each stakeholder optimise only the part that affects them?
- Are formal mechanisms in place, such as operational committees, escalation protocols or service-level agreements, to resolve priority conflicts between stakeholders, or are they handled on a case-by-case basis depending on who has the greatest influence at the time?

The logic for progressing is cumulative. Depending on which block presents a weakness, with more negative answers, the bottleneck will be different:

- If the bottleneck is in the first data block: governance is not yet the priority; the priority is ensuring that basic information flows in real time.
- If data is being exchanged but the trust level is insufficient: the bottleneck lies in standards and trust in shared information, not in a lack of systems.
- If the answers are positive in the first two blocks but negative in the third (the most common situation among ports handling high traffic volumes): your technology is already ready for Level 5. The only thing missing is for the port community to come together and agree on how decisions will be made jointly.

More Smart Community than Smart Port

For years, we have used the term Smart Ports to refer to ports that use new technologies to transform traditional port services into interactive and dynamic services, making them more efficient and transparent (Serrano, 2020). Perhaps it is time to pay greater attention to the concept of **Smart Community**. Because a smart port is not the one that accumulates the most systems, sensors or platforms: it is the one whose community is **able to turn data into decisions and decisions into results**.

Lessons to be learnt

Innovation projects such as STM Validation, MISSION and DYNAPORT, together with the pilot projects promoted by the Port Call Optimisation Network, **continue to be essential for advancing the digital maturity of port communities**. However, the analysis suggests that these initiatives **primarily address the requirements associated with Levels 3 and 4 of the Port Call Maturity Model (PCMM)**.

The **transition to Level 5**, where JIT ceases to depend on isolated initiatives and becomes a systematic operational practice, **requires addressing a problem of a different nature**. Beyond the availability of technology platforms, it is necessary to **establish governance mechanisms** that define the commitments of each stakeholder, the coordination processes between organisations, and the principles underpinning trust in shared data and in the decisions derived from it.

From this perspective, the central issue is no longer the selection of new technological tools, but rather the **development of the organisational and institutional capabilities required for coordinated decision-making**. In other words, once a certain level of technological maturity has been reached, **the main challenge** is no longer sharing information, but **building the trust and governance mechanisms that enable stakeholders to share decisions**.

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