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Governance of inter-organizational systems: a longitudinal case study of Rotterdam's Port Community System

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Abstract:

An increasing use of inter-organizational systems, as Port Community System (PCS), can be observed in port collaborations. As multiple organizations often rely on PCS, even for business-critical processes, proper governance of these systems is crucial. This study aims to explain the governance of inter-organizational port collaborations using a lifecycles paradigm. The governance is explored using three points of view – i.e. governance mechanisms, governance aspects, and governance models – and by describing the actors' roles in collaborations. A case study in the port of Rotterdam is analyzed to explain how these actors affect the governance models through the mechanisms to govern the aspects in each lifecycle stage. The port collaboration in Rotterdam has gone through three full governance lifecycles and has entered the fourth iteration after the set-up of Portbase. During the last two cycles, the collaboration has maintained its Network Administrative Organization governance model. This case study analysis of Rotterdam's port collaboration provides an example of how a systematic approach could help to discuss and communicate the governance of inter-organizational port collaboration systems and gives some lessons learned for other collaborations.

Keywords:

collaboration; governance; inter-organizational system; lifecycle; Port Community System.

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1. Introduction

Inter-organizational collaboration systems have emerged to address the operational and information system related challenges of traditional collaborations [1]. Companies expect benefits and competitive advantages from their collaborations, such as network expansion, business process simplification, cost reduction, or other benefits that are unique for each domain. In maritime port collaborations, ports are critical hubs in which Supply Chain (SC) activities are drawn together. The performance of the port authorities, companies, government, and other entities in carrying out their SC activities largely depends on the effectiveness of their collaborations. A port collaboration's physical, information, and financial flows are interdependent, thus causing a lot of coordination challenges for parties in the port [2]. To address these challenges, a port collaboration is commonly supported by a Port Community System (PCS), which is the state of the art in information systems and connects SC actors in port environments using inter-organizational services.

As multiple organizations rely on a PCS, even for business-critical processes, effective governance of the collaboration is crucial. Inter-organizational governance is the act of coordinating a collaboration of multiple companies [3, 4]. Current literature has acknowledged the lack of attention on governance of inter-organizational collaborations which are supported by information systems [3]. The governance ensures that the diverse coordination needs of the different members in a collaboration are met. Moreover, even though there is quite a consensus in the definition of governance of inter-organizational collaborations, prior studies have been using the term "governance" but actually only address a specific part of governance. Some studies focus on the governance mechanism [5], the governance aspects [3], or the governance models [4]. Most studies do not specify their points of view on inter-organizational governance and often jump on the trend of "governance" as a buzzword. This loose use of the "governance" term leads to a lack of a comprehensive understanding of inter-organizational governance. In addition, the paradigm of collaborations' governance is shifted from a static perspective towards a dynamic context-dependent perspective, which introduces the governance lifecycles [6].

This fragmentary knowledge of inter-organizational governance has been exacerbated by the increasing complexity of collaborations. Despite being the result of joint agreements between companies, inter-organizational collaborations do not eliminate the competition between these companies. Moreover, the global competition nowadays has urged port collaborations to expand over the boundary of industry sectors, countries, and continents. SC activities at ports are increasing, but so is competition in global SCs [7].

Designing governance is viewed as a crucial step in developing a PCS [8]. Thus, to design effective PCSs, an understanding of inter-organizational governance is needed. A study by De Langen [9] has focused on the governance of port collaboration, but this study only addresses the governance as coordination mechanisms. Another study by Srour et al. [10] discusses the lifecycles of port collaborations. However, this study has not shown how the theory of dynamic governance could be used in analysing the evolution of governance in depth. Other empirical studies on inter-organizational systems, such as Rodon, Pastor, and Sesé [11], have emphasized the importance of in-depth longitudinal study in this area. This study aims to fill this gap by demonstrating the theory of dynamics governance. The case study presented gives an understanding of port collaborations' changing governance models and how each actor involved shape dynamic mechanisms in order to govern the collaboration's aspects.

This research uses a single case study to apply the theory of dynamic governance for port collaborations. A single case study is selected because of the context-dependent characteristic of port collaboration. Thus, the lesson learned from this single case study will enrich the-state-of-the-art knowledge on the governance of inter-organizational collaborations, especially the port collaborations.

2. Inter-organizational Port Collaborations

A port collaboration is the act of independent organizations working together to execute their SC activities related to one or multiple ports. To coordinate this cooperation, port collaborations can adopt a PCS. "A PCS is an electronic platform which connects the multiple systems operated by a variety of organizations that make up a seaport, airport or inland port community. It is shared in the sense that it is set up, organized and used by firms in the same sector – in this case, a port community" [8]. Going beyond traditional function of PCS to share information, nowadays PCS offers modules to support a variety of SC activities [2]. The recent development of PCS includes the cloud services, which is growing to be the most significant factor in the historical development of information technology outsourcing [12].

In explaining inter-organizational collaborations in ports, it is important to understand the roles of each organization related to the collaborations. Wagenaar in van Baalen, et. al. [2] categorizes organizations involved in container transport into five groups based on the organizations' activities in the SC arrangement; the categories are: customer group, organizing group, physical group, authorizing group, and financial group. However, this categorization has not taken the adoption of a shared information system into consideration. Further, Chandra and Hillegersberg [1] proposed five general roles of organizations based on the analysis of several Supply Chain Collaborations (SCCs) which implement cloud-based systems. This classification is suitable to analyze the port collaboration context and to systematically communicate the collaborations' boundary design, business model, and governance to potential members or other parties. The five roles of organizations in a port collaboration are:

- *Member*. Entities which are the members of a port collaboration can be involved in the operational, tactical, or strategic activities of the collaboration. The members adopt the shared services to support their SC activities in the port *environment*. In order to maintain their access to these services, the members can invest into the PCS or/and pay access fees per transaction. Any organizations that are directly involved in the SC activities can be members in a port collaboration – the arrangement is determined by the port collaboration's business model. Thus, the members' size, type of organizations, culture, experience, or other criteria can be homogenous or diverse. The potential members are presented in Table 1.

Table 1. Potential members of port collaborations [2]

Group based on the organizations' activities in the SC arrangement	Examples of organizations
Customer group	Shipper; Consignee
Organizing group	Forwarder (merchant haulage); Shipping line agent (carrier haulage); Logistics service provider (4PL)
Physical group	Sea terminal operator; Shipping line/sea carrier; Pre- or On-carrier: carrier inland transport, i.e., barge operator, rail operator, road carrier; Inland terminal operator; Logistics service provider (3PL); Empty container depot operator
Authorizing group	Customs; Port authorities; Seaport police; River police; Inspection authorities

- *PCS operator*, is a provider who delivers the PCS, either software as a service or on premises with web access, for supporting the coordinated SC activities of port collaborations' members and enabling the collaborations. PCS operator is responsible to manage and maintain the PCS according to Service Level Agreements (SLA) with the members [8].
- *SC partner*. Outside port collaborations there are organizations which perform SC activities related to the collaborations. These organizations are not members of port collaborations, but may get access to the shared system. However, their benefits are not a priority for the collaborations. As a consequence, these organizations will not be expected to pay fees for using the system.
- *Other partner*, is an organization that support port collaborations besides the SC partner and the PCS operator. Examples of organizations with this role are bank, insurance company, internet providers, software developers to

whom PCS operators outsource a part or all of their software and/or platform development, universities, research institutes, associations, and labor organizations.

- *Orchestrator*, is a company that coordinates the SC activities inside the port collaboration.

These roles can be classified into *essential roles* – members and PCS operators – and *potential roles* – SC partners, other partners, and orchestrators. The existence of PCS and companies with the essential roles indicates that the collaboration is a PCS-enabled inter-organizational port collaboration as shown in Figure 1. On the other hand, a port collaboration does not necessarily have any SC partners, other partners, or orchestrators. The boundary of a port collaboration is determined by its' business model, which defines who can be the collaboration's members (customers). Based on this business model, the PCS operator may be related to the port collaboration as an internal entity, which has power over the PCS' development and management, or as an external entity, which is interchangeable.

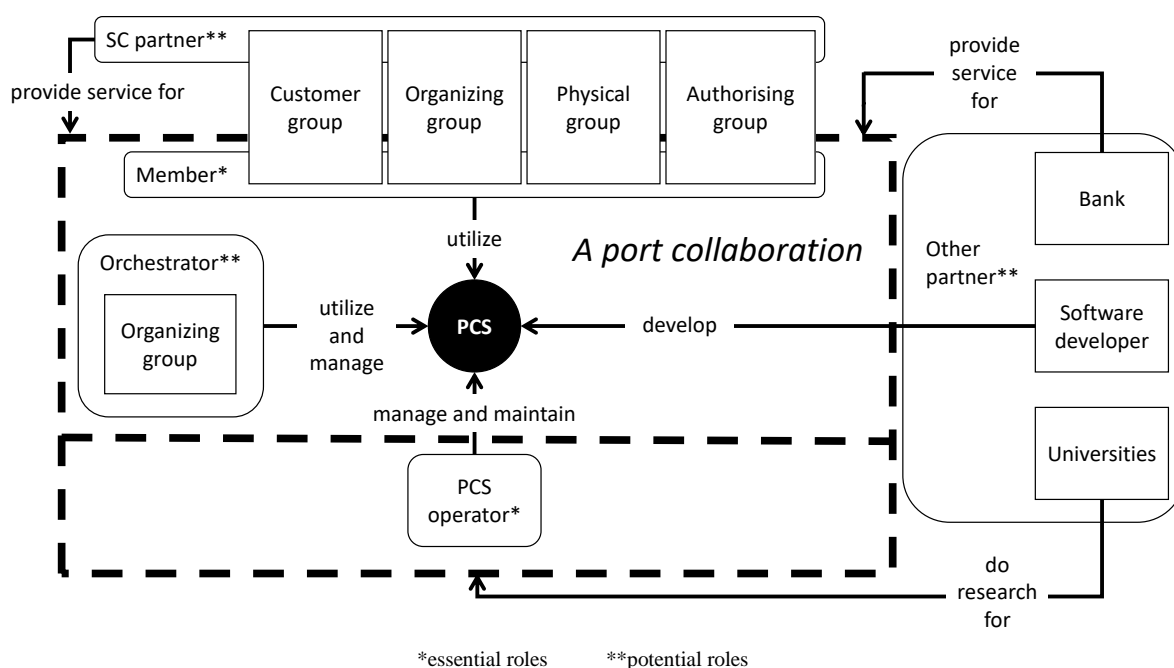


Fig. 1. Roles and example of organizations in a port collaboration

3. Inter-organizational Governance

In this study, several points of view on inter-organizational governance are used to address the dynamic and context-dependent governance – i.e. the governance mechanism, the governance aspects, and the governance models. In each stage of a collaboration's lifecycles, these points of view are interrelated; the understanding of a collaboration's governance using one point of view cannot be separated from the understanding of the same governance using other points of view.

3.1 Governance Mechanism

As stated by Ebers (1997) in Cropper, Huxham, Ebers, and Ring [13], governance mechanisms are the means (instruments) through which entities manage the content flows and coordinate their relationships. Governance

mechanisms are classified into formal and informal mechanisms of coordination [6]. These mechanisms complements each other in the governance of inter-organizational collaborations [14].

Formalized mechanisms can take the form of monitoring, control, and reporting systems through which organizations structure their interaction in an explicit way [6, 14]. Formalized mechanisms have been advocated in conditions of high asset specificity [6], to reduce risk and uncertainty [5] and prevent dissolution of inter-organizational collaborations [3]. Thus, formalized mechanisms become the foundation for the collaborations' stability.

The most common formalized mechanism in inter-organizational collaborations is a *contract*. Contracts entail an anticipation to make explicit both payoffs and task coordination [5, 14]. Other mechanisms that could be used by collaborations are *regulations, policies, and procedural approaches* in: decision making [14, 15]; partner selection [14]; joint information and communication systems [15]; shared marketing, planning or implementation of services [14, 15]; joint activities [14, 15]; integrated service capacities (e.g. a one-stop entity at the service of network clients) [15]; organization of meetings [15]; incentive structures [6, 13]; and administrative controls [6, 13]. In addition to contracts, *documented formalized mechanism* could also exist in the form of Service Level Agreements [16], costs and benefits analysis [17], definition of the network agenda [15], documented dispute resolution procedures [6], and standard operating procedures [6].

Informal mechanisms are characterized by relationships rather than by bureaucratic structures [6]. Consequently, the mechanisms are not legally enforced in inter-organizational collaborations. The moderating effect of informal mechanisms on the need for formal contractual mechanisms [6] are evident in the inception of a collaboration. Later, these effects become more inconspicuous in collaborations with a hierarchical governance, but never entirely go away. A comprehensive contract may not be possible because of bounded rationality and the cost of writing, negotiating, and implementing such a contract [5]. As a consequence, informal mechanisms provide flexible adjustment procedures to handle future contingencies in the collaborations [5], especially when monitoring and formal controls are difficult and costly [6].

Some forms of informal mechanism are: personal and informal contact between collaborations' members [15]; reciprocity and equity, as well as other norms [6, 13] which are developed through social exchange in the past and based on future expectation [5]; commitment [5, 6]; flexibility [5]; information exchange [5]; and trust [5, 6, 13]. According to Zaheer (1998) *trust* is the expectation that the counterpart will behave in a reliable, predictable, and in a fair manner [6]. Along the phases in the governance lifecycles, trust between members of inter-organizational collaborations could be established and nurtured.

3.2 Governance Aspects

Markus and Bui [3] developed a framework of six characteristics for mapping specific type of governance models for information-system-based inter-organizational collaborations. Fundamentally, the characteristics are governance aspects of inter-organizational collaborations. Table 2 demonstrates how these characteristics correlate with the corporate governance assets identified by Weill and Ross [18]. Weill and Ross [18] distinguish companies' six key assets that need to be governed to accomplish their strategies.

Table 2. Comparison between corporate and inter-organizational governance aspects

Markus and Bui [3]	Weill and Ross [18]					
	Human	Financial	Physical	Intellectual Property	IT	Relationship
Organizational form and legal status	--	--	--	--	--	--
Who can be members?	--	--	--	--	--	X
Who can be equity owners?	--	X	--	--	--	X
Capital investment and operational funding	--	X	X	--	--	--
Board composition and decision making	X	--	--	--	--	--
Data governance	--	--	--	X	X	--

This comparison justifies that Markus and Bui [3] characteristics are basically key assets of collaborations. Some of the connections are loosely defined, but those are not imprudent. The gap is explained by the nature of collaborations. First, collaborations mainly concern members' coordination, so the human assets are not strongly reflected in the collaborations' governance. Second, because collaborations involve multiple companies, the legal forms are not always carved in stone and require careful planning and coordination. Therefore, the Markus and Bui [3] study is used as a foundation to explore the governance aspects of inter-organizational collaborations, as follows:

- *Membership.* The value of collaborations is determined by the members. Thus, membership governance in a collaboration is strongly concerned with the member selection. A larger number of members usually results in a higher organizing cost. Collaborations have to decide the number of members based on added value of additional members and the balance between coordination costs and complexity of the network [19]. After being selected, the members must be able to interoperate swiftly. This interoperability includes the capability to quickly connect and their compatibility to enable a superior response speed. Decision rules and logic with regard to connection and disconnection will be a crucial component for the success of the collaboration [19]. After selecting the members, collaborations need to ensure members' participation. The members are required to participate by making investments and/or sharing information. Success as well as effectiveness of collaborations depends on the ability to encourage and sustain participation. Collaborations need to attract their member' participation by ensuring membership benefits. Markus and Bui [3] observe three ways to attract participation of members:
 - Ensuring that owners do not profit financially at the members' expense;
 - Drawing owners from all major segments of the community;
 - Providing for participants to have a say in decision making.
- *Capital investment.* The purpose of a collaboration would be defeated by excluding members that do not contribute to building the collaboration. Consequently, organizations may not be willing to fund the development of collaborations, and organizations may wait to join a collaboration until their partners join [3]. The adoption of cloud services, instead of on-premise systems, by inter-organizational collaborations could reduce a significant amount of investment needed. However, collaborations still need capital to provide services with a specific quality standard. Collaborations need a formalized governance to provide the legal authority required to amass and disburse funds and to protect the physical and intellectual properties involved in the information system and standards. Collaborations need to attract capital to fund their technological and organizational requirements and would need to find a way to overcome their shareholders' reluctance.
- *Operational funding.* Collaborations have non-trivial ongoing operating and maintenance costs, which may involve the employees' salaries, rents, and multiyear contracts with the system providers. To fund these costs, inter-organizational collaborations could use mixed revenue streams composed by [8]: (1) annual or monthly subscription fee by services or for all services; (2) fee per unit charge specific for the collaborations' fields (tons, watts, km, etc.), per service charge, or per EDI transaction charge; and (3) fee per stakeholder.
- *Decision making.* In a decision making process several plans are created, evaluated and ranked by an objective function to identify the best one [20]. The investors naturally gain decision making capabilities, which might be unattractive to some members due to limitations in resources, geographical locations, or experiences.
- *Data governance.* Inter-organizational collaborations amass substantial data resources from interactions between members. The system provider or the leading members could potentially use this data to gain a competitive edge over the other members. Therefore, collaborations need formal governance to address members' concerns about who owns the data, how the data is protected, and who can access the data.
- *Governance entities* are responsible to coordinate the members' activities. In a port collaboration, these entities also engage in contracts with PCS operators to acquire the required PCS. Governance entities could be all of the members, a particular leading member, or a separated legal form; the selection depends on the governance models of a particular collaboration. Important factors for the choice of organizational form could be taxation [3], field-specific law, and the members' past experience.

In addition, there are governance aspects that are specific to collaboration with a separated governance entity; those are:

- *Equity owners.* If a specific governance entity is established in a collaboration, there are three alternative ownership models for the entity: member-owned [21], investor-owned [21], and a hybrid combination of both [3]. The two factors that are most influential in the choice are diversity among the member organizations and competition with other stock exchanges [21]. Member-owned stock markets are limited in terms of available capital. This problem is compounded, according to Hart and Moore [21], by the slow and possibly contentious process of collective decision making in member-owned cooperatives. In investor-owned companies (such as publicly listed stock corporations), there is greater availability of capital for investment, whether it comes from issuing equity or undertaking debt. Moreover, ownership plays an important role because it goes hand in hand with decision making capabilities [3]. The authoritative style of decision making associated with investor-owned companies promotes a speedy decision process. One major advantage of member-owned is the fact that it is more responsive to the members' preferences. Although authoritative decision making in investor-owned may be faster than collaborative decision making in member-owned, the latter may be preferred by members. In fact, democratic governance structures may actually help motivate potential members to join and participate in a collective undertaking like open source software development [22].
- *Board composition.* In a separated governance entity, the board composition determines how decision-making capabilities are divided among owners and members. If the governance entity has a large number of owners, exercising control on a day-to-day basis would be ineffective. In that case, owners of a governance entity might be un-fit to take on decision making responsibilities and represent members.

3.3 Governance Models

Even though differences in naming and classification are present, there are four basic governance models for inter-organizational collaborations [1]. These models are illustrated in Figure 2.

- *Market*, is formed by contractual relationships between suppliers and buyers [23]. A market has certain features such as multiple suppliers of the same product or service [16] and short-term partnerships which mainly occur during the transaction. In this governance model, inter-organizational system providers can be seen as suppliers of a coordinating service and members can be seen as customers.
- *Shared governance*, in which members participate in network governance without a separate and unique governance entity [4]. Collaborations applying this governance model are governed by regular meetings among members. In these collaborations, the members are collectively responsible for making decisions.
- *Lead organization*, in which a particular member coordinates major network-level activities and decision making in a network [4]. This particular member takes sole responsibility of its inter-organizational collaboration. In a collaboration applying a lead organization governance model, the leading member should have adequate power – which could be acquired through market domination, law enactment, or buyer-supplier relationship dependencies – over the remaining members. Centralized data in the inter-organizational system could be used by the leading member to gain a competitive advantage. For this reason, a study by Markus and Bui predicts that inter-organizational collaborations will most likely be governed by organizations that are not one of the members [3].
- *Network Administrative Organization (NAO)*, which is a separate entity that is established to govern the network [4]. “Capturing and leveraging a position in a business network does not mean one must own or control the platform on which those networks run” [22]. The NAO model provides inter-organizational collaborations with the benefits of having a neutral governance entity.

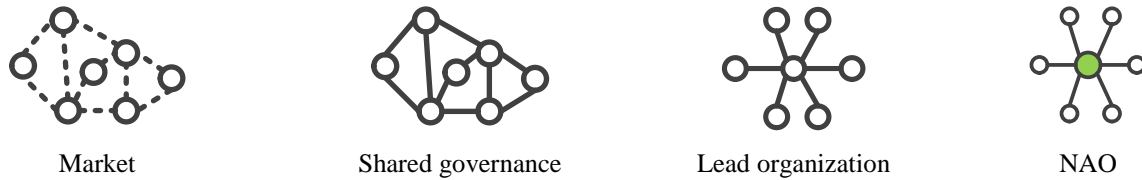


Fig. 2. Governance models

3.4 Lifecycles of Inter-organizational Collaborations

Below, we describe four phases in the lifecycles of inter-organizational collaborations, adapted from Lowndes and Skelcher [23]:

- *Pre-partnership collaboration.* A collaboration's lifecycle begins when an initiator decides to dedicate its resources – e.g. finance, human resources, and network – to develop a collaboration. In this initial phase, the scope of the collaboration is defined by assigning roles to each company involved, inviting potential organizations, and defining the business requirements. Next, how to govern the collaboration is discussed. During these activities, collaborations initially rely mostly on informal governance mechanisms [6], supported by trust and a sense of common purpose [23]. This is against the common view that collaborations start with formalized governance and proceed to cycles which reinforce trust between actors [6].
- *Partnership creation and consolidation.* After the partnerships are established, collaborations which decided on hierarchical governance design an assertion of status and authority differentials, as well as the formalization of procedures [23]. The design of formalized governance mechanisms can also occur in other collaborations which aim at less hierarchical governance. However, the less hierarchical collaborations will focus on intensifying the partnership between the companies to prepare for the program delivery. During this phase, the alternative services are assessed. At the end of this phase, the selected service should be implemented and made ready to be used. The success of collaborations in this phase depends on the members' willingness to financially contribute to the set up as well as the willingness to exchange their information with other partners [10].
- *Partnership program delivery.* In this phase, after connecting the collaborations' members using inter-organizational services, the business processes of the partners are executed. The market (or quasi-market) mechanisms of tendering and contract, with low levels of cooperation between providers dominate collaboration in this phase [23]. These mechanisms can be reinforced by informal governance, depending on the collaboration design. During this phase, the system providers, such as a PCS operator, can request members to pay fees for accessing the system. Usually, this fee is mainly meant to cover the development and maintenance expenses [17].
- *Partnership termination or succession* is characterized by a re-assertion of an inter-organizational governance mechanism as a means to maintain the actor's commitment, community involvement, and staff employment [23]. This phase can be triggered by any changes inside the collaboration or around the collaboration.

4. The Governance of Rotterdam's Port Collaboration

This section presents the history of Rotterdam's PCS. The port of Rotterdam and the community around it have been selected as a case study for this research. This port collaboration is selected because: (1) the collaboration has a fairly long history in operating a PCS, (2) the port of Rotterdam is the largest port in Europe and it is one of the leading ports in the world [24] with four different containerized on- and pre-carriage transport modalities – road, rail, inland shipping, and short sea shipping [2], and (3) many studies on this port have been published, which enriches the analysis in this

study. Data used in this study is a combination of an interview with the Managing Director at Portbase (the PCS of the port of Rotterdam) and secondary data collected by reviewing reports, studies, as well as industry magazines and journals.

The history is divided into three period: (1) pre-PCS, (2) Port Infolink, and (3) Portbase. The pre-PCS period is the era of initiative. During this time, the port community collaborated to establish an inter-organizational system. As a result of the port community's collaboration, the first PCS in Rotterdam port community – which was developed and maintained by Port Infolink – was established in the second period. Later, this PCS was replaced by Portbase's PCS.

4.1 Pre-PCS

The port of Rotterdam, located in the Netherlands, was the biggest port in the world in 1962 [25] and has been the biggest logistic hub of Europe ever since. The port infrastructure is owned by the municipality of Rotterdam and managed by the Port of Rotterdam Authority [26]. The Port Authority – a joint-venture between the Municipality of Rotterdam and the Dutch government – is responsible to develop, manage and exploit the port in a sustainable way and to render speedy and safe services for shipping [27]. In 1989 the port and companies in its community employed about 70,000 people who handled 291.8 million tons cargo that came from and distributed to 31,343 sea-going vessels and 120,000 inland vessels; this throughput positioned the port of Rotterdam on the highest position among the world's other major ports [26].

In the 1980s, a system of Electronic Data Interchange (EDI) – consisting of a network, standard messages, and a software – developed in the Netherlands for the port of Rotterdam [25, 26]. The project called INTIS (International Transport Information System) was established in 1985 by the port community, the Municipality of Rotterdam, and the Dutch PTT Telecom [26]. The system aimed to handle the information flows between all the parties involved in transportation and shipping in the port community use standardized messages in accordance with EDIFACT [2, 25]. In 1989 more than 80 companies were connected to the INTIS network [26]. This number increased to 120 companies in 1992 [28]. Despite of the positive results generated, INTIS floundered. The main problem were not technical, but organizational. INTIS' biggest challenge was to convince potential users of the short-term benefits of automated business systems [28]. In the end, the project did not result in a PCS [2].

After INTIS ended, the port of Rotterdam's community focused on a bilateral data transfer on a lower scale than INTIS [2]. Prior to the PCS implementation, data was managed on a bilateral basis via an assortment of EDI tools, faxes, emails, or by making telephone calls [7]. Information systems development resulted in disconnected systems, many bilateral exchange systems, and a low rate of data reuse [2].

In the 1990s, the port of Rotterdam and its community established the Port Community Rotterdam (PCR) project [29]. As stated by the Rotterdam Municipal Port Management in Lakshmanan [29] PCR aimed to “create a faster, smarter design for a container transport logistical chain by developing, simulating, implementing, and managing port-wide information technology applications”. This attempt and a later attempt called PCR-RIL to develop a PCS failed because there was not enough enthusiasm and support from the port community [2].

By the end of the 1990s, there was general discontent with the state of the port of Rotterdam's information system [10]. In 2001 the port of Rotterdam decided to analyse the scope and potential solutions for a PCS in Port of Rotterdam Main Information Services (PROMISE) project, which concluded that the PCS for the port of Rotterdam should be developed specifically (tailor-made) for the port of Rotterdam with the latest proven technology [2].

4.2 Port Infolink

The *pre-partnership collaboration phase* was initiated by the Port of Rotterdam Authority [7]. The Port Authority began by identifying the most critical problem hampering the efficient flow of goods through the port, which is the import processes [10].

Port Infolink B.V. was set up in 2002 as a separated governance entity. The Customs department and the Association of Rotterdam Shipbrokers and Agents, Deltalinqs, joined the initiative *informally* in the *partnership creation and consolidation phase* [30]. It was decided that the Port Authority will be the one and only *owner* of Port Infolink [30]. This ownership means that the Port Authority will bear the initial *investments* to develop the information system [10]. Port Infolink had a *Supervisory Board* – consisting of representatives of the Port of Rotterdam Authority, Dutch Customs, Deltalinqs, and the companies in the port collaboration – which decided on the strategy and set the priorities for the collaboration [2]. The existence of these representatives enabled Port Infolink to gain a neutral position in the port collaboration [2].

This project involved other stakeholders in the *partnership program delivery phase*, such as software development firms based in Rotterdam [10] working with Port Infolink based on *contracts*. The import SC, which was the focus of Dutch government at that time, was supported by communication modules connecting the Harbourmaster and the Dutch Customs [2]. The developed PCS succeeded to leverage the existing dissatisfaction of the Port Authority and Customs in order to promote a paperless import process [10]. As the two main parties agreed on the urgency of the problem, the first services of the new PCS were developed and implemented successfully [10]. This system implementation was easily accepted because the Dutch Customs already had planned to automate the import SC [2].

In 2005, Port Infolink had been in the middle of developing a single PCS. The challenge was to transform a wide range of message formats to a single, common XML format, which is enabled by Xenos terminalONE solutions [7]. There were two designs of connectivity to the PCS [2]:

- Users sent data in EDI or XML format, which would be converted to the internal XML-format for the PCS and stored in the PCS database; later these data could be sent and reused by any parties in the collaboration.
- By utilizing Web-based applications, users could see, enter, or adjust the information on their Web screen.

The PCS was connected to OTP (Overheidstransactiepoort/The Public Transaction Gateway) to send and retrieve information on the behalf of the companies in the port collaboration to and from Customs, Food & Consumer Product Safety Authority, and Plant Health Department. The PCS was designed to [7]:

- Provide any-to-any data exchange connectivity between any disparate platforms, which is the foundation of the PCS service.
- Provide *regulations, policies, and procedural approaches* for *data governance* by: (1) authenticating every data exchange, in every protocol and format, to ensure that no data is sent or received unless both the recipient and the data type for that recipient have been pre-approved; (2) determining the communications *protocols and business rules* required for each specific data exchange between a shipper and the port and ensures that communications are sent using those same protocols and rules; (3) storing the data centrally [31]; (4) making the data available to all parties who have access to the information [31]; (5) securing all data exchanges with standard, key-based security; (6) manipulating and delivering data to appropriate back office systems, based on *business rules*; and (7) re-sending data when acknowledgement is not received in defined intervals until such acknowledgement is received, or a timeout period has been reached.

The PCS provided by Port Infolink was developed using a modular implementation approach, which is referred to as the next generation of PCS that was getting implemented [17]. In 2006, the PCS consisted of 15 services (including import, export, communication between organizations in the community, communication with governmental organizations, carrier haulage, and merchant haulage) which were available for 1,000 companies with 2,500 users who exchanged about 1 million transactions each month [2]. According to Port Infolink, the modular architecture had three advantages [2]:

- Relatively low development costs. The development cost of this system was estimated to be roughly 35 million euros, which were divided into two categories, i.e. the central platform development and modules developments. The platform provided standard functionalities – messaging, authorization, and authentication – so its

development cost was high. On the contrary, the modules were built relying on these standard functionalities, thus the development costs were relatively low.

- Stable maintenance cost of the PCS. The maintenance cost was not sensitive to the change in the number of modules and transactions.
- Possibilities to reuse the existing functionalities in new services. Consequently, the cost and time to develop new modules were cut to minimal.

Later, Port Infolink adopted an architecture which provides mechanism for the *data governance*.

“The virtual agent can pull information from the barge or terminal databases, but does not directly share this data with any other agent. Instead all agents meet in a type of virtual market place where the barge agents negotiate with the terminal agents for appointments. In this way, the system design mirrors current point-to-point communication and negotiation practices, but improves the speed at which they occur” [10].

With the new system, the SC activities in the port of Rotterdam were getting faster and more efficient. The Port Authority could pass along the significant cost reductions to other entities in the port environment [7]. The *benefit sharing* was controlled by Port Infolink. Lower costs increased traffic and additional savings realized when the electronic transaction systems were integrated with e-Government systems for Customs [7]. “At that time we stepped in the middle, [we do] not only automate and optimize the business-to-government flow but also make it more attractive to reuse the information”, Portbase Managing Director. Only three years after the establishment, the enthusiasm for Port-Infolink was mutual between the port of Rotterdam and Deltalinqs. “At the most recent consultation, Deltalinqs, the Association of Rotterdam Shipbrokers and Agents, quite unequivocally called Port Infolink a great success” Pieter Struijs, Rotterdam's director of infrastructure and maritime [7].

Next, Port Infolink changed its *revenue stream*. The Port Authority believed that the market itself needs to invest [7]. Thus, Port Infolink started to charge the *members* for accessing the services in 2007. “In the beginning, there were some resistances, but we were strict on what we were going to charge and how we were going to charge, so no companies left us” (Portbase Managing Director). During this *partnership program delivery phase*, Port Infolink also maintained close formal and informal relationships with other actors in Dutch SCs.

During this *partnership program delivery phase*, Port Infolink also maintained *close formal and informal relationship* with other actors in Dutch SC field. For example, Port Infolink participated in PROTECT (2005-2008), a research project funded by the Dutch transport research fund Transumo together with Dutch Customs, the shippers branch organization EVO, Transport and Logistics Netherlands, Holland Distribution Council, Det Norske Veritas, RSM Erasmus University, TNO, Technical University Delft and Buck Consultants [31]. This project aimed to increase the security of global supply chain – which included the information system security, supply chain structure, and strategies – to address the threat of criminality and terrorism.

In the end of Port Infolink's lifecycle, the collaboration entered the *partnership succession phase*. This succession was incited by the thriving Dutch maritime SC activities and the growing concern to preserve the competitive position of Dutch ports. By this point in time, Port Infolink had already offered 24 different services, with around 4500 users who sent more than 20 million electronic messages a year [30].

4.3 Portbase

As of early 2009, the next governance lifecycle was marked by the merger of Port Infolink in Rotterdam and PortNET in Amsterdam, which provided the Ports of Rotterdam and Amsterdam with one joint PCS [30]. This merger aimed to actualize a vision of single national PCS in Dutch ports [2].

PortNET's history started eight years before the merger – in 2000. PortNET was a public-private partnership organization which successfully encouraged the development and use of ICT in the ports of the Amsterdam North Sea Canal area [30]. Even though Port Infolink was younger than PortNET, Port Infolink had developed more functions in its PCS, which were logistic and navigation functions [17]. The merger *contract* guaranteed that the PortNET *members*

would be able to use the services of Port Infolink for the exchange of data in the mid-2009 [32]. Even though PortNET had maintained a centralized governmental PCS for business and various government agencies for six years [17], it was decided that Port Infolink's PCS would be the foundation for their future service.

In the beginning, Portbase's *board of management* consisted of a director from Port Infolink and another director from PortNET [33]. It was after the Portbase B.V. established that the "neutral" notion began to be used in describing the company. Portbase has roles as a neutral *PCS operator* and *orchestrator* for Dutch port communities. At its' launching, Portbase offered 25 different information services and had approximately 1300 clients in all port sectors [33]. "Portbase's main objective is to create a competitive edge for Dutch ports by reducing SC costs and increasing the quality. We provide better information in [an] easier way for all its users", (Portbase Managing Director).

At present, Portbase is in the *partnership program delivery phase*. The *ownership* is shared between the Port of Rotterdam Authority (75%) and the Port of Amsterdam Authority (25%). Portbase's *Management Board* and its team are supported by a *Supervisory Board* and an *Advisory Board*. Both Port Authorities are represented on the *Supervisory Board*, together with other Portbase's main business partners. The *Supervisory Board* is responsible for evaluating Portbase's performance and deciding on its PCS development strategy [34]. This responsibility regarding the development of Portbase's PCS is shared with the *Advisory Board*, which is initiated by Deltalinqs. The *Advisory Board* gives advice, proactively or reactively, on the Portbase's PCS and the services that are to be developed in the PCS [34].

Portbase' PCS has four PCS functions: dangerous goods declaration, customs, logistics, and navigation [17]. The major development in the PCS is the digitalization of export processes. The services provided through each function are available by using several application modules [17]. Thus, Portbase's PCS retains Port Infolink's PCS modular architecture approach. These services are built on top of a platform provided by Oracle. Besides the main services *members* also have access to build their own services on top of Portbase's platform – e.g. ProRail's Wagonload Information System. In order to develop these services, Portbase collaborates with IT companies and service providers which support its *members*. The services are used in all Dutch ports to guarantee synchronized data between its *members*. Nowadays Portbase offers 43 services to support its community. By offering these services, Portbase provides a standardization of information that is being exchanged in the port community.

To support these services, Portbase emphasizes the importance of system and data security. According to Portbase's website, "information is visible only to those in certain roles (need-to-know basis)" [35]. This statement proves that Portbase implement a strict *data governance*, which had been practiced by Port Infolink beforehand. Moreover, Portbase offers a data encryption for Web interface connection, and a free User Management service to the *members* to help the organizations in enforcing the *data governance* procedure [35].

The generic infrastructure and services are developed in-house by Portbase in project working groups. The infrastructure and platform are *supported financially* by its *owners* – i.e. the Port Authorities. Meanwhile, the *members* pay Portbase *access fees* based on their transaction for exploitation and development of the services on Portbase' platform, based on two packages [36]:

- Portbase Basis Plus. The *members* can decide to pay *subscription fees* for the services for lower *transaction fees*.
- Portbase Basis. *Members* that do not subscribe will pay higher *transaction fees* for using the services.

Portbase issues monthly invoices for the *members*; the settlement takes place once a year [36]. With this *revenue flow*, Portbase's balance sheet is break-even and proves its standing as a *non-for-profit* company.

Nowadays, Portbase's community has expanded – i.e. agents, barge operators, shipbrokers, Customs, empty depots, exporters, importers, forwarders, Food & Consumer Product Safety Authority, inspection stations, Port Authorities, selection points, companies, rail infrastructure managers, rail infrastructure operators, traction suppliers, road haulers, and terminals. The port of Rotterdam still maintains its influences in the import and export SCs that pass through the port. The Port Authority is one of the founding members of a cooperation which aimed to reduce traffic on the main road leading to the port during rush hours [37]. By the end of 2016, Portbase had 3900 companies as members and 14000 users that were involved in 82 million transactions within the system [38]. Today Portbase' PCS has been

implemented in The Rijkswaterstaat Maritime Navy and several Dutch ports: Rotterdam, Amsterdam, Harlingen, Zeeland Seaports (Vlissingen and Terneuzen), Dordrecht, Scheveningen, Den Helder, Gronigen Seaports (Delfzijl and Eemshaven), and Moerdijk.

5. Discussion

The PCS-enabled Rotterdam's port collaboration had been through three full lifecycles of inter-organizational governance and is now in the fourth lifecycle as illustrated in Figure 3. The first and second lifecycle occurred in the 1990s, which was indicated by the establishment of PCR and PCR-RIL projects. Following the failed attempts to develop a PCS, the Port of Rotterdam Authority initiated the third lifecycle by the end of the 1990s. Thus, the third lifecycle was started and resulted in the establishment of Port Infolink in 2002. This lifecycle lasted until Port Infolink was merged with PortNET in 2009. The last phase of Port Infolink overlapped the *pre-partnership phase* of its successor, Portbase.

PCR and PCR-RIL projects did not scale because the Port of Rotterdam Authority did not manage to gather support from the port community. At that time, this challenge was not a novel issue. The INTIS project, which was initiated a decade earlier, was also terminated due to the organizational failure in convincing potential users to join the project. The lifecycles of PCR and PCR-RIL projects were terminated prematurely before the project entered the *partnership program delivery* phase. Both projects did not develop a PCS and a solid port collaboration. Because there is a limited information regarding the governance of both projects, the discussion in this study focus on the third and fourth lifecycles.

In the beginning of the third lifecycle, the Port of Rotterdam Authority was the sole initiator and powerhouse of the collaboration. *Formal governance mechanisms* had not been enforced yet in the *pre-partnership collaboration* phase. Consequently, the Port Authority depended on *informal governance mechanisms*, such as *contacts* between the Port Authority's employees and the Dutch Customs' employees and *trust* on the Port Authority. In the second phase, the establishment of Post Infolink was an indicator that the Rotterdam's port collaboration adopted a *NAO governance model*. The organizations' roles in the collaboration are illustrated in Figure 4.

In this cycle, Port Infolink adopted an EDI-based PCS and later a web-based PCS. The collaboration made the *data governance* their priority in the *partnership program delivery* by establishing strict *documented rules, procedures, and policies*. Port Infolink connected the Port of Rotterdam Authority, shipping lines, agents, carrier inland operators, and the port terminal, mainly throughout the import processes. During this lifecycle, the port collaboration exercised *formalized and informal governance mechanisms* to govern the governance aspects that are presented in Table 3, which successfully lead the collaboration to the *succession phase*.

In the fourth lifecycle, the *pre-partnership collaboration* phase was started and ended together with the third lifecycle's *partnership succession* phase. During this period, Port Infolink's PCS continued functioning for the Rotterdam's port collaboration. In addition to the usual day-to-day activities, the port collaboration was also engaged in the discussion and preparation for the merger. The collaboration depended on the *informal mechanism* before the *formal mechanism* was enforced through the merger. In the next phase, Portbase was established to substitute Port Infolink and PortNET. Portbase maintains the governance best practices from Port Infolink, preserving the *NAO governance model* and exercise *formalized and informal mechanisms*. The governance model and the organizations' roles in the collaboration are presented in Figure 5.

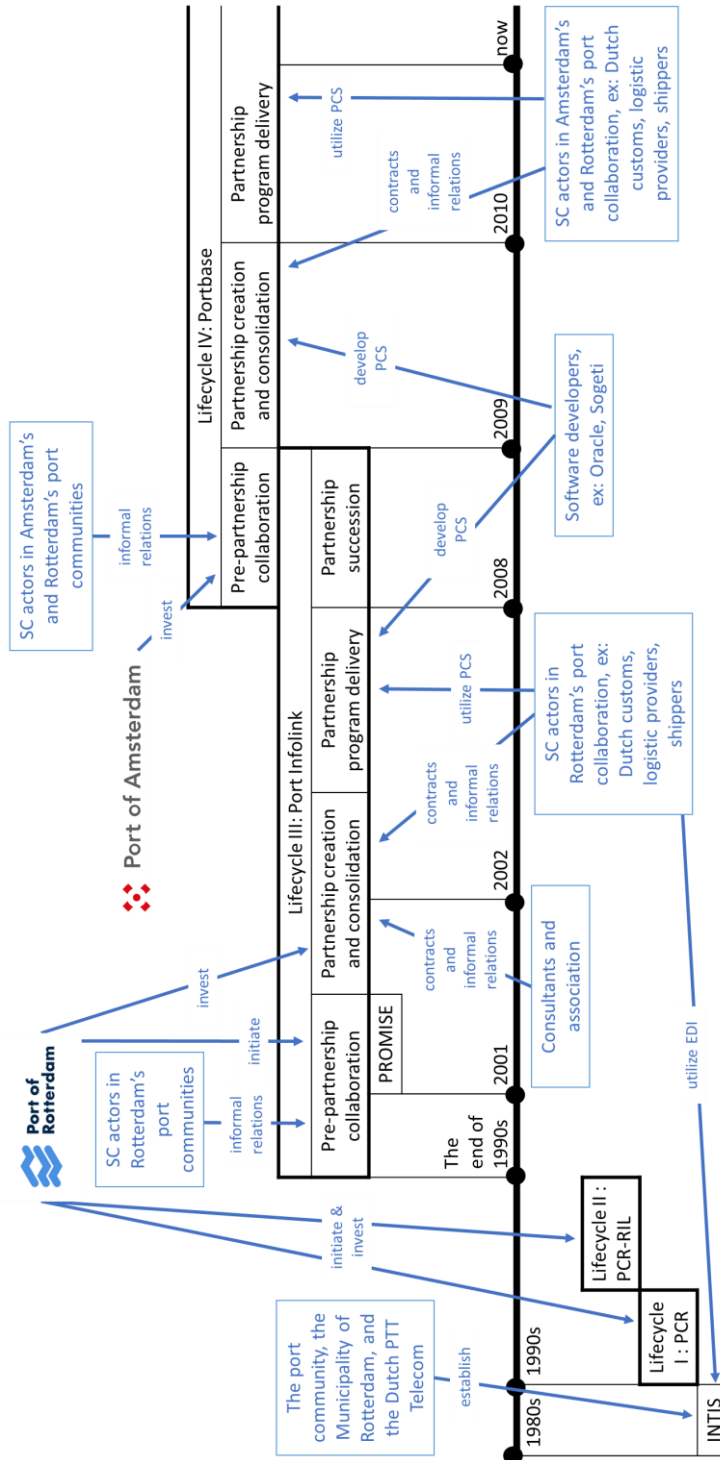


Fig. 3. The governance lifecycles of the Rotterdam's port collaboration [39, 40]

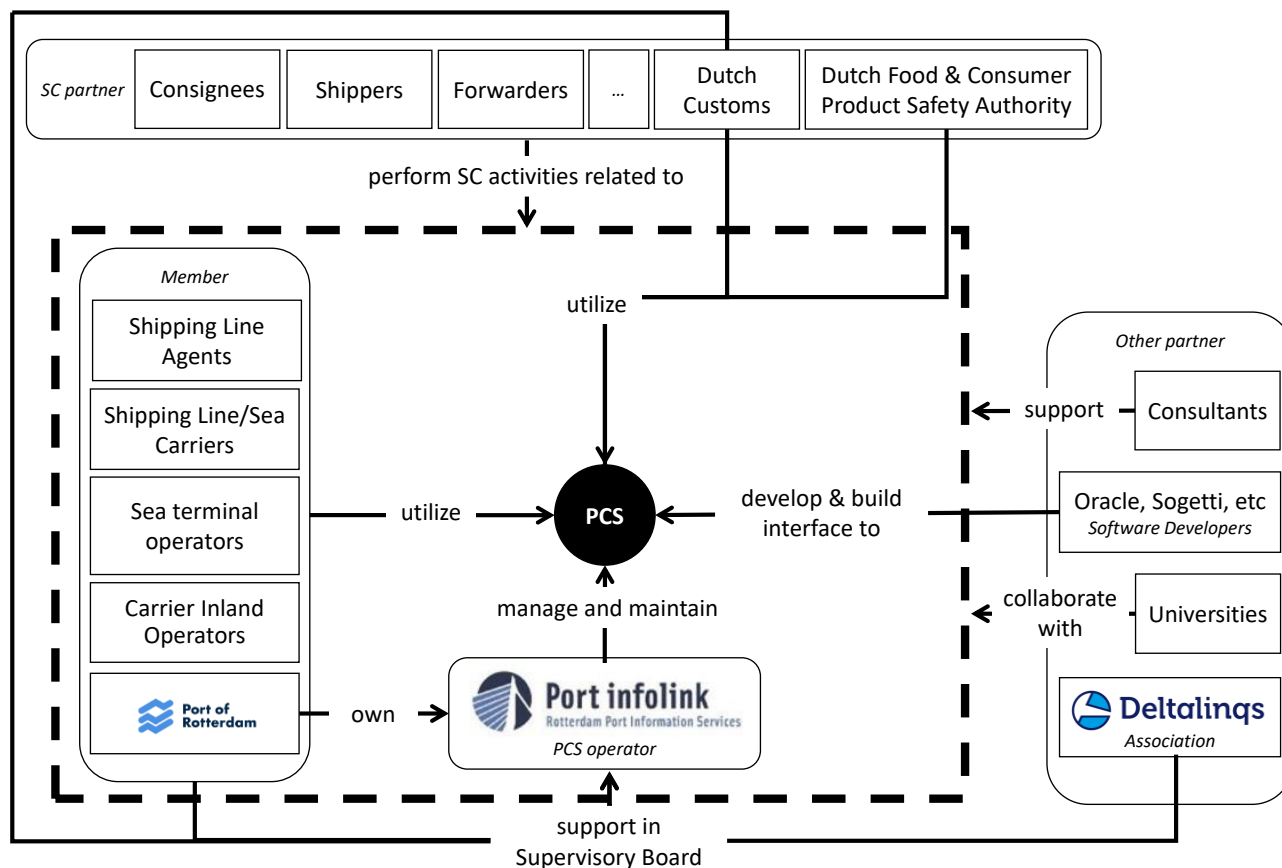


Fig. 4. Lifecycle III: the governance model of the Rotterdam's port collaboration [39, 41, 42]

The differences between the governance models in the third lifecycle (Port Infolink) and fourth lifecycle (Portbase) are: (1) the addition of the Port of Amsterdam Authority, which together with the Port of Rotterdam Authority owns and invests in Portbase; (2) Portbase claims to be an *orchestrator*, which is a development from Port Infolink's role that is limited to *PCS operator*; (3) Portbase manages to include the shippers, consignees, and forwarders in the PCS-enabled port collaboration; and (4) Portbase has an *Advisory Board* and the arrangement of representatives in Portbase's Supervisory Board is different from Port Infolink's *Supervisory Board*.

Furthermore, stark distinctness can be observed in Table 3. Table 3 compares the arrangements of governance aspects in the third and the fourth lifecycles, which port collaborations are governed by Port Infolink and Portbase, respectively. First, Portbase enlarged its collaboration. The collaboration *membership* is not limited to the Rotterdam's port community anymore. The data sources – the shippers, consignees, and forwarders in import and export SC – are included in the current Portbase's collaboration. Second, the *investment* for Portbase come from two port authorities, which are the *equity owners* – the Port of Rotterdam Authority and the Port of Amsterdam Authority. Third, Portbase offers two financial plans for funding the *operational cost*. These plans give the *members* flexibility in deciding on the plan that fits their needs. Fourth, Portbase's organization structure consists of a *Management Board* and its team, a *Supervisory Board*, as well as an *Advisory Board*. There is a clear distinction between the *documented responsibility* of the *Supervisory Board* and the *Advisory Board*. This distinction helps both Boards to focus on the issues in the respective levels of *decision making*.

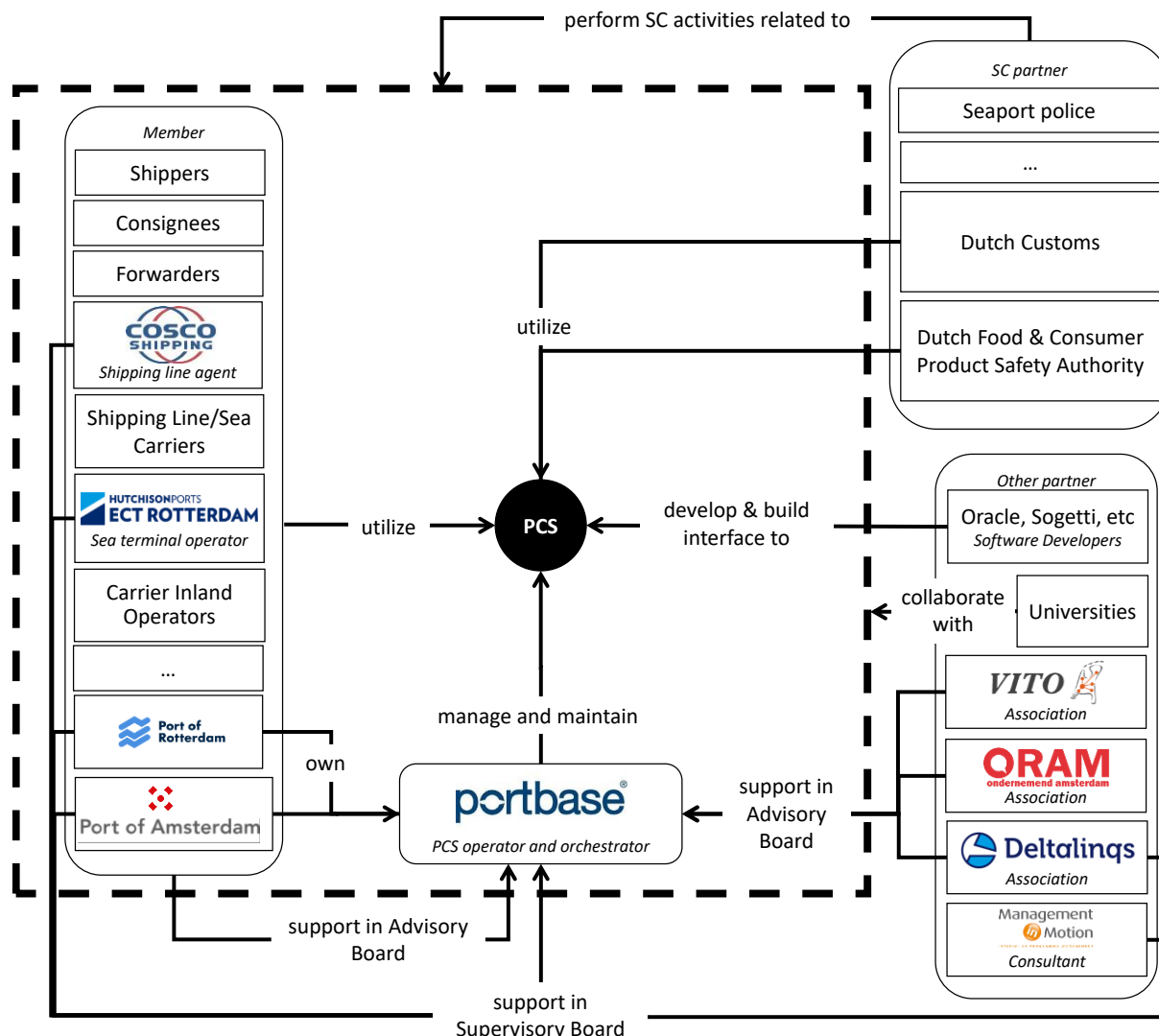


Fig. 5. Lifecycle IV: the governance model of the Rotterdam's port collaboration [39-47]

Table 3. The governance aspects' arrangements in the third and fourth lifecycles

Governance Aspect	3 rd Lifecycle (Port Infolink)	4 th Lifecycle (Portbase)
Membership	<ul style="list-style-type: none"> The membership was limited to organizations that conducted SC activities in or related to the Port of Rotterdam (location-based membership). Port Infolink's PCS managed to connect shipping line agents, sea carriers, sea terminal operators, carrier inland operators, and the Port of Rotterdam Authority to each other and with the Dutch Customs and Dutch Food & Consumer Product Safety Authority. 	<ul style="list-style-type: none"> In the beginning, the membership was limited to organizations that conducted SC activities in or related to the Port of Rotterdam and Port of Amsterdam (location-based membership). Later, other Dutch ports are also included. Portbase' PCS manages to connect the shippers, consignees, dan forwarders, which were not connected by Port Infolink's PCS.

Governance Aspect	3 rd Lifecycle (Port Infolink)	4 th Lifecycle (Portbase)
Capital investment	The Port of Rotterdam Authority was the sole investor.	The Port of Rotterdam Authority and the Port of Amsterdam Authority share the investment for Portbase.
Operational funding	<ul style="list-style-type: none"> 2002 – 2007: The Port of Rotterdam Authority paid the operational cost. 2007 – 2009: Members paid access fees. 	Members pay Portbase access fees based on their transaction and can opt to pay subscription fees.
Decision making	<ul style="list-style-type: none"> The benefit and cost sharing was decided by Port Infolink's Management Board and Team. The Supervisory Board decided on the strategy and set the priorities for the collaboration. 	<ul style="list-style-type: none"> The Management Board and Team decide on the operational, tactical, and strategical decision, such as: benefit and cost sharing (via access fees and subscription fees), infrastructure maintenance and development, as well as selection of software developer and other partners. The Supervisory Board is responsible for evaluating Portbase's performance and deciding on its PCS development strategy. The Advisory Board gives advice, proactively or reactively, on the Portbase's PCS and the services that are to be developed in the PCS.
Data governance	Regulations, policies, and procedural approaches were enforced.	Regulations, policies, and procedural approaches are enforced.
Governance entities	Port Infolink B.V. coordinates the PCS-enabled information sharing collaboration in the port of Rotterdam.	Portbase B.V. coordinates the PCS-enabled information sharing collaboration in several Dutch ports.
Equity owners	Port Infolink's shareholder is the Port of Rotterdam Authority.	Portbase's shareholders are: <ul style="list-style-type: none"> The Port of Rotterdam Authority (75%) The Port of Amsterdam Authority (25%).
Board composition	Port Infolink had a Supervisory Board: Port of Rotterdam Authority, Dutch Customs, Deltalinqs, and the major companies in the port collaboration.	In the beginning, Portbase was supported by board of directors from both prior companies. Today, Portbase is supported by: <ul style="list-style-type: none"> A Supervisory Board: Port Authorities, Deltalinqs, Cosco, ECT, and Management in Motion. An Advisory Board: Port Authorities, Deltalinqs, ORAM, VITO, and the major companies in the port collaboration.

Portbase has become a successful *PCS operator* and *orchestrator* in European maritime port collaboration. The success can be observed from the increase in the number of Portbase's *members* from 3700 to 3900 companies [38] and the financial stability of the port of Rotterdam [24], which is the central hub of the port community. This success is related strongly to the ability of Portbase in attracting potential members and engaging its *members*. This ability was a trait that is inherited by Portbase from its predecessor, Port Infolink. Moreover, the port of Rotterdam declares that there is a room for improvement in terms of the *members'* ease of doing business [24]. Thus, this is an opportunity for Portbase in developing its support for Rotterdam's port community.

In the beginning of Port Infolink establishment, Port Infolink chose an ideal process – import process – to be automated by the first version of PCS. This choice was proven to be an excellent decision. The import process is favorable by the Dutch Custom. Therefore, Port Infolink had a strong support from the Dutch government. This support helped Port Infolink in attracting the port community, establishing *trust* and *contacts* in the *pre-partnership collaboration* phase, as well as gaining data and information regarding the process for the PCS development. Later, Port Infolink managed to save the time and decrease the cost of the import process. This benefits realization was a concrete example for other potential members that had not joined the collaboration at that time.

Port Infolink addressed the recurrent organizational issues in previous projects by the establishment of a *NAO governance model*. Thus, Port Infolink inaugurated a neutral position in the collaboration. Port Infolink as a separated governance entity maintained its neutrality through:

- giving equal opportunity to join the *membership* to all eligible potential members.
- being open about the non-for-profit status in publishing the *investment* and the *operational funding*.

- implementing a strict and transparent *data governance*.
- communicating clear *rules, policies, and procedures* regarding the collaboration's operation for example, the access fees.
- involving the members and Deltalinqs in a *Supervisory Board*.
- having the Port of Rotterdam Authority, a public limited company, as the single *equity owner*.

Retaining the governance model and most of the governance aspects' arrangements, Portbase evolved and develop more sophisticated details. Portbase identified the best practices in maintaining the governance entity's neutrality. Furthermore, Portbase uses the "neutral" word in communicating its value to its *members*, potential members, and *partners*. This wording emphasizes the importance of Portbase's neutrality to preserve the collaboration's performance.

However, the use of Portbase's PCS does not mean that Rotterdam's port community is problem-free. The port of Rotterdam is struggling for years with delays in the container on barges, and the problem has been persistent in 2017 [48]. Another challenge that needs to be addressed is the sustainability issue. The port of Rotterdam has announced its vision to be a zero-emission port by 2050 [49]. This vision is in line with the trend to support low-carbon shipping in the global supply chain. In addition, the global supply chain is also leading the port of Rotterdam into a greater inter-organizational collaboration that involves other ports around the world. All of these problems and challenges have to be addressed by the port community as an integrated collaboration, and Portbase should participate in the process as well.

6. Conclusion

In the first part of this study, a structured way to define a governance of inter-organizational collaborations with a lifecycles paradigm is proposed. There are three points of view used: governance mechanisms, governance aspects, and governance models. These points of view are used in analyzing a case study in the port of Rotterdam. The port collaboration's dynamic governance are explored using the framework that is introduced in the first part of this study.

The PCS-enabled Rotterdam's port collaboration had been through three full lifecycles of inter-organizational governance and is now in the fourth lifecycle. The first two lifecycles were terminated prematurely before a PCS developed. The last two lifecycles were successful in implementing a PCS in the port collaboration. A NAO governance model was established in the third lifecycle and sustained throughout the fourth lifecycle to coordinate the governance aspects using the formal and informal governance mechanism. In the third lifecycle, the governance entity was Port Infolink. Later, Port Infolink merged with PortNET to establish Portbase, which is the governance entity in the fourth lifecycle. Portbase flourishes to be a successful neutral PCS operator and orchestrator in European maritime port collaborations. Nowadays Portbase supports not only Rotterdam's port collaboration, but also several other Dutch port collaborations.

The case study analysis of Rotterdam's port collaboration gives an example of how a systematic approach could help to communicate and give a comprehensive overview of the governance of inter-organizational collaboration. This analysis can also serve to discuss future adaptations to the governance model and as an inspiration to other inter-organizational governance designs. The systematic approach proposed in this study could be beneficial for researchers, consultants, and companies that are working on establishing an inter-organizational collaboration to identify the important roles of each party involved in both pre-partnership collaboration as well as partnership creation and consolidation phases. Having the roles clearly defined, all parties can decide on the suitable governance model for the collaboration. In the subsequent phases, the approach can be beneficial to explain the dynamic governance within the collaboration.

This study is limited to one case study. In the future, a cross-case analysis will be conducted. Using the cross-case analysis, the critical success factors of the governance of inter-organizational collaboration would be an interesting topic to be analyzed further. Moreover, future research could consider adopting a multi-dimensional success metrics of an inter-organizational collaboration to assess the success of a collaboration and the influence of the governance on the

collaboration's success. Thus, the future research could develop an approach in designing appropriate governance for inter-organizational collaboration taking the collaboration's evolution into account.

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