

The implementation of berth allocation policies that enable Just-in-Time arrival in port calls

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Abstract

Purpose – Just-in-Time (JIT) arrival in the context of port calls can be used to reduce fuel and emissions to achieve environmental targets. The purpose of this paper is to study the implementation process of the Pre-booking Berth Allocation Policy (PBP) and analyze the effectiveness of this policy for the implementation of JIT in port calls.

Design/methodology/approach – The study deploys a single case study approach to empirically analyze port authority's transition from a first-come-first-served (FCFS) arrival policy to the PBP. Observations, interviews and documents were used to collect data during 2020–2022. The analysis deployed the capability, opportunity, motivation and behavior model.

Findings – The transition from FCFS to PBP requires an inter-organizational approach, engaging external actors to manage diverse needs and preferences. This fosters effective transition and addresses conflicting interests. The PBP enables JIT arrival, enhancing operational and environmental performance, but faces barriers such as resource dependency and lack of trust. Information sharing capability among the actors, supported by Port Community Systems and adjusted operating rules, is crucial. Moreover, the PBP facilitates integration between sea and hinterland transportation, improving planning and efficiency across maritime transportation chains.

Research limitations/implications – The single case study limits the generalizability of the findings.

Practical implications – Implementing the PBP is complex and demands careful planning from managers. Involving port call actors in the transition is helpful for port managers because they provide valuable feedback and highlight overlooked issues.

Originality/value – Five propositions are suggested to highlight the role of inter-organizational collaboration, information sharing and overcoming barriers such as resource dependency to successfully realize the benefits of JIT in maritime transportation chains.

Keywords Just-in-Time arrival, Port call coordination, Berth allocation policy, Maritime logistics, Change management, Port service quality, COM-B

Paper type Research paper

1. Introduction

Just-in-Time (JIT) arrival, in the context of port calls, refers to managing the sailing speed of vessels to arrive at the pilot boarding place when the availability of berth and nautical services is ensured (IMO, 2020). JIT arrival can be used to reduce fuel consumption and emissions from vessels by detecting delays at the destination port and adjusting the sailing speed accordingly (Merkel *et al.*, 2022). Estimates regarding the potential of JIT range from 2% to 20% in fuel and emissions savings (Jia *et al.*, 2017; Merkel *et al.*, 2022), prompting international institutions and government administrations to endorse its use for emission reduction (IMO, 2020; SMA, 2021). However, the actual implementation of JIT remains limited in practice (Sung *et al.*, 2022).

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In the context of tramp shipping, the First-Come-First-Served (FCFS) mechanism that is used in most ports to coordinate vessel arrival with required resources is considered a barrier limiting the implementation of JIT arrival (Senss *et al.*, 2023). One frequently discussed issue in connection with FCFS is how it drives speed competition among shipping companies, resulting in the “rush-to-wait” behavior, that is inefficient vis-à-vis fuel consumption and pollution (Adland and Jia, 2018). This behavior may also partially explain the relatively long delays experienced by tankers and dry bulkers, which on average spend around 9% of their annual time delayed at anchorage (IMO, 2020). To implement JIT, and realize its potential, there is a need for an intervention that drives a behavioral change of actors’ decision-making regarding the sailing speed of vessels from “rush-to-wait” to more coordinated speed decisions aligned with the availability of berth and other resources at the port of call. The Pre-booking Berth Allocation Policy (PBP) is an example of such an intervention that potentially drives the behavioral change of actors to implement JIT arrival in port calls (Mohammed, 2023). The relationship between JIT and the PBP is that the latter allows shipping companies, charterers, port authorities and terminal operators to agree on a berth time window during which the arriving vessel is guaranteed the berth. This allows for an appropriate (and potentially lower) sailing speed based on the guaranteed time window and mitigates the risk of other vessels taking the berth as in FCFS.

Previous research in maritime logistics and port calls has underlined the importance of PBP to enable the implementation of JIT (Gibbs *et al.*, 2014; Kontovas and Psaraftis, 2011). However, studies about the process undertaken by port authorities to implement the PBP, including the required capabilities, resources and activities, are limited. The transition from FCFS to PBP demands exploration into how it enhances actors’ capability and motivation to implement JIT, and the broader implications of both PBP and JIT on port service quality and customer satisfaction driving this transition. Moreover, the limitations and barriers of the PBP are also under-explored. Research focusing on the drivers and barriers associated with the PBP and JIT is necessary to enhance the sustainability and service quality of maritime transportation chains. The purpose of this paper is to study the implementation process of the PBP and analyze the effectiveness of this policy for the implementation of JIT in port calls. Two research questions (RQs) are derived from the purpose:

- RQ1. How does the change from FCFS arrival policy to PBP in the context of port calls unfold over time?
- RQ2. What are the drivers and barriers of the PBP to implement JIT arrival in the context of port calls?

To answer the questions, the study deploys a single case study approach in Gävle with the capability, opportunity, motivation, behavior (COM-B) model (Michie *et al.*, 2011) as the main lens for analysis. Addressing this transition from a behavioral standpoint is relevant due to the conservative behavior of the shipping industry in embracing innovations and changes (Raza *et al.*, 2023).

The study contributes to the maritime logistics as well as sustainable transports by addressing how port authorities can deploy the PBP to realize the potential of JIT and enhance port service quality. Previous studies estimating the fuel and emissions savings potential of JIT assume the availability of the PBP, without considering its implementation. This study addresses this gap and explains how these savings can be realized in practice by analyzing the implementation and the effectiveness of the PBP in implementing JIT. The study further contributes by addressing how the PBP integrates sea-side transportation with hinterland transportation.

The remainder of this paper is organized as follows: The frame of reference is presented in Section 2. The methodology is presented in Section 3. Empirical data and the implementation

of the PBP are presented in [Sections 4](#) and [5](#), respectively. The discussion is presented in [Section 6](#). The conclusion and future research directions are presented in [Section 7](#).

2. Frame of reference

The frame of reference consists of three sections. The port call process is described in the first section, followed by a review on the relationship between berth allocation policies and port service quality in the second. Change management literature and the COM-B model are presented in the third section.

2.1 Description of the port call process

The port call process is a key process in managing maritime transportation and includes the “late nautical miles” in voyage execution, nautical services and cargo-operations provided during the arrival/departure of vessels. In [Figure 1](#), an illustration of these processes, and the different actors involved, is presented. In most ports, FCFS is used to coordinate port calls in tramp shipping, which means that the allocation of berths is determined by the sequence of the arrival of vessels to the port ([Cho et al., 2022](#)).

The “late nautical miles” in voyage execution are about 24–72 h before arriving at the port. Here, decisions regarding the sailing speed are based on charterparties (voyage and time charterparties) between charterers and vessel-owners ([Poulsen et al., 2022](#)). In voyage charterparties, vessel-owners control the decision-making about the sailing speed, whereas in time charterparties, charterers control this decision-making process. In both cases, vessel-owners and charterers are at times incentivized to “rush-to-wait.” In poor market conditions, vessel-owners operating under voyage charterparties may “rush-to-wait” to maximize their profits from demurrage, i.e. a fee paid by charterers to vessel-owners if the agreed laytime exceeds ([Adland and Jia, 2018](#)). They may also rush to avoid charterparty cancellation risks by arriving late ([Adland and Jia, 2018](#)). In time charterparties, charterers may prioritize cargo delivery over maintaining optimal sailing speed, contributing to “rush-to-wait” behavior ([Poulsen and Sampson, 2019](#)).

Nautical services and cargo-operations are provided by different actors, are sequentially interdependent and consist mainly of pilotage, towage, mooring, inspection and loading and discharging. For example, pilotage is compulsory in most ports due to safety concerns ([Wu et al., 2022](#)) and the unavailability of pilots (or tug-boats operators) may affect the services that come after ([Poulsen and Sampson, 2020](#); [Nikghadam et al., 2023](#)). In addition, the Vessel Traffic Service (VTS) department is also involved in the process and acts on behalf of the port authority to oversee safety and traffic management within the port ([Fransen and Davydenko, 2021](#)).

2.2 Berth allocation policies and port service quality

Despite being the dominant berth allocation policy in ports, FCFS is criticized for reasons including discouragement of information sharing among actors ([Cho et al., 2022](#)) and incentivizing the “rush-to-wait” behavior ([Adland and Jia, 2018](#)). Studies have explored

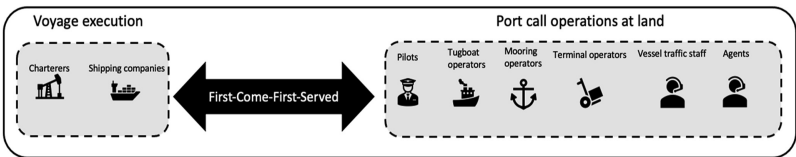


Figure 1.
Illustration of the port
call process

potential benefits associated with the transition from FCFS to alternative arrival policies. For example, [Merkel et al. \(2022\)](#) and [Jia et al. \(2017\)](#) estimated savings between 2% and 20% in fuel and emissions by the implementation of JIT in the Swedish and global context of port calls for the tramp shipping segment, respectively. In the Chinese container port context, the implementation of JIT would reduce service delay, fuel consumption and emission by 6.87%, 8.11% and 4.98% for calling vessels ([Yu and Voß, 2023](#)). Transitioning from FCFS to PBP positively affects berth utilization in the Port of Amsterdam ([Eisen et al., 2021](#)). Similarly, simulations of a coordinated arrival policy based on pilotage and towage capacity have shown to reduce delays in the Port of Rotterdam ([Nikghadam et al., 2023](#)). In addition, a proposed policy aimed at minimizing maximum delays at a port owned by Abu Dhabi ports shows potential for reducing total delays and improving resource utilization compared to FCFS ([Abou Kasm et al., 2021](#)).

These studies reveal that the deployed arrival policy in ports affects port service quality and customer satisfaction. The resource, outcome, process, management, and image and social responsibility (ROPMIS) model, consisting of six dimensions, can be used to assess the relationship between port service quality and customer satisfaction ([Thai, 2008, 2016](#); [Abdul Rahman et al., 2023](#)):

- (1) Resource: availability and condition of equipment and facilities, financial stability and physical infrastructure.
- (2) Outcome: service-provision speed, reliability, pricing and consistency and safety and security.
- (3) Process: employees' attitude and behavior in meeting customers' requirement and application of information technology in customer services.
- (4) Management: relates to efficiency in operations, application of information technology in operations, understanding customers' need and requirement and receiving feedback from them.
- (5) Image and social responsibility: the reputation in the market and socially and environmentally responsible behavior for human and operations

The use of this model in Vietnamese and Singaporean ports revealed that the outcome dimension had the most impact on customer satisfaction ([Thai, 2016](#)), whereas in Korean ports, the management dimension was the most influential ([Yeo et al., 2015](#)). Though, studies that assess the effects of the transition from FCFS to the PBP and JIT on port service quality and customer satisfaction are limited.

2.3 Change management

Organizational change is vital for the success and competitiveness of organizations and involves modifying strategic or operational processes in response to new conditions to improve performance ([Da Ros et al., 2023](#)). Despite its importance, many change initiatives fail due to issues such as the lack of change readiness or clashes in values among change agents and recipients ([Nashund and Norrman, 2022](#); [Al-Haddad and Kotnour, 2015](#); [Burnes, 2015](#)). Organizational change management aims to facilitate successful change processes and outcomes ([Jimmieson et al., 2009](#)). Change processes involve a series of events and activities that unfold overtime to describe or explain how and why organizational changes occur ([Greer and Ford, 2009](#)). The change management literature includes models and frameworks proposed to manage change processes and determinants of successful change outcomes. The foundation of these models is [Lewin's \(1947\)](#) three-step model, which was followed by various models to manage change processes (See, e.g. [Da Ros et al., 2023](#); [Al-Haddad and Kotnour, 2015](#)).

Determinants associated with successful change outcomes include factors related to change agents and recipients, such as the purpose of change, effective communication of change, justice of change and the perceived value versus loss that is associated with the change (Naslund and Norman, 2022; Armenakis *et al.*, 2007; Kark Smollan, 2006). Some studies follow a simultaneous approach that considers the change determinants in different phases of change processes to foster a successful change outcome (Whelan-Berry and Somerville, 2010). In the context of logistics and supply chains, research on change processes is limited and tends to prioritize technical aspects over behavioral ones (van Hoek *et al.*, 2010; Gupta *et al.*, 2022). However, change processes in logistics are recognized as more complex due to increased capacity needs and the need for effective re-planning (Greer and Ford, 2009; van Hoek *et al.*, 2010).

Omar *et al.* (2012) emphasize the importance of following a change model to analyze change initiatives in logistics. An example of such a model is the COM-B, which can be used to analyze behavioral change. COM-B originated from healthcare research and consists of four components: capability, opportunity, motivation and behavior (Michie *et al.*, 2011). Capability refers to the individual's psychological and physical capacity to engage in the activity concerned. Opportunity refers to the social and physical factors that lie outside the individual that make the behavior possible or prompt it. Motivation refers to brain processes that energize and direct behavior, e.g. habitual processes, emotional responding and analytical decision-making. In the COM-B system, these components interact to influence behavior. For instance, capability and opportunity impact motivation toward the behavior. The target behavior is unlikely to occur without meeting the preconditions of capability, opportunity and motivation (Michie *et al.*, 2011).

3. Research process and methodology

The focus of this study is on the transition from FCFS to PBP in ports. A longitudinal single case study was deployed to study the transition and is justified by the following reasons. The single case study approach is appropriate to study underexplored and complex phenomena such as organizational changes (Edmondson and McManus, 2007; Ellram, 1996). The transition from FCFS to PBP is both under-researched and complex, which justifies the choice of this method. Moreover, case studies are also suitable to study behavioral and organizational factors in a multi-actor environment (Barratt *et al.*, 2011). The port call process involves multiple actors, and the transition from FCFS to PBP can be affected by their organizational and behavioral dynamics, supporting the use of this method. The Port of Gävle (PoG) was selected as a case to study because it represents an unusual case and offers good access to data. PoG initiated the Time Slot Gävle project to implement the PBP. The PBP implementation was focused on the energy products berth in the port.

3.1 Data collection

The longitudinal case was conducted by collecting primary and secondary data during 2020–2022. The primary data were collected through participatory observations and interviews, and the secondary data were collected by reviewing documents related to the project of PBP implementation. Twelve activities related to the implementation process of the PBP were observed. These included two risk management workshops, eight project meetings between partners, a large workshop hosted by PoG to introduce the PBP, and a presentation by PoG to the Swedish Maritime Administration. Eleven and 15 actors participated in the first and second risk management workshops, respectively. Those participants represented various organizations operating in PoG and the discussion in these workshops focused on risk identification and mitigation that are associated with the PBP. Eight project meetings were observed. These were held regularly between PoG managers, two consultants, a shipping

company manager and two managers from the shipping company and the oil and gas company, respectively. Progress, activities and decisions related to the PBP were discussed in these meetings. In the introductory workshop, 30 participants, representing different shipping companies, shipping agencies, pilots, surveyors, load/discharge masters and terminal operators, Port Community System (PCS) developer and PoG staff were present. The workshop addressed the necessity of the transitions to the PBP, its operating rules, and encouraged the participants to provide feedback about the PBP. The presentation to the Swedish Maritime Administration was part of a conference related to the “Smart port calls” program initiated by the administration. Three follow-up interviews (of the introductory workshop) – lasting between 30 min and 1 h – were conducted with two agents and one terminal manager. The narratives of these interviews addressed specific issues (information sharing quality and fairness of operating rules of the PBP) that were raised by those actors during the introductory workshop. The interviews also delved into drivers and barriers associated with the PBP. The secondary data were collected by reviewing 10 archival documents:

- (1) A project plan for the PBP
- (2) Two risk management reports
- (3) JIT emissions savings report in PoG
- (4) PBP instruction document (e.g. “know-how”)
- (5) Feedback and improvement suggestions about the PBP
- (6) Description of the PBP
- (7) Performance measurement indicators
- (8) Port call process map
- (9) Port call process quality evaluation report

In [Table 1](#), details about the profile of participants, the topics that were discussed in the observations and interviews and a description of the archival data are provided.

3.2 Data analysis and research quality

A two-step data analysis approach was used in this study. In the first step, a visual mapping strategy ([Langley, 1999](#)) was deployed to create a map of the implementation process of the PBP. This approach is well-suited with the longitudinal nature of the study, spanning a two-year period to track the implementation process in real-time. The resulting visual map chronologically organizes the critical activities and outcomes that unfolded between 2020 and 2022. The map was created using the raw data that was collected during the observations and the real-time archival data provided by PoG. The process of combining these data collection methods allowed for a comprehensive representation of the details and progress of the PBP implementation process within the visual map.

In the second step, the COM-B model was used. The choice of COM-B is justified because recent publications, including the IMO’s JIT study, emphasize the role of behavioral factors as the primary hindrance to JIT implementation ([Heaver, 2021](#); [Senss *et al.*, 2023](#); [IMO, 2020](#)). Adopting a behavioral lens, like the COM-B, is appropriate for addressing these behavioral aspects and navigating the multifaceted transition from FCFS to the PBP and JIT. Furthermore, the COM-B model was constructed from 19 change frameworks, surpassing their limitations. The model has also been successfully used to assess the effectiveness of management mechanisms aiming to change behavior in different contexts such as food waste

Data collection method	Data	Participant profiles and description of the data
Observations	Two risk management workshops	11 and 15 participants, representing shipping companies, charterers, surveyors, load/discharge master, terminal operators, agents and PoG, participated in the first and second workshops, respectively Focus was on risk identification and mitigation associated with the PBP
	Eight project meetings	Three managers from PoG (one sustainability and two VTS managers), two consultants, one fleet manager of the shipping company, and one operations manager from the oil and gas company participated in the meetings Focus was on the progress of the PBP
	PBP introductory workshop	30 participants representing shipping companies, shipping agencies, terminal operators, pilots, PCS developer and PoG staff were present Focus was on motivating the transition, describing how the PBP works and receive feedback about the PBP from the participants
Interviews	Presentation to Swedish Maritime Administration (Smart port call program)	Presentation of PBP to managers from two other Swedish ports and officials from the administration
	Three follow-up interviews	Two agents and one terminal manager were interviewed Discussion was based on issues raised by the interviewees during the introductory workshop
Archival data	PBP project plan	Describes planned activities and milestones of the PBP
	Two risk management reports	Describe the identified risks and mitigation measures associated with the PBP
	JIT emissions savings report	Estimates on potential emissions savings realized by the implementation of the PBP and JIT in Gävle
	PBP instruction document	Helps agents and shipping companies in berth request procedure
	Feedback on the PBP	Summarizes actors' feedback and improvement suggestions obtained from the introductory workshop
	Description of PBP	PowerPoint document presented during the Smart port call program that provides an overview of the PBP
	Performance measurement indicators	List of indicators for performance measurement
	Port call process map	Process map over the physical structure, actors and information systems currently used in PoG
	Port call process quality evaluation report	Evaluation of current bottlenecks and improvement potential from various port call actors' perspectives. The report was conducted about a year before the implementation of the PBP

Table 1.
Overview of the
collected data

Source(s): Author's illustration

disposal (Manika *et al.*, 2022) construction material procurement (Jones *et al.*, 2016), reduction of abandoned, lost or discarded fishing gear (Fennell, 2023) and the use of live-stream platforms in online retailing (Li and Kang, 2022).

In the context of this study, COM-B was used to analyze the implementation process of the PBP and the effectiveness of the PBP in facilitating JIT arrival. This implies the identification of the capabilities (C) and enablers that are needed for a successful transition from FCFS to the PBP, and the capabilities that are created through the PBP and their relations to JIT. The barriers (O) that emerged during the implementation process and those that hinder the implementation of JIT despite the transition to the PBP were also identified. Lastly, the motivation (M), i.e. implications of PBP/JIT on port service quality and customer satisfaction that motivates the transition are analyzed. These three components served as the main themes to structure and synthesize the collected data.

The quality of the research was ensured by a variety of measures. The study triangulates three data sources – observations, interviews and documents – to either validate the findings or find conflicting data to elaborate on. Notes were taken during the observations and interviews. Two of the interviews were also recorded.

4. Empirical data

The background to the case and a description of the PBP are presented in this section.

4.1 Case background

PoG is located on the Swedish east coast, 200 kilometers north of Stockholm. Approximately 1,000 vessels call at PoG annually from the container and bulk segments. The focus of the study is on liquid bulk transportation carried by product tankers. On average 80 product tankers call PoG annually, and there is only one energy berth equipped with a pipeline system to handle energy products that these tankers call upon. This berth is also shared between eight oil and gas terminals representing different companies. From the oil terminals in PoG, there are, for example, several trains departing daily from the port to supply Stockholm Arlanda Airport with jet fuel.

PoG has a proactive green port strategy to reduce Scope 1–3 emissions consisting of four categories of measures: (1) developing infrastructure to support energy-efficient operations, (2) developing the port as an energy hub, (3) enhanced coordination for energy-efficient operations and (4) long-term measures such as future energy products in the port. The focus of this study is on the third category, which the PBP is part of.

4.2 Description of the pre-booking berth policy

The PBP is mandatory for all product tankers calling PoG to use the berth for energy products. A request to book the berth must be made by vessel representatives (e.g. vessel crew, agents) before arrival. This request is communicated to PoG's VTS through a PCS, or the port's webpage, and must contain the following information: Contact details for applicants (e-mails), the IMO number of the vessel, the Estimated Time of Arrival (ETA) at the outer port area and the laytime (time window for berth reservation). When this information is sent, the VTS responds with a Recommended Time of Arrival (RTA) by e-mail. This RTA is either based on the applicants' requested time window, or, if the requested time is unavailable, a new valid RTA is suggested to the applicants. The RTA is reserved for 12 h after it is sent to the applicants. Then, applicants must confirm the RTA, also by e-mail, and 36 h before arrival. This confirmation means that the vessel enters the booking system in the PCS. This PCS was developed prior to the PBP, but during the transition, a newly developed feature – Berth Planning Tool – was added. Berth Planning Tool is the booking system that is

used to manage berth requests and to enhance port call visibility, e.g. illustration of vessels calling PoG with their booked time windows. Once the tanker is berthed and cargo-operations commence, the vessel crew, together with agents and load/discharge masters are responsible for updating the Estimated Time of Departure (ETD). This update is necessary to enhance the accuracy of time windows and RTA. In [Figure 2](#), an illustration of the actors, and the information content, direction and modality associated with the berth request process is presented. Deviation from the ETA is acceptable for up to 3 h, but a longer deviation could lead to losing the time window. During the voyage, the crew and the agent are encouraged to update the laytime of the vessel to provide accurate information.

5. Implementation of the pre-booking berth allocation policy

The visual map represents the implementation process of the PBP, including the different phases and activities that unfold are presented here. This map provides the answer to [RQ1](#): “How does the change from First-Come-First-Served arrival policy to Pre-booking Berth Allocation Policy in the context of port calls unfold over time?”

5.1 Phase 1: initiation, urgency and scope of the PBP

The starting point of the PBP implementation was initiated by two partnering companies – A shipping and an oil and gas companies – with frequent port calls at PoG. In 2019, they explained how they use JIT to manage their port calls when vessels are calling at the oil company’s terminal in the refinery. After consideration, PoG approached legal experts to ascertain whether modifying the port’s current bylaws to support the PBP is feasible. On receiving the green light from lawyers, PoG initiated the Time Slot Gävle project in 2020 to implement the PBP. The urgency for the transition was driven by two objectives related to port service quality: enhancing the planning process of port calls through the PCS and reducing emissions. The PBP streamlines the planning, coordination and joint

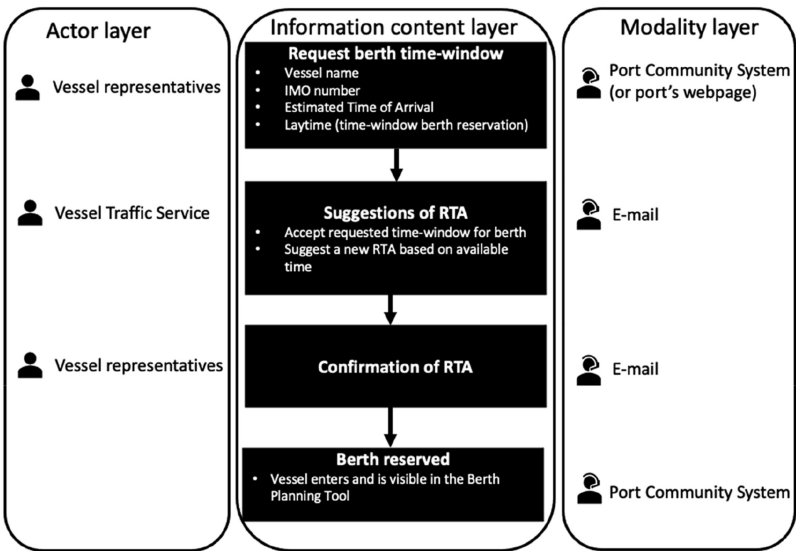


Figure 2.
Illustration of the
information sharing
procedure for the PBP

Source(s): Author’s illustration

decision-making among port call actors, leading to operational and environmental benefits during voyages and port stays.

A project consortium was formed, consisting of sustainability and VTS managers from PoG, external consultants (experienced vessel captain and terminal manager) and the two managers from the shipping and oil and gas companies, respectively. Among PoG, the shipping company and the oil company, a formal partnership was created and received support from the Swedish Energy Agency. Thus, the scope of the change was inter-organizational from the beginning, involving partners outside the port organization. A project plan was also drawn up during this phase, covering activities and milestones related to the implementation period from early 2020 to late 2022. These activities and milestones form the basis for the implementation of the PBP, as described in [Section 5.2](#).

5.2 Phase 2: activities to implement the PBP

Five categories of activities unfolded during the implementation: (1) evaluation and documentation of current processes, (2) risk management, (3) PCS development, (4) modifications to the port's operating rules and (5) introductory workshops and training programs.

5.2.1 Evaluation and documentation of current processes. The evaluation and documentation of current port call processes was conducted through three activities, each summarized as follows:

- (1) *Estimation of JIT potential:* Estimating the emissions reduction potential of JIT/PBP in PoG is valuable to motivate the implementation of the policy. Two researchers from the Swedish Environmental Institute conducted an analysis to estimate the emission reduction potential in PoG using various data sets, e.g. Automatic Identification System (AIS) and vessel-specific data ([Parsmo and Jivén, 2020](#)). The analysis revealed that transition would yield positive emission reduction potential. For the specific tanker segment, the potential is estimated by comparing two scenarios using historical data from 2017. The first represents the actual (historical) service speed of voyages. The second (which comprises three sub-scenarios) assumes that on average, the PBP would enable speed reduction by 5%, 10% or 15% for all port calls. The scenario with a 5% speed reduction results in carbon dioxide emission savings of 7.5%, followed by 15.2% and 22.3% for the other two scenarios ([Parsmo and Jivén, 2020](#)). PoG frequently communicated this emission reduction potential to motivate the transition to the PBP.
- (2) *Port call process mapping:* A process map was created, focusing on the physical structure of the process, and the actors involved and the information systems supporting them.
- (3) *Port call multi-actors' analysis:* A process quality evaluation (prior to the PBP implementation) was conducted by a consultancy company. The evaluation was based on 20 interviews with various actors (agents, terminal and mooring operators, surveyors, load/discharge masters, VTS staff and pilots) and focused on actors' operations, their perceptions of information sharing quality in the port, and the transition toward the PBP. The main takeaway from the report is actors underlining the need to enhance information sharing quality in the port. For example, many of the actors rely on various modalities to access information or lack specific information content that they need. Actors' attitude toward the PBP was positive.

5.2.2 Risk management. Two risk management workshops related to the PBP were conducted. Scenario planning was deployed during the workshops for risk identification and

mitigation. PoG managers started by providing examples of potential disruption scenarios that may occur during port calls executed on the PBP basis, and participants were encouraged to discuss potential solutions to manage these disruptions. Some additional disruption scenarios (and risks) were also provided by the participants. Both workshops ended with respective risk management reports, which were later shared with the participating actors.

Four categories of risks emerged from the workshop. The first relates to information, such as agents or crews unaware of the mandatory berth request, or insufficient quality of information sharing. The second is technical, e.g. the PCS is disrupted. The third relates to the operational dimensions of the policy, such as how a shortage of pilots, or berth cancellations, affect operations and performance. The fourth relates to commercial factors and charterparties. For example, suggested RTA can conflict with times and sailing speeds agreed in the charterparties between shipping companies and charterers.

5.2.3 Port community system development. Continuous development of the PCS was carried out during the implementation of the PBP, with the key developed feature being the Berth Planning Tool. Additional features, aiming at easing the use from actors' perspective, and gathering data in the PCS to enable performance measurement were also added. Furthermore, this activity highlighted the need for specialized and experienced employees to lead certain aspects of the change. One of the external consultants was experienced in the information systems used in port calls. This consultant led to the development process of the PCS with the software developer, and his experience streamlined this part of the transition.

The Berth Planning Tool categorizes users into five classifications with varying degrees of access control based on their roles. For example, agents have limited access where they are allowed to send, confirm and update berth time windows. This classification prevents unauthorized users from making changes in the booking system, a risk that was identified in the workshops.

5.2.4 Modifications to the port's operating rules. Legal expertise was consulted by PoG to review and revise current rules (and contracts) at PoG that may conflict with the PBP. Two types of adjustments were made. The first modified one paragraph in the port bylaws; all product tankers calling PoG to use the energy berth are obliged to make berth reservations before arrival. The second modification was made to the operating rules, and specified what, when and how information is shared to make the berth reservation. A know-how document was added to the operating rules on PoG's website to guide users on the practicalities and requests of the berth.

5.2.5 Introductory workshop and training programs. An introductory workshop and training programs were used to increase actors' readiness for the implementation in terms of enhanced understanding of the PBP and the usability of the PCS supporting it. The introductory workshop was held for 30 participants from different organizations. The workshop informed those actors about the objectives, the rules and how the PCS (Berth Planning Tool) is used to support the PBP. The workshop began with a presentation on berth reservation procedures in the PCS, followed by discussions on practical aspects of the PBP. Participants provided feedback on operating rules, PCS usability, and potential additional features that they desired to be added to it. The workshop concluded with a list of improvement suggestions for PoG, some of which were later implemented. The workshop was complemented by training programs provided to VTS staff and agents to enhance their change readiness. Like the introductory workshop, they focused on PCS usability and the new responsibilities of actors that come with the transition.

5.3 Phase 3: performance indicators and measurement

PoG management sought to evaluate the PBP's effectiveness, necessitating a performance measurement system with relevant indicators and the data sources to measure these

indicators. While not finalized during the study, various meetings were held to discuss relevant performance indicators, which included: vessel anchor time, berth laytime, sailing speed, denied RTA requests and emission savings. Challenges arose in measuring performance, with some indicators having more than one measurement source, and it is not always known which of these have the higher data quality. Additionally, data ownership issues, such as accessing sailing speed decisions (particularly the JIT decision-point that is held by shipping companies and charterers), hindered accurate emission savings evaluation.

The visual map of the implementation process is presented in Figure 3. The different activities (in white), and documents (in grey) that were produced from these activities during the three phases are presented.

6. Discussion

In this section, answer to RQ2 “What are the drivers and barriers of the Pre-booking Berth Allocation Policy to implement Just-in-Time arrival in the context of port calls?” is provided.

6.1 Drivers and barriers for effective transition toward PBP

Organizational changes are often assumed to be driven by internal constituents (Omar *et al.*, 2012). However, this study suggests that change processes in maritime logistics and port calls require broader considerations than the top-down or bottom-up approaches. PoG deployed an inter-organizational change management approach to its transition from FCFS to PBP, which included external port call actors, such as shipping companies and port service providers. This indicates active engagement by the port authority with various actors involved in port calls, fostering an understanding of their needs and preferences through collaborative initiatives such as workshops and training programs. In turn, this approach enabled an effective change process and management of conflicting interests among competing actors.

The multi-actor environment of port calls entails diverse interests and motivations regarding the PBP and JIT. A conflict of interest was identified concerning the operating rules of the PBP. PoG decided that berth reservations can be made 36 h before arrival at the earliest. Companies with long-distance voyages objected to this, whereas those with short-distance voyages supported it. The objection of long-distance voyage companies was driven by earlier

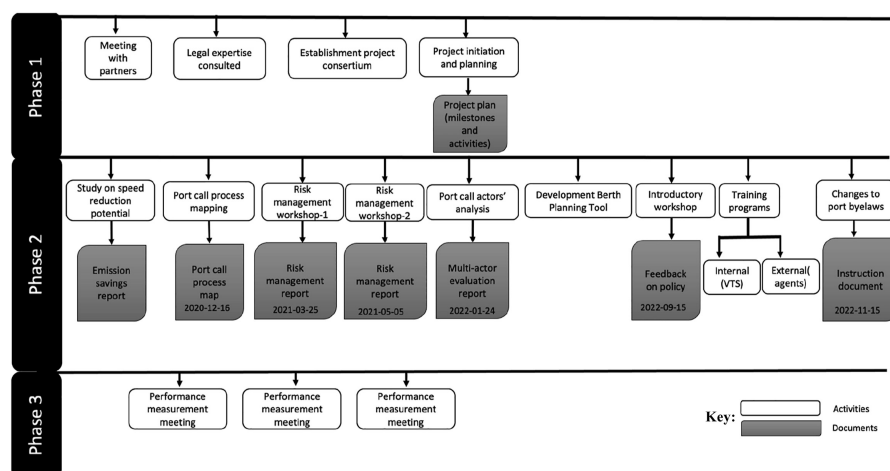


Figure 3.
Overview of the
phases, activities and
documents produced
during the
implementation of
the PBP

berth reservations is correlated with higher fuel and emission savings potential, also suggested by [Merkel et al. \(2022\)](#). However, earlier berth reservations (e.g. 72 h instead of 36 h) may negatively impact companies with frequent and short-distance voyages. Such conflicting interests in change processes are related to the valence factors, i.e. attractiveness and justice of change from a change recipient perspective ([Armenakis et al., 2007](#)). Unequal benefits allocation among actors may pose barriers diminishing their motivation for behavioral change toward JIT, especially those who perceive their benefits to be less. However, the inter-organizational change management approach enabled PoG to manage these conflicts. For example, during one workshop, they justified the 36 h rule to the objectors by highlighting that many vessels calling PoG sail short distances, aligning with the 36-h timeframe. Justifying these kinds of decisions is important to keep the motivation of actors intact.

In addition to resolving conflicts, this approach also encouraged actors to voice preferences to influence the change process. PoG managers were expecting some reluctant behavior from the participants in the workshops. Surprisingly, the participants actively engaged and provided valuable feedback about the transition. Motivating change recipients by engaging them in the change process is presented as an enabler of successful change outcomes ([Da Ros et al., 2023](#)). However, the study is novel in its exploration of the resulting effects of motivating actors through engagement in the change process in the maritime context. The effect of motivating and engaging actors in the transition was enhancing PoG's capability in implementing the PBP, as those actors enabled PoG's managers to capture overlooked issues. For example, additional features were added to the PCS based on actors' feedback to ease the use of the system. This also illustrates that customer feedback enhances the service quality offered by the port, in line with [Thai \(2016\)](#). This implies that the inter-organizational change approach is beneficial for both change agents and change recipients.

In alignment with previous research in organizational and logistics change literature, the value of training change recipients to enhance their readiness for change ([Greer and Ford, 2009](#)) was also seen in this study. PoG provided training programs and instruction documents to VTS staff and agents. These supported their readiness and capability in operating under the new conditions of the PBP that differ from FCFS.

Based on the above discussion, the following propositions are suggested:

- P1. The transition from FCFS to PBP requires port authorities to deploy an inter-organizational change management approach that involves and engages with external actors to manage their needs and preferences.
- P2. Deployment of inter-organizational change management approach in transitioning from FCFS to PBP enhances actors' capability, motivation and barrier management, facilitating an effective change process.

6.2 Motivation to implement just-in-time in port calls

Previous studies motivated the implementation of JIT by its fuel and emissions savings potential ([Merkel et al., 2022](#)). In this case, shipping companies, charterers and the port authority were all driven by the prospect of these savings. These potential savings aid shipping companies and charterers in compliance with the recent uptake in environmental regulation undertaken by the International Maritime Organization (IMO) through measures such as the Carbon Intensity Indicator (CII). The CII rates vessels from A to D based on the environmental performance, and JIT can be used to enhance environmental performance and thereof CII ratings of vessels. This links the transition from FCFS to PBP and JIT with the environmental and social dimensions of port service quality ([Thai, 2016](#)). By facilitating shipping companies' and charterers' capability to comply with these environmental

measures, the PBP and JIT contribute to increased satisfaction levels among those customers. Moreover, the port's own environmental performance is enhanced by JIT. Social motivation and being the "pioneer" in implementing this environmentally focused arrival policy was also mentioned by actors as a motivating factor.

Terminal operators and nautical service providers prioritize the planning process improvements facilitated by the PBP over potential fuel and emissions savings. Their motivation for adopting the PBP stems from its ability to reduce uncertainties, such as vessel arrival sequences, through enhanced information sharing. This decreased uncertainty improves decision-making for resource planning and allocation, such as the manpower and equipment required for pilotage and discharging operations. Streamlined resource planning enhances the service reliability offered by those actors to the shipping companies, boosts operational efficiency and reduces costs, leading to overall better service performance.

From the perspective of oil and gas companies (charterers) and their respective terminals in PoG, the PBP enables their voyage planning to become more integrated with their hinterland transportation planning. Guaranteed berth windows facilitated by the PBP allow terminal managers to plan more effectively for the next "transportation leg." The next transportation leg implies trucks picking up deliveries from the terminal to supply regional gas stations or trains departing from the terminals to supply industries with large shipments, like the aviation industry in Arlanda airport in this specific case. Therefore, the findings recognize the PBP as a mechanism that enables the integration of operations in ports and maritime transportation chains. Studies have shown that maritime transportation chain integration results in increased operational and environmental performance and customer satisfaction (Woo *et al.*, 2013; Hussein and Song, 2024; Yeo *et al.*, 2015). However, these studies either focus on the integration of container maritime transportation chains (Hussein and Song, 2024) or the integration between land transportation and ports, e.g. trucks accessibility to port services (Jacobsson *et al.*, 2017). This study differs from previous research by focusing on the performance effects of maritime transportation chain integration in the tramp context, which operates under different conditions compared to the container segment and requires different mechanisms for integration. The integration enabled by PBP is beneficial for the energy and operational efficiency of voyages, and also for the planning of port operations and hinterland transportation to final destinations/customers.

Based on the above discussion, the following proposition is suggested:

- P3. The PBP enables the integration of operations within maritime transportation chains, leading to enhanced performance of these operations and higher level of customer satisfaction.

6.3 Capabilities needed to implement just-in-time in port calls

Both insufficient information sharing quality and coordination among port call actors are recognized as barriers limiting the implementation of JIT (Veenstra and Harmelink, 2022; Johnson and Styhre, 2015). In this case, and prior to the PBP, various actors elaborated on their experiences about information quality deficiencies and emphasized the need for enhanced information sharing quality. Moreover, unlike FCFS, effective management of port call operations based on PBP and JIT has a higher dependency on sharing and using information to coordinate operations. These aspects make it essential for port authorities and other actors leading the transition to manage information quality deficiencies and develop coordination capabilities that facilitate joint decision-making among the actors, aligning sea-side with land-side operations. This study identified two mechanisms to address the coordination capabilities: the development of PCS (particularly, the Berth Planning Tool as a unique feature to support the PBP) and the adjustment of port's operating rules. The PCS integrates various actors' information systems into a cohesive platform to streamline

information sharing and accessibility. PoG's operating regulations mandate the use of the PCS for berth reservation and information sharing. This configuration ensures effective access to information within the PCS, preventing it from being spread across multiple channels such as emails and phones. The implications of these mechanisms on information sharing quality are earlier accessibility and better visibility in the PCS. This leads potentially to more effective use of information that makes port call actors capable of joint decision-making to integrate their operations.

Based on the above discussion, the following proposition is suggested:

- P4. JIT arrival has a higher dependency on information sharing among port call actors. This requires the development of port community systems to streamline the use of information for joint decision-making to facilitate operational integration.

6.4 Barriers to just-in-time in port calls

Various barriers, beyond the control of the port authority, that impact the effectiveness of PBP and JIT were identified. The study revealed dependencies on external resources, not under PoG's ownership or control, as constraining barriers to the effectiveness of PBP in implementing JIT. Recall that the coordination associated with PBP manages the interdependency between vessel arrival and berth availability, the latter owned/controlled by PoG. However, there are other external resources that the PBP helps to coordinate but cannot guarantee their availability for the purpose of JIT. Pilotage is an example of a precondition for JIT arrival, however, it is overseen by the Swedish Maritime Administration and cannot be guaranteed by the PBP. Similarly, mooring and inspection services are essential, but they fall outside the jurisdiction of PoG. However, in practice, different port authorities have varying governance and business models and operating conditions (e.g. open hours). Some ports, like PoG, follow a landlord model which charges fees for infrastructural services. Whereas other ports may undertake operational responsibilities such as nautical and terminal operations, which require the ownership of different kinds of resources (Poulsen and Sampson, 2020). PoG's landlord model limits the RTA that is communicated to facilitate JIT based on berth availability. Although valuable, such RTA may not realize the full potential of JIT, as it is still interdependent on the availability of nautical and terminal operations. In contrast, RTA which is based on more resources in addition to the berth is more likely to realize the full potential of JIT. Thus, the findings uncovered relationships between the effectiveness of the PBP to realize the benefits of JIT, resource dependency and port governance models.

Based on the above discussion, the following proposition is suggested:

- P5. Greater resource dependency in port operations limits the effectiveness of the PBP to implement and realize the potential of JIT. The degree of resource dependency is influenced by the port governance model deployed by the port authority.

Even if such RTA that considers all port call resources is provided, it does not guarantee that the decision-making around the sailing speed undertaken by charterers and shipping companies will be adjusted to JIT arrival. Speed decisions are subject to charterparties, and to modify them, vessel-owners and charterers must incorporate clauses such as JIT clause or Virtual Arrival clause. If these clauses are not incorporated, speed adjustments are not guaranteed and therefore the potential of implementing JIT is limited. Various barriers may hinder the use of these clauses or the incentives for speed reduction. The first is economical, depressed markets with low freight rates incentive shipping companies' rush to wait behavior to maximize demurrage profits (Adland and Jia, 2018). This economic incentive may outweigh the benefits of PBP and JIT, discouraging actors from their adoption. While this behavior was not observed in this case, its potential to discourage the implementation of JIT should not be

overlooked. However, recent initiatives, such as the CII and the inclusion of shipping in the European Emission Trading System may influence actors' behavior toward adopting the PBP and JIT. In addition, the uncertainties surrounding the fuel and emission savings of JIT and their cost and/or profit allocation also hinder the actors from its implementation (Rehmatulla and Smith, 2015). In contrast to speed reduction, discussions arose regarding potential scenarios for faster sailing speeds of vessels in response to certain risks that emerged from the workshops. Managers from shipping companies showed a neutral stance on this phenomenon, citing market conditions such as fuel prices as determinants. They were determined to retain full control over sailing speed decisions, without being subject to enforcement by ports. This phenomenon is not directly related to the barriers of JIT but concerns its intended outcome. Faster sailing speeds, at least on a voyage-level basis, may lead to more emissions. Existing literature on JIT focuses primarily on speed reduction, but the simultaneous consideration of PBP and JIT in this case challenges that narrative.

Besides those commercial and technical barriers, social barriers were also identified. One interviewed agent showed skepticism toward the transition to the PBP, based on previous experiences, and that "my work will become more complicated, while PoG will get the information they need." This agent saw value for other actors and more burden for himself as an outcome of the transition. This is similar to the fairness of benefits allocation among shipping companies with different voyage distances. Again, such behavior may decrease the motivation of certain actors in the transition, resulting in negative implications on PBP and JIT. The lack of trust among shipping companies and charterers and crew members with conflicting opinions about speed decisions may also pose barriers that affect JIT/PBP negatively (Viktorelius and Lundh, 2019). Weather-related aspects may also do so.

The degree of influence of those identified barriers on realizing the potential of JIT varies depending on the specific context of the maritime transportation chain. This suggests that there is no "one size fits all" PBP configuration, and instead, the "right" PBP configuration to effectively implement JIT should fit the context. Thus, port call actors are encouraged to first understand how contextual barriers limit the PBP (or similar arrival policies) in implementing and realizing JIT's potential benefits in their transportation chains. Furthermore, to manage those barriers and allow the PBP configuration and JIT to fit with the context, a resource bundling capability is a potential solution (Laksmana *et al.*, 2020). Such capability enables port authorities to configure and deploy their resources in conjunction with those of shipping companies and port call service providers to implement JIT arrival in their specific context.

In Figure 4, the interplay between the propositions is summarized. The adoption of inter-organizational change management (P1 and P2) facilitates the transition to the PBP, supporting JIT implementation (P3). JIT provide various benefits, including fuel and emission savings, improved service quality and integrated transportation between sea and hinterland. Information sharing is vital for the success of PBP and JIT, with PCS and adjusted port operating rules aiding the transition (P4). However, barriers like resource dependency and trust issues hinder PBP effectiveness in realizing the benefits of JIT (P5).

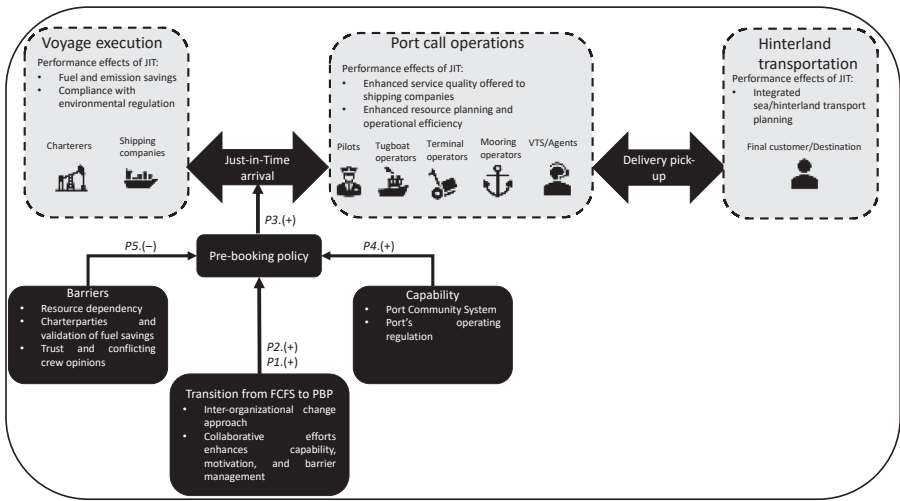
7. Conclusion and future research

The theoretical contribution and managerial and policy implications of this study are presented here. Directions for future research are also proposed.

7.1 Theoretical contribution

The literature on maritime logistics addressing the JIT phenomenon has primarily focused on its potential. The majority deploys a modeling approach to estimate the fuel and emission savings associated with JIT, assuming its implementation (Merkel *et al.*, 2022; Jia *et al.*, 2017). This study focuses on the actual implementation of JIT and contributes to the literature by explaining how

Figure 4.
Relationship between
propositions



Note(s): (+) implies positive relationship whereas (-) implies negative relationship

the estimated potential can be realized in practice. The study confirms the findings of previous literature that underlines the necessity of the transition from FCFS to PBP (or similar arrival policies) to implement JIT (Kontovas and Psaraftis, 2011; Gibbs *et al.*, 2014). Previous literature has motivated the implementation of JIT mainly due to its positive environmental effects, i.e. fuel and emission reduction for shipping companies and charterers. This study found that the PBP and JIT enable the integration of the sea-side transportation with hinterland transportation, which further motivates their adoption. For example, terminal managers can conduct more effective hinterland transportation planning from the port to the final destination as they are better informed about vessel arrival times through the PBP. Such integration practices are important for the service quality and customer satisfaction. To realize these benefits, port call actors must be capable of sharing and accessing information to conduct joint decision-making. This capability is addressed through PCS that integrates the information systems of different actors, resulting in the effective use of information. Finally, the study uncovered new relationships related to the barriers that are associated with PBP and JIT. Dependencies on external resources can constrain the effectiveness of the PBP in realizing the potential of JIT. These dependencies are influenced by the governance model that is used in the port.

7.2 Managerial and policy implications

The study underlines that the transition from FCFS to PBP is necessary to realize the potential of JIT. However, this transition is complex, as the need to prolong the change duration and to have an appropriate change capacity (e.g. qualified employees managing the change process) were evident. In addition, the inter-organizational structure of port calls adds to the complexity, as actors representing different organizations have varying preferences and needs regarding the transition. Port managers are therefore encouraged to consider the complexity of such transition and undertake comprehensive planning and resource allocation when embarking on such initiatives. Although complex, embracing an inter-organizational change management approach to the transition was valuable, and managers are encouraged to adopt it in a multi-actor environment like the port call process. The port call actors provided the port authority with constructive feedback and highlighted overlooked issues associated

with the PBP. Engaging those actors in transition and allowing them to influence it enhanced their motivation and capability regarding the PBP. In addition, the study underlined that the influence of the identified barriers associated with JIT depends on the context. Therefore, managers are encouraged to understand their contextual barriers and configure their arrival policies based on those barriers to realize the full potential of JIT.

JIT arrival is recognized as a win-win and cost-effective measure to reduce emissions from shipping and enhance operational efficiency and service quality in ports. Industrial policy makers are encouraged to include JIT in their policy plans as a measure to achieve emission reduction targets. Furthermore, they can support initiatives aiming to facilitate its implementation and the arrival policies supporting it.

7.3 Limitations and future research

Various directions can be taken for future research. Multiple case studies and surveys can be used to test the propositions. This study is limited to a landlord port and primarily oil and gas transportation in the Swedish context. For future research, multiple case studies can be used to study how ports operating under different governance models can bundle their resources with other actors to manage the barriers and the capabilities required to implement JIT in their specific context. The configuration of information systems required to integrate the sea-leg with the hinterland-leg that delivers to the final destination is another valid research direction.

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Further reading

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