Journal of Supply Chain Management Science

https://journals.open.tudelft.nl/jscms

http://dx.doi.org/10.18757/jscms.2022.6680

Port call information sharing and inter-organizational relationships: an exploration

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Article history: received 18-08-2022, accepted 07-11-2022, published 30-12-2022

Abstract – Ports have been taking major steps to improve information sharing for supporting their port call services. Despite the strong aspiration for this improvement, progress is still slow. In this paper, we argue that the progress is hampered by the challenges of an inter-organizational nature. To explore this argument, we conceptualize the link between inter-organizational relationships and information sharing in ports. We use and operationalize the partnership model, which was originally proposed for the supply chains, for the port context. We test the applicability of the model for the port of Rotterdam. Data was collected using desk research, expert interviews and surveys amongst all port actors. We find that potential for inter-organizational relationships varies substantially between the port actors, which implies an unequal potential for information sharing between them. While some actors show potential for strong relationships, in which two-way frequent exchange of information is supported, others could only support basic, occasional, or unbalanced information sharing. Therefore, it is unrealistic to assume that the information can be uniformly exchanged between all the actors. Instead, we suggest tailored information-sharing strategies that fit to actors' business interests and characteristics. We conclude that this salient aspect of inter-organizational relationships between port actors should be acknowledged and considered for the effective design of port development strategies.

Keywords: Inter-organizational relationships; Information sharing; Port call; The nautical chain

1. Introduction

Ports are busier than ever. The number and size of vessels calling at ports are growing (Lind et al. 2020). Vessels' waiting time in ports is increasing, which is an indication that the ports are struggling to handle this growing demand (UNCTAD 2021). Currently, cargo vessels could spend up to 40% of their port time waiting for port services (Slack et al. 2018). Waiting times increase fuel consumption, CO2 emissions, and the risk of collisions (Pratap et al. 2019). To cope with this growing demand, ports need to improve their efficiency in providing their services and be able to accommodate more vessels in shorter times.

As has become clear in recent years, information sharing is becoming a central strategy for transforming ports into smart, efficient, and green ports (Shaw et al. 2017). During a port call, various services including traffic management, pilotage, towage, mooring are offered by several port actors, including the harbour master, the pilot organization, the tugboat company, the boatmen organization. Information sharing regarding the availability of the resources and adjustments to the initial plans are instrumental to synchronize services and together create a seamless and robust chain of services. The benefits of information sharing are extensive and there is a general consensus on connecting the port actors to share information (Ahmad et al. 2021).

Sharing information is greatly facilitated by means of new developments in Information and Communication Technologies (ICT) such as the Internet of Things (IoT), blockchain, and cloud computing (Parola et al. 2020). These days, many ports are equipped with ICT platforms that connect the port actors to exchange information; we refer to Heilig et al. (2017) for an overview of information systems for ports. Clearly, the technology for sharing information is already available. However, the progress is still slow (Lind et al. 2020) and hampered by challenges of an inter-organizational nature

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(Nikghadam et al. 2021). Sensitive information may need to be shared with multiple parties across organizations and adjusted multiple times. Therefore, information sharing may be costly and risky for port actors. As such, it is necessary to address the extent to which port actors are willing to take on the challenge with others.

Literature shows that information sharing across organizations is an attribute of their business relationships (Cheng 2011). Information sharing is enabled through strong, cooperative relationships (Heaver 2015) while, conversely, weak relationships limit the exchange of sensitive information. Therefore, in ports too, it is essential to investigate port actors' relationships to assess their information sharing potentials. Literature also presents various examples of studies that looked into port actor relationships. These studies focused on cooperative relationships and report its benefits. De Martino et al. (2008, 2013) highlight the benefits of cooperative relationships regarding service quality, efficiency and innovation. Talley et al. (2014) introduce the concept of port service chain, as a service network for the provision of port services. Their study demonstrates that ports with cooperative relationships are more effective than non-cooperative ones (Talley et al. 2014). An implicit assumption of these studies is that port actors would be willing to engage in cooperative relationships if it is beneficial for the port collective. This assumption is questionable, as in most of the major ports today, actors are self-governed organizations that act aligned with their own business interests, avoiding actions and decisions that are not in line with these interests, even if the collective benefits.

In short, despite the strong aspiration to enhance information sharing and promote cooperative relationships in the literature, the important question "How willing are the port actors to engage in cooperative relationships?" is overlooked. What is missing is the perspective of the individual port actors in their cooperative relationships, a gap which is also acknowledged by Talley et al. (2014). In this paper, we address this gap by investigating the port actors potentials in these aspects. We present a first approach for port managers and policy makers to assess port actors' inter-organizational relationships and information sharing potentials.

In the following, we develop an extension and application of the Lambert (2008) partnership model by operationalizing it for the actors involved in port calls. Next, we present an application of the model for the case of the port of Rotterdam. We identify the port actors' potentials for inter-organizational relationships in general and more specifically for information sharing. This leads to recommendations which support policy-makers in designing effective development strategies for smart, efficient and digitalized ports.

The paper is organized as follows. Section 2 extends the review of the literature that addresses actors' relationships in the port call context. Section 3 briefly explains the main components and definitions of port call operations as used to operationalize the Lambert model. Section 4 interprets the new partnership model in a port context. In Section 5, we present our case for the Port of Rotterdam (PoR). Section 6 discusses the findings and the managerial implications. Finally, section 7 concludes the study and presents future research directions.

2. Literature review

There is an extensive body of literature that studies the relationship between the organizations within a port. Two main streams of literature exist: one stream has focused on the relationship between terminals and the other on the relationship between the Port Authority and terminals.

Most of the attention has been paid to the relationship between the terminals of a port. Many studies support the cooperative relationships of terminals and highlight the cost-saving benefits of their cooperation (Song 2002, Lee and Song 2017). They argue that cooperation between terminals allows idle resources of one terminal, like quay cranes, berthing and stacking locations to be used by the other when there is a shortage of resource. This cooperation for resource sharing in turn results in shortening berthing time and dwelling time, reducing costs, improving facility utilization and service level (Budipriyanto et al. 2015). However, despite all the benefits, the development of long-term cooperative relationships between terminals is restricted by a variety of barriers such as, lack of trust and commitment, resistance to change, incompatibility of operating and strategic goals, lack of resources, strategic considerations (Van Der Horst and De Langen 2008, Yuen and Thai 2017). As a result of their highly competitive market environment, they compete with each other to be shipping companies' choices (Munim and Saeed 2019). Their competition can be beneficial in some aspects, however. For example, this competition results in innovation and entrepreneurship as competing parties constantly aim to improve their services. The most widely accepted argument in favour of the competition within organizations of a port is that it prevents monopolistic power of actors, such as high tariffs (Theys et al. 2010).

The other stream of literature, that investigates the inter-organizational relationships within a port, focuses on the relationship between the Port Authority and terminal. This topic has been of particular

interest because the policies set by the Port Authority determine the entry rules of terminals into the port and the competition amongst them (Grifoll 2019). For example, long-term leases encourage terminals to invest more in development strategies. While it limits the entry of new terminals to the port and the innovations they could have brought (Heaver et al. 2001). The competition level between terminals is a very important consideration for Port Authorities in their vision for the future. When it is not entirely clear if the operating terminals will stay in the port, it is very difficult to set such a vision for the port (Ishii et al. 2013). Therefore, the strategic relationship between the Port Authority and terminals of a port is very important for both terminal and the Port Authority. The relationship between the Port Authority and terminals is compared to the buyer-supplier relationship in supply chains. This comparison is used to investigate whether the parties have an incentive to cooperate (Zheng et al. 2020).

In the literature, the investigation of relationships of organizations within a port is mostly focused on terminals and the Port Authority, ignoring other actors including pilot organizations, tugboat companies, and boatmen organizations. Even a few studies that considered these actors, did not treat them as self-governed organizations but approached them as resources that can be pooled and centrally optimized (Talley et al. 2014). For example, Abou Kasm et al. (2021) present a mathematical model which enables optimal allocation of the pilotage and towage resources to servicing the vessels.

The approaches which are based on pooling resources centrally can only apply to traditional centralized port structures where port actors, hence, their resources and their decisions are managed by a central Port Authority. However, since the decentralization reform, a large diversity of port governance structures has emerged (de Oliveira et al. 2021). Among them, the landlord port structure is found to be the dominant and most effective port structure for large and medium-sized ports (Zheng and Negenborn 2014, Tseng and Pilcher 2017). In a landlord port structure, instead of the Port Authority having public control over planning and operations, self-governed public and private port actors are in charge of diverse roles and responsibilities such as pilotage, towage, and mooring services (Cui and Notteboom 2018). Examples of ports with a decentralized structure are Port of Rotterdam, Barcelona, Vancouver, and Auckland (The World Bank 2007). This decentralized structure necessitates acknowledging the port actors' perspectives and taking them into account for proposing feasible development strategies.

In summary, while the extant literature considers the Port Authority and terminals in port actors' relationships, it does not recognize all relevant port actors and their unique self-organizational properties. Without having a clear understanding of these actor's perspectives, it is impossible to determine the precedents of their relationships, such as information sharing realistically. In the next sections, we address this gap by proposing and demonstrating an approach for assessing the potential strength of relationships between port actors. Below we first define the scope of the research.

3. The port call; services and actors

In this section, we briefly present the scope of this study and describe the services and actors involved in the port call process.

Ports provide a variety of nautical-technical services to vessels calling the port. These nautical services include traffic management, pilotage, towage and (un)mooring and cargo operations; these are offered respectively by the Harbour Master (HM), the pilot organization, a tugboat company, a boatmen organization, and a terminal.

Incoming vessels request a berth from the terminal they wish to visit and plan their voyage after the terminal's confirmation. When the vessel departs from its origin, it submits an administrative clearance request to the HM's office of the destination port. Upon the HM's confirmation, the pilot organization, tugboat company, and boatmen organization receive the vessel's estimated time of arrival (ETA) so that they can plan accordingly. When the vessel arrives at the port, it asks for operational clearance from the HM. If the traffic at the port permits, with the guidance of HM, the vessel takes the pilot on board. Under the pilot's command, the vessel starts sailing through the channels. Where tug assistance is needed, the tugboats connect and tow/push the vessel to the designated berth. Once there, boatmen help moor the vessel. When the vessel is safely moored, the incoming voyage is completed and the terminal can start with cargo handling operations.

For outgoing vessels the sequence of nautical services starts upon the completion of cargo operations; prior to that, the vessel asks for administrative clearance from the HM. If the clearance is given, the pilot organization, tugboat company, and boatmen organizations are updated regarding the estimated time of departure (ETD) so that they can plan accordingly. When the traffic of the port allows, the pilot comes on board, tugs are connected, boatmen get ready to unmoor and the vessel leaves the berth. When tug support is no longer needed the tugboats disconnect. Once the vessel has left the port area, the pilot leaves the vessel

and returns to the pilot station. Finally, the vessel notifies the HM that it has successfully departed. Figure 1 shows a simplified visualization of the nautical chain (NC) services for incoming vessels.

Figure 1. The nautical chain (NC) services for an incoming vessel.

The above descriptions of NC services show the necessity for the actors to have relationships and share information about their plans and execution of their assignments, such that they meet at an agreed time at the agreed place (Lind et al. 2020). Take, for example, the case of an outgoing vessel that is delayed due to unfinished cargo operations, while the pilot, tugboat, and boatmen are ready and waiting to serve the vessel. The tugboats which are ready according to the initial plan may decide to take their next assignment in the meantime, instead of waiting idle. However, they may not be able to be back at the time the delay has been resolved and terminal operations have been completed. Communicating such decisions helps others to adjust their plans accordingly, but also bares the risk of being disagreed with and facing repercussions. The related challenge in our research is to investigate how willing they are to share the most updated and sometimes sensitive information and decisions. In the next section, we present an approach to address this question.

4. Assessing the relationship and information sharing potentials in ports

In this section, we present our approach to assess the potential strength of relationships and willingness to share information by port actors. We build on the original partnership model of Lambert (2008), which we introduce in section 4.1. Next, we extend and operationalize the approach for the context of the port's NC services.

4.1. The partnership model

The relationship between organizations, and hence the attributes of their relationship, vary. The supply chain literature suggests four possible types of cooperative relationships between organizations: Arm's length relationship, Type 1, Type 2, and Type 3 partnerships (Lambert 2008). When two organizations have an arm's length type relationship, they conduct transaction-based business without having a sense of shared commitment. This type of relationship helps two organizations meet the daily needs of their business and the relationship terminates when the exchange ends. In the literature Type 1, 2, and 3 partnerships are also named coordination, cooperation, and collaboration, respectively.

- In Type 1 partnerships (coordination), the organizations explicitly identify each other as partners. They share tasks- and project-related issues and they coordinate their activities and planning on a limited basis usually conducted on an ad-hoc basis between individuals. There are low or no joint investments, technological developments, and personnel exchanges. Trust is limited and commitment to each party is transaction- or project-based.
- Type 2 partnerships (cooperation) go one step further than coordination of their activities. Here, parties integrate their activities. Multiple units and functions within organizations are involved in the partnership. The parties may jointly invest in their own low-value resources and technologies.
- In Type 3 partnerships (collaboration), two organizations are operationally integrated. The partnership extends to almost all levels including strategic and tactical levels in both organizations. Activities in the partnership are a significant part of business for both parties. Both parties are committed to each other's long-term success, at all levels. The parties jointly invest in high-value resources such as personnel, technologies, and Research and Development (R&D) activities.

Several models have been proposed in the literature that investigate the inter-organizational relationships (Mohr and Spekman 1994, Tuten and Urban 2001, Lambert 2008). Among these models, we chose the partnership model proposed by Lambert (2008) due to its specificity and simplicity in terms of evaluating the factors that influence organizations' relationships. Although the original model is suggested for supply chains, it can be applied by analogy for port studies. Literature provides several studies that argue that the port sector shares common features of supply chains - like relationships between organizations (Bichou and Gray 2005, Panayides and Song 2008). Take, for example, buyer-supplier relationships. In a similar way as supply chains, in ports, organizations provide services that are used by others. The former can be seen as

suppliers of services for the latter. A clear example of this buyer-supplier relationship is the relationship between the terminal and the Port Authority (Zheng et al. 2020). Later, we show that the model can be operationalized well for the port using this reasoning.

Lambert's partnership model states that the strength of the relationship between organizations will depend on two types of indicators: drivers and facilitators. Drivers are the compelling reasons for organizations to develop a relationship with others. Drivers are primarily classified into four categories: cost efficiency, customer service, flexibility, and profit stability. Facilitators are elements of the corporate environment that support the relationship between two parties. Facilitators are classified into four main categories and five additional factors. The main categories are compatibility, management philosophy, mutuality, and similarity; additional factors are shared competitors, physical proximity, exclusivity, prior experience, common end-users.

The assessment of drivers and facilitators is done by means of a survey, as follows (see Appendix A and B for drivers and facilitators, respectively). Respondents are asked to score items under each category on a Likert scale (from 1 to 5), answering to what extent the relationship with the other party contributes to each category. For drivers, if the respondent scores 3 or higher on a driver category, one more question needs to be answered, i.e., whether the factor is a competitive advantage for their business. If the answer is yes, one extra point is added to the score of that category. The total score of drivers is the sum of scores assigned to the four categories. Hence, the total score of drivers ranges between 4 and 24. Once we assessed the surveys, if the two parties have dispersed scores for drivers, the lower score is used to determine the potential relationship type because the relationships are only as strong as their weakest commitment. Similarly, facilitator scores are recorded on a Likert scale (from 1 to 5), indicating to what extent parties match in terms of facilitator categories. Respondents are asked whether the relationship is facilitated by means of each factor. The answers are assessed by Yes/No scoring 1 or 0. The total facilitators' score is the sum of all four categories and five additional factors. Total facilitators score ranges between 4 to 25.

The partnership model assesses drivers and facilitators based on Figure 2, to determine the relationship potential. When there are both high drivers and facilitators (above 16), the model recommends a stronger relationship, namely Type 2, 3 partnerships. In cases where there are low drivers or low facilitators, the partnership potentials are also low and there is a potential for a Type 1 partnership or arm's length relationship. When drivers' scores are very low (below 8) the potential is so low that the partnership is not seen as worthwhile to pursue.

Facilitators score	**Driver score**		
	Low (8-11 points)	Medium (12-15 points)	High (16-24 points)
Low (8-11 points)	Arm's length	Type 1	Type 2
Medium (12-15 points)	Type 1	Type 2	Type 3
High (16-25 points)	Type 2	Type 3	Type 3

Figure 2. Relationship potential based on drivers and facilitators score (Lambert 2008).

4.2. Operationalization of the partnership model for the NC

In this section, we adapt, operationalize and apply the Lambert (2008) partnership model to the NC. We follow the main four categories of drivers (cost efficiency, customer service, flexibility, and profit stability) and facilitators (corporate compatibility, management philosophy, mutuality, and similarity) and operationalize these to match the business scope of the port actors. Table 1 presents drivers and facilitators of the relationships in the NC supplemented by examples for each category. For constructing this table we are inspired by the earlier studies where the NC actors' interests are presented and discussed (Talley 2019, Talley and Ng 2022).

Table 1. Drivers and facilitators of the relationships in the NC.

Drivers	Facilitators
Cost efficiency	**Corporate compatibility**
Reducing material costs and Information handling costs, Saving personnel costs and service costs, Reducing information handling costs, Improving managerial efficiencies	Keeping commitments, Seeing employees as long-term assets, Valuing external stakeholders, Commitment to partnership ideas, Willingness to change
Customer service	**Management philosophy**
On-time delivery of services, Better tracking of movements, Improving ordering processes, Shortening turnaround times, Shortening waiting times, Improving operational processes	Organizational structure, Degree of top management support, Types of motivation used, Importance of teamwork, Degree of employee empowerment
Flexibility	**Mutuality**
Flexibility in rescheduling due to the vessel's delays, actors' delays, and extreme weather conditions	Management skilled at two-sided thinking, taking the perspective of the partner organization, mutual respect, expressing goals and sharing expectations, having a longer-term view, willing to share financial information
Profit Growth	**Similarity**
Growth in profit, growth in the number of contracts, Market share stability	Financial strength, Relative market share in their respective industries, Productivity, Technological sophistication
	Additional factors
	Shared competitors, Physical proximity, Exclusivity, Prior successful experience, Having the same end-user

4.3. Identifying information sharing potentials

As relationship types differ, attributes of the relationship differ as well. In this study, we focus on information sharing as an attribute of relationships. While stronger relationships enable a more frequent exchange of critical information, it is limited in weak relationships. Based on the literature (Xu and Beamon 2006, Lambert 2008) the following information sharing guidelines are suggested: Using different methods and departing from different theories, multiple attempts have suggested that power may influence various aspects of decision-making. For example:

- In arm's length relationships, information sharing potential is limited and one-way, from one party to the other. Parties share transactional information.
- In Type 1 partnerships, each party uses its own information system and shares the information with the other party at a task- or project-level. Communication is primarily one-way, from one to the other, and non-routine. Planning is done individually and shared with the parties on a project basis.
- In Type 2 partnerships, information sharing is two-way but unbalanced. When information sharing is unbalanced predominantly one party is the sender and the other is the receiver. Planning is usually performed individually and shared with the partner to eliminate conflicts. Each party has its own information sharing system rather than jointly using one. Information sharing is regular and includes critical information including strategic and tactical information.
- Type 3 partnerships enable the frequent exchange of critical information. Planning may be performed jointly and at multiple levels. Information sharing is two-way and balanced. The parties often have a joint customized electronic information system. Planning can reach up to strategic levels. Sharing critical information at all levels is facilitated. Namely; strategic, tactical, operational, and interpersonal levels.

Figure 3 summarizes the information sharing guidelines based on the relationships types.

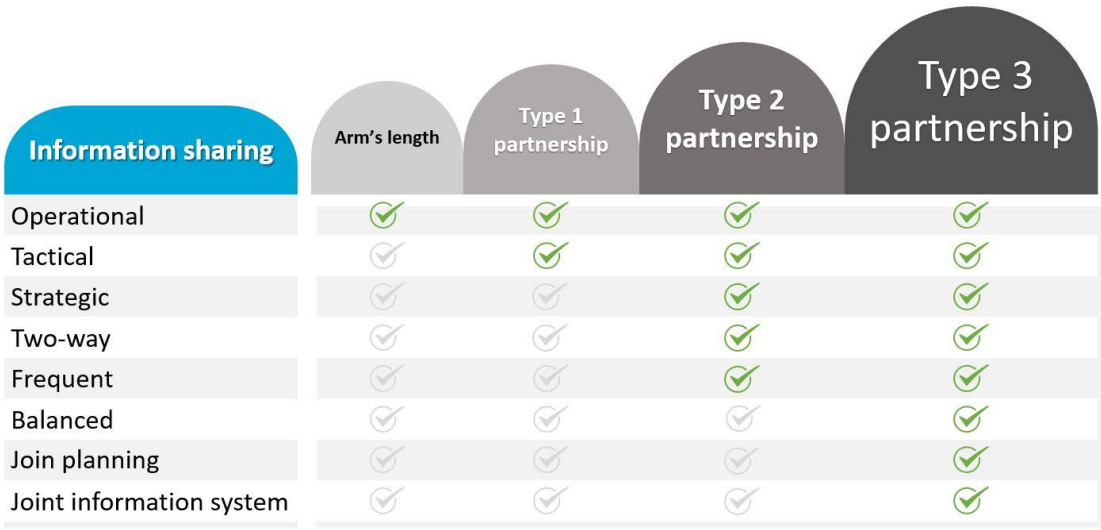

Figure 3. Information sharing guidelines.

In the next section, we describe the approach's implementation in a case study.

5. Case study: The Port of Rotterdam

In this section, we present the implementation of the above model for the port of Rotterdam. The Port of Rotterdam is the largest port in Europe with almost 30,000 sea-going vessel calls per year. The Port Authority owns and develops port infrastructure and leases it to the private sector. This makes the Port of Rotterdam a so-called 'landlord' port. The HM is part of the Port Authority and is responsible for ensuring the efficient flow of traffic through the port on behalf of the government. Whereas the HM is public without financial concerns, other actors are private. Terminal operations, towage and mooring services are carried out by specialized private organizations. Pilotage has been private since 1988.

The required data were collected by means of desk research, expert surveys, and expert interviews.

- We carried out desk research to get insight into the port operations and current state of information sharing as practiced currently (Nikghadam et al. 2021, Port of Rotterdam 2021).
- Expert surveys were conducted based on instructions of the Lambert (2008) partnership model as presented in Section 4.1 (for example, see Appendix A and B). Interviewees were representatives of the actor organizations: the HM, pilot organization, tugboat company, boatmen organization, and container terminal.
- Surveys were complemented with semi-structures interviews for validation and further elaboration and have taken place during 2019-2020. The experts participating included a senior policy maker at the HM Department of the port of Rotterdam, a senior maritime pilot, a former director of a tugboat company, an operational manager of the boatmen organization, and a quality supervisor of the largest (ECT) container terminal.
- The final results were validated by a policy maker at the HM of the port of Rotterdam.

In the next sections we report the results in detail.

5.1. Relationship potential

Based on the described method in section 4.1, we determine the relationship potentials. We discuss the results for each pair so that all relationships can be systematically covered.

Pilot and Boatmen organizations: the relationship between pilot and boatmen organizations has the potential to be the strongest relationship in the Port of Rotterdam. Both parties believe that the relationship is beneficial in terms of all four categories of drivers. Additionally, with all the similarities in their corporate compatibility and management philosophy, their cooperation is highly facilitated. Considering their high drivers (17 and 20 for the pilot and boatmen organizations, respectively) and facilitators score (18), their relationship potential is as strong as the Type 3 partnership. The following quote of a pilot illustrates how employees of these two organizations see each other:

"The boatmen are the eyes and ears of pilots."

Pilot organization and the HM: both the pilot organization and the HM scored high on drivers (13 and 16 respectively) , with slightly higher drivers score for the HM. From their perspective, the relationship benefits their flexibility and customer service. These two aspects are the most important drivers for them, rather than financial aspects like cost efficiency or profit growth. The facilitator score for their relationship (14) showed that the corporate environment is relatively supportive with lots of similarities in their cultural and managerial aspects. Therefore, their relationship potential is a Type 2 partnership.

Pilot organization and tugboat company: the relationship between the pilot organization and the tugboat company can be one of the strongest relationships of the NC. Their equally high drivers score (15) indicates that their drivers are mutual. Improvements in customer service, flexibility and customer service are the most important drivers for both parties. With all the similarities in their corporate compatibility and management philosophy, their cooperation is adequately facilitated (15). Therefore, their relationship potential is a Type 2 partnership.

Boatmen organization and terminal: the drivers of boatmen organization are found to be considerably higher compared to the terminal (22 and 15). From the boatmen organization's perspective, its relationship with the terminal is advantageous in almost all four categories. If the terminal's drivers score was equally high, the relationship potential could have reached up to a Type 3 partnership. However, the terminal's drivers score is medium. As quoted by the terminal representative:

"On-time and smooth mooring services are essential for the terminal. Yet, the mooring services are not the main determinants of terminals' success. The terminal's business scope extends to cargo operations. Hence, costs and profits associated with boatmen's services are relatively insignificant for the terminal."

Survey results show that their corporate environment is quite supportive as their facilitator is scored moderately high (11). Hence, their relationship potential is a Type 2 partnership.

The HM and tugboat company: the overall drivers score for both parties is found to be medium (14 and 12 for the HM and tugboat company respectively). From the tugboat company's perspective, improvements in flexibility and customer service are the main drivers. One of the reasons raised by respondents was as the following:

"The HM is involved with making decisions regarding the location of tugboat's resting stations in the port, which directly impacts the tugboat company's cost efficiency and flexibility in its daily practice".

For the HM too, the relationship with the tugboat company contributes to improvements in customer service and flexibility. Yet, considering their business dissimilarities and incompatibilities reflected in their facilitators score (11), their relationship potential is a Type 1 partnership.

The HM and boatmen organization: the drivers of boatmen organization in its relationship with the HM is found to be moderately high (15), mainly for flexibility and profitability reasons. However, the drivers of the parties are not equal. Although the HM acknowledges that the relationship has an impact on customer service and flexibility, the overall drivers score (11) is still relatively low. Therefore, despite the reasonably high drivers score (14) for the boatmen organization, their potential relationship is Type 1 partnership.

The HM and terminal: both the HM and the terminal scored equally low in the drivers (7 and 8 for the HM and terminal respectively). This means that from the both parties perspectives the benefits of relationship are rather insignificant. Respondents explained the low drivers score for both parties in view of the fact that the HM is in the public domain, whereas the terminal performs in the business domain as the following:

"The HM's main interests are regarding the safety of the port. The terminal's main interests, namely cost efficiency and profitability, relate to its business relationship with shipping lines."

Also, considering their low facilitators score (7), which is an indicator of the dissimilarities in their business characteristics, the development of a strong relationship becomes even less likely. Therefore, their potential relationship type is arm's length.

For the remaining relationships, i.e., tugboat company and boatmen organization, tugboat company and terminal, pilot organization and terminal, the drivers' score of either of the actors or both are found to be very low (Below 8). As such, the relationship potential is so low that it is not necessary to proceed with the model (Lambert 2008). We illustrate the actor's relationships with a network in Figure 4. Nodes of the network denote actors of the NC and links denote the relationship potential between the actors. The thicker the link, the stronger the relationship potential. The shading gradient of the link denotes the disparity of

drivers score. The darker end of the link is the actor with the higher driver score. When the drivers score is equal for both parties the link is solid.

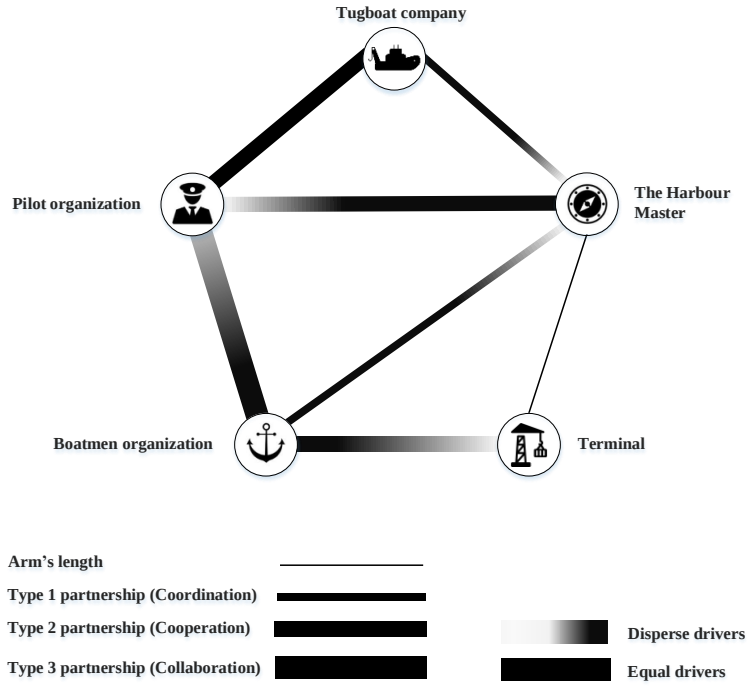

Figure 4. Relationship potentials in the NC of the Port of Rotterdam.

5.2. Information sharing potential

In this section, we discuss the implications of the above findings for information sharing in the port of Rotterdam. First, we take the previous section's findings, the relationship potentials, and match them with the information sharing guidelines presented in section 4.2. Accordingly, we derive the information sharing potentials.

The Type 3 partnership potential between the pilot and boatmen organizations allows the highest level of information sharing. Employees at all departments can be expected to engage in a two-way, balanced, and frequent exchange of critical information including their strategic and tactical decisions. The relationship is so strong that it enables the integration of some activities for the pilot and boatmen. The Type 2 partnership potential between the pilot organization and HM, pilot organization and tugboat company, and boatmen and terminal enables a frequent two-way exchange of strategic and tactical information between the parties. The Type 2 partnership supports individual planning with the exchange of information for joint modifications of their plans, based on the request of the other party. A stronger partnership Type 3 would have allowed them to strive for a joint planning arrangement. Yet joint planning is not supported by their relationship potentials

The uniquely strong partnership potential of the terminal with the boatmen organization enables terminal's information sharing between these two only. Direct communication by the terminal to pilots could have helped better planning, yet, their potential is limited. The type 1 partnership potential between HM and tugboat company, and the HM and boatmen organization, supports mostly one-way sharing of information. There is low or no potential for sharing sensitive information. The arm's length relationship potential between HM and terminal enables only low-level transactional information sharing. This means that information sharing can be very limited and critical information, at a tactical level for instance, is not enabled. Therefore, in the absence of measures to motivate both parties, further information sharing seems unlikely. For example, further exchange of information between the HM and terminal would have allowed to pool data and help provide more accurate estimates regarding the arrival and departure times to each other. We find, however, that the current relationship potential between them would not support this level of information sharing.

In summary, the results show that different pairs of actors have different information sharing potentials, varying widely from no information sharing to two-way frequent exchange of critical information.

5.3. Current information sharing practice

In this section, we investigate the current state of information sharing as practiced in the port of Rotterdam. Next, we will confront them with the information sharing potential as identified above. This comparison provides an indication of the feasibility of new information sharing opportunities.

The required data were collected by means of desk research and complemented with expert interviews from the HM of the Port of Rotterdam (For details see (Nikghadam et al. 2021). First, the NC services were mapped; next, all information exchanges for planning and execution of the processes were identified.

When a vessel notifies its arrival or departure, the HM forwards the information to the tugboat company, the pilot- and the boatmen organizations for the planning of the NC services. The pilot organization, tugboat company and boatmen organization plan individually, to prepare for serving the vessel at the vessel's requested time. If either of them cannot deliver its service, an updated ETA or ETD is proposed. Multiple exchanges of information between the actors may be needed to agree on the proposed time. The common information system currently in use for these two-way communications is developed and owned by the pilot organization. During the execution of services, the pilot exchanges information with the tugboat and boatmen continuously and communicates regularly with the HM to inform the voyage details and be updated about the traffic.

Not all the actors communicate directly for the execution or planning of their operations. For instance, the tugboat company and boatmen organization do not exchange information in their daily operations. The terminal does not systematically exchange information with the HM. The information submitted by the vessel (agent) in the PCS is provided separately to the HM and the terminal in strictly separated domains (public and private, respectively) and not exchanged between the HM and terminals. Hence, the information that the terminal obtains is from the vessel itself and it is not received from the actors and not shared with them. Two-way exchange of planning information between the HM and terminals would have allowed to pool information and provide more accurate estimates. As we established above, however, the information sharing potential between them would not support this level of information sharing. The only information sharing of the terminal is its link with the boatmen organization. The boatmen act as an intermediary between the terminal and pilot organization. For example, when the berth of an incoming vessel is occupied with another vessel or the cargo operations are delayed for an outgoing vessel, the boatmen at berth acquire the expected times of terminal operations from the terminal employees and inform the pilot. Direct information sharing between the terminal and pilot organization could help to improve the planning, but currently there is no potential for such level of information sharing.

Figure 5 illustrates the information sharing as currently practiced in the Port of Rotterdam. The nodes indicate the actors and the arrows indicate the information sharing between them. The comparison of the current information sharing in practice with the information sharing potentials, presented in 5.2, shows a perfect match between the two. This means that in the Port of Rotterdam, where there is potential, the corresponding level of information sharing is practiced. This supports the idea that relationship potentials are an important precondition for information sharing. We discuss our findings further in the next section.

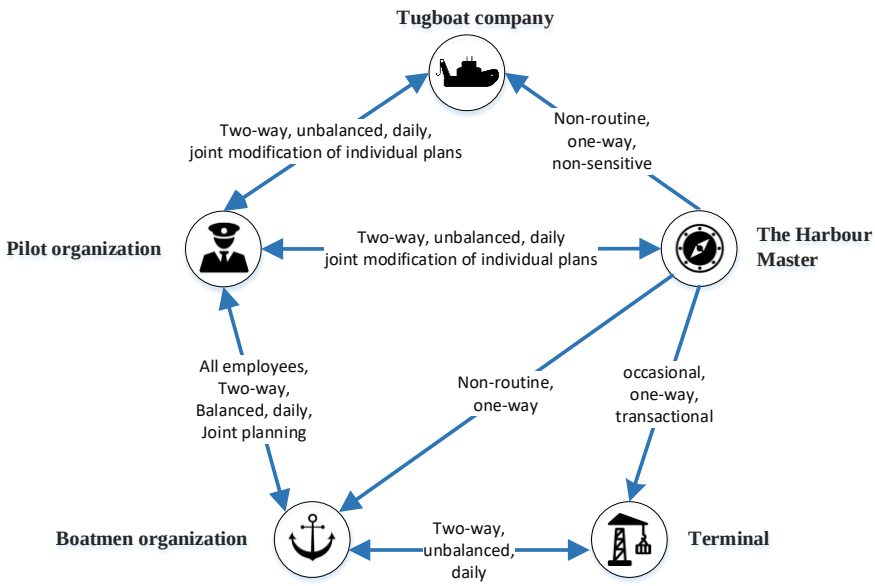

Figure 5. Current state of information sharing in the NC of the Port of Rotterdam.

6. Dicussion and managerial implications

The implementation of the model to the Port of Rotterdam gives rise to several implications for practice. Based on the extant literature, the following discussions emerge.

Firstly, our results show that the relationship potentials within the port vary substantially. While some pairs have the potential of reaching a Type 3 partnership, some pairs' potential is very limited. This means that not all the actors are willing to engage in strong relationships and the network of actors relationships is not composed of fully connected and equally strong relationships. These findings complement the current literature on port studies, which discusses cooperative strategies for ports without the distinction between the relationship type and actors involved (Lee and Song 2017). The existing literature on port relationships is binary, characterizing actor relations as either cooperative or competitive (see the literature review section). We argue that, instead, a full spectrum of inter-organizational relationships, namely coordination, cooperation and collaboration, must be considered together with their unique attributes. Adding this distinction reduces the risk of counterproductive incentive design and policy-making for ports.

The diversities in relationship potentials are directly relevant for information sharing. Our findings show that information sharing between different actors is not equally facilitated. They vary from no direct information sharing to the frequent sharing of critical information. Therefore, we argue that it is unrealistic to assume that information can and will be exchanged equally well within the port. As a result, port digitalization efforts and the application of ICT tools for information sharing can only be effective if the differences in information sharing potentials are acknowledged. This point has remained substantially unexplored so far, despite the extensive literature on information sharing in ports (Fruth and Teuteberg 2017). In this regard, our findings also suggest a need for tailored information-sharing strategies, that fit closely to the actors' information sharing potentials. Questions to address in the future include *how* ICT tools should be designed and developed to support these diversities, and which information should be shared by *whom*, *how* and *when*.

The comparison of the current state of information sharing in practice, for the case study, with the information sharing potentials shows a perfect match between the two. It shows that when the potential allows, information sharing is practiced. Consequently, in order to advance information sharing practices it is necessary to approach this as an attribute of relationships and promote the relationships first, rather than targeting the information sharing on its own.

Relationships are not static. They can to be promoted to stronger relationships to enable more advanced information sharing. Various measures may need to be introduced to achieve this. The measures can be designed considering each pair's drivers and facilitators. For the illustrative case of the HM and tugboat company, this would imply the following. To promote the relationship, from the existing Type 1 partnership to Type 2 partnership, the HM that is the least motivated party should be incentivized. Measures should address customer service and flexibility for the HM, as cost efficiency and profit are not the dominant drivers for the HM in its relationship with the tugboat company.

Finally, our results provide an empirical validation of an important implicit assumption in the literature. Previous studies have highlighted the positive impact of cooperative relationships between the pilot organization and tugboat company on port effectiveness (Talley et al. 2014). Their implicit assumption was that these two actors are willing to cooperate. Our results confirm that considering their Type 2 partnership potential, both parties have a strong willingness to engage in a cooperative relationship.

7. Conclusions and future work

In this study, we present an approach to assessing the relationship potentials between port actors. This topic is highly relevant to determining the potential for information sharing between the actors, which is at the core of port digitalization efforts. This is the first study that presents an approach that can be used by the port managers to assess the relationship and information sharing potentials.

We put forward an extension of Lambert's partnership model for ports. Our study shows that the partnership model of Lambert can be operationalized well for this problem. A first application of the approach was carried out for the port of Rotterdam. The different drivers and facilitators applied well to the port actors and can be assessed using surveys and interviews.

We arrived at a number of empirical findings, which gave rise to several managerial implications. We found that the relationship potentials vary strongly between port actors, which implies that also the potential for information sharing is unequal. This means that some actors are more willing to engage in stronger relationships and advanced information sharing than others. Based on this, we argue that port digitalization efforts and application of ICT tools for facilitating information sharing can only be effective if this diversity

is acknowledged. Therefore, as opposed to the current binary approach in the literature, a full spectrum of inter-organizational relationships and their unique attributes must be considered when addressing port information sharing.

Further research could develop in different directions. Firstly, the data collected for this case study were obtained by interviewing single respondents from each organization, considered elite informants. The use of multiple respondents might generate different and possibly also more robust results. Secondly, this study has implemented and demonstrated the partnership model for one case, the Port of Rotterdam. Implementing the approach on new case studies and carrying out comparative studies or panel studies could help track the success factors of different port-cases and port structures, even as they develop through time. Thirdly, we note that actual relationship levels cannot be assessed with this model. Therefore, this approach could be complemented with models that assess the actual relationships within the port. Finally, this study could also be framed using action research to support the next steps to implement future cooperative relationships in ports.

Acknowledgments

We thank the contributions of all who participated in the surveys and interviews. This research was part of SwarmPort project number 439.16.108 and was supported financially by NWO (The Dutch Research Council).

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Appendix A

Assessment of Drivers for Organization A in its relationship with Organization B

Drivers are motivations of your organization to engage in the appropriate level of business relationships with the service providers. Please fill in the boxes, answering the questions considering the following scale.

Very low	Low	Medium	High	Very high
①	②	③	④	⑤

Cost Efficiency

To what extent organization A's relationship with organization B reduce costs or improves asset utilization for organization A? such as; ① ② ③ ④ ⑤

- reducing service costs
- reducing information handling costs
- improving managerial efficiencies

If you marked cost efficiencies in the shaded area, respond to this question. If not, skip.

Do you think that the above-mentioned aspects are substantial competitive advantages for organization A? No □ Yes □

Customer Service

To what extent does organization A's relationship with organization B improve the service provided to the vessel by organization A? such as; ① ② ③ ④ ⑤

- On time delivery of services
- Better tracking of movements
- Improving ordering processes
- Shortening turnaround times
- Shortening waiting times
- Improving operational processes

If you marked cost efficiencies in the shaded area, respond to this question. If not, skip.

Do you think that the above-mentioned aspects are substantial competitive advantages for organization A? No □ Yes □

Flexibility

To what extent does organization A's relationship with organization B improve flexibility for organization A? such as; ① ② ③ ④ ⑤

- Flexibility in rescheduling due to vessel's delays
- Flexibility in rescheduling due to service provider's delays
- Flexibility in rescheduling due to extreme weather conditions

If you marked cost efficiencies in the shaded area, respond to this question. If not, skip.

Do you think that the above-mentioned aspects are substantial competitive advantages for organization A? No □ Yes □

Profit Growth

To what extent organization A's relationship with organization B increase porofit for organization A? such as; ① ② ③ ④ ⑤

- Growth in profit
- Growth in sales volume
- Market share stability

If you marked cost efficiencies in the shaded area, respond to this question. If not, skip.

Do you think that the above-mentioned aspects are substantial competitive advantages for Organization A? No □ Yes □

Appendix B

Assessment of facilitators for organization A in its relationship with Organization B

Facilitators are the factors which provide a supportive environment for the growth and maintenance of a partnership. Please fill in the boxes answering the questions considering the following scale.

Very low	Low	Medium	High	Very high
①	②	③	④	⑤

Corporate Compatibility	**To what extent organization A and organization B are similar in terms of cultural and business related aspects? such as;**	①	②	③	④	⑤
	- Keeping commitments					
	- Seeing employees as long-term assets					
	- Valuing external stakeholders					
	- Commitment to partnership ideas					
	- Willingness to change					

Management Philosophy	**To what extent organization A and organization B are similar in terms of management philosophy? such as;**	①	②	③	④	⑤
	- Organizational structure					
	- Degree of top management support					
	- Types of motivation used					
	- Importance of teamwork					
	- Degree of employee empowerment					

Mutuality	**To what extent organization A and organization B have the skills for a mutual relationship? such as;**	①	②	③	④	⑤
	- Management skilled at two sided thinking					
	- Management skilled at taking the perspective of other organization					
	- Management skilled at expressing goals and sharing expectations					
	- Management having a longer-term view					
	- Management skilled at mutual respect					

Similarity	**To what extent Organization A and Organization B are similar in terms of power ?such as;**	①	②	③	④	⑤
	- Financial strength					
	- Relative market share in their respective industries					
	- Productivity					

Do organizations A and B have shared competitors that tend to unite their efforts?	Yes □	No □
Are the key players in organizations A and B are in close physical proximity to each other?	Yes □	No □
Is there a willingness to deal exclusively with the partner?	Yes □	No □
Do organizations A and B have prior experience with successful partnerships?	Yes □	No □
Is the vessel a high-value end-user for organizations A and B?	Yes □	No □