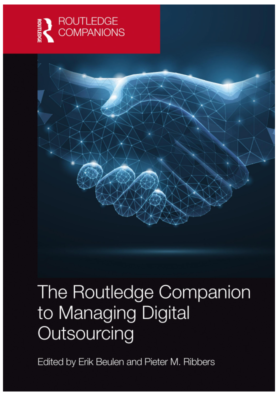

The Routledge Companion to Managing Digital Outsourcing

Erik Beulen, Pieter M. Ribbers

Supply chain coordination and integration

Publication details
https://test.routledgehandbooks.com/doi/10.4324/9781351037785-6
Jos van Hillegersberg, Dissa R. Chandra
Published online on: 28 Jul 2020

5

SUPPLY CHAIN COORDINATION AND INTEGRATION

Jos van Hillegersberg and Dissa R. Chandra

5.1 Introduction

Supply chains and business networks are dynamic, and subject to forces of disintegration and re-integration. Their structure is often large and complex. Still, agility is required to provide value to the end-customer. Agility and responsiveness require effective and efficient collaboration between organizations in the network. This can only be realized with properly designed and well-governed IT and information systems.

In this chapter, we review the business drivers for supply chain collaboration and the role of IT in disabling and enabling collaboration. We then discuss inter-organizational governance, as the interplay between technology and governance is an important part of sustainable collaboration. This can be viewed as a new type of alignment – the alignment between inter-organizational services, processes and governance, and the IT and systems that support it. We review types of Inter-Organizational System (IOS) and IOS governance (Section 5.4) and the role of IT and information systems (Section 5.5). As an example, we describe some aspects of Portbase, a logistics IOS illustrating network collaboration and IOS governance (Section 5.6). We conclude by discussing the state of the field and briefly point at the potential impacts of recent technologies.

5.2 Drivers for supply chains and networked business

As a result of drivers such as specialization, globalization and the increasing complexity of products/services, value chains usually consist of many tiers. Businesses in each tier fulfill a specific task to add value to the product/service. This specialization has many potential advantages. In [1], three types of advantages are given. (1) Disintegration advantages, related to the benefits of not having activities in-house that can be better sourced from external companies. One can think of focusing on core competencies that provide superior product/service quality, cost, flexibility speed and innovation. As noted in [2], this also includes the benefit of modularization of products/services. (2) Location-specific advantages, such as placing specific product/service capabilities in geographical regions that offer certain policy, infrastructure or labor market benefits and (3) externalization advantages that encompass the benefits of co-specialization, organizational learning and relationship capital.

In [3], "vendor managed inventory (VMI), efficient customer response (ECR), and collaborative, planning, forecasting, and replenishment (CPFR)" are given as examples of vertical coordination. Clearly, to bring these benefits to the end-consumer, seamless integration is needed across the value chain. The coordination and collaboration that crosses supply chain tiers is referred to as *vertical integration*.

Each specific business function is a candidate for being outsourced and subsequently procured externally. The drivers and risks may vary based on the type of function that is externally sourced in the value chain. For example, drivers in logistics, procurement and IT partly overlap, but also differ (see Table 5.1). Compiling extant literature [4] gives a variety of factors that drive the externalization of the logistics function. For the outsourcing of the procurement function, a survey conducted with procurement managers finds that the presence of specific competences and product commoditization plays an important role [5]. Similarly, different factors are at play in the sourcing of IT services [6].

Within a tier of a value chain network, businesses perform similar tasks. For reasons such as location, regulation, market, specialization, etc., the number of players in a tier may vary. These players may simply co-exist, be in competition or cooperate. The reasons for cooperation can be many, such as risk sharing, gaining flexibility, cost reduction, knowledge exchange, innovation, complementing networks or services. Several scenarios can be thought of that require coordination and collaboration within a tier – *horizontal integration*. In [3], examples of reasons for horizontal collaboration are given: sharing private information, facilities or resources to reduce costs or improve service, manufacturers' consolidation centers (MCCs), joint route planning and purchasing groups.

Given the many drivers for externalization and outsourcing of business functions, one would expect to see very fine-grained business networks, with each business only providing highly specialized and focused functions and relying on the value network for everything else. Proponents of the dynamic value network envisage the dominance of smartly orchestrated networks in which capabilities are dynamically sourced and coordinated [7,8]. However, the same factors that drive the outsourcing of functions may also re-shift the

Table 5.1 Varying drivers for business function externalization

Externalization of logistics [10]	*Externalization of procurement [5]*	*Externalization of IT services [6]*
Logistics cost reduction	Contract manufacturer competence	Exploration of knowledge
Diverting capital investment	Lack of competencies at OEM	Innovation
Enhancement of business process	Product commoditization	Intellectual property
Expertise of 3PL service providers	Offshoring opportunity	Value network of client and/or supplier
Focus on core competencies		Interaction and integration of resources
Reduction of warehouses and vehicles		Complementary competencies
Increasing of inventory turnover		Continuous improvement
Enhancement of flexibility in operations		Interaction and integration of resources
Access to emerging technology		Joint problem-solving
Productivity improvement		

balance toward insourcing or reshoring. Hartman et al. [9] find, based on 12 case studies of companies that insourced a previously outsourced manufacturing function, that external events often change, and conditions cause companies to reconsider their sourcing strategies. Re-integration decisions have recently been made by e-commerce giants such as Amazon.com that is moving away from contracting logistics services: “It has created its own logistics division and acts as its own freight forwarder” [10].

In summary, many drivers and counterforces determine the structure, composition and granularity of the value network. Outsourcing can have mixed effects on firm performance depending on the type of outsourcing and the context. Based on a survey of the literature, Lahiri [11] finds that “outsourcing involves tradeoffs between lowering cost and enhancing innovation capabilities”. Moreover, the review shows that “a firm’s careful balancing of vertical integration and strategic outsourcing for innovation helps achieve superior performance”. It is also important to realize that outsourcing decisions that impact value network configurations are not fully rational. Changing environment, uncertainty and the bounded rationality of the decisions clearly play a role. Historical reasons, tradition, personal friendships and family ties, politics and trust can all be instrumental in value chain linkages and performance [12].

In the next section, we focus on the role of IT and information systems to enable effective collaboration and coordination in the supply chain. Drivers, such as shown in Table 5.1, only materialize if supported by effective IT. We introduce the literature in this area and then discuss various types of supply chain collaboration and coordination technology.

5.3 Responsive supply chain and the role of IT

The complex and dynamic structure of today’s supply chains calls for mature levels of business network integration and agility. An agile business network is able to respond to largely unpredictable changes with ease [13]. Various related terms are used in the literature referring to similar abilities. In [14], the term responsive supply chain is used. The authors identify three major enablers: (1) value chain or a collaborative network of partners, (2) Information Technology (IT) and systems and (3) knowledge management. We have already discussed what drives the value chain structure. Now we focus on the systems and technology and their role as enabler or barrier.

How can technology and systems support the inter-organizational linkages between organizational nodes in the network? In addition to strategic and organizational barriers, IT systems continue to cause barriers to business integration: “both academia and industry observers have long been concerned about the continued slow, painful process and many cases of failure to realize the performance value of IOS” [15]. Technical complexity that can occur in inter-organizational integration goes beyond that of systems engineering within the organization. Inter-organizational processes will need to connect at least two systems embedded in different architectures and systems landscapes. Each organization involved will bring its own systems, procedures and practices to the table. Often, these have evolved over time and include proprietary technologies and customizations. The lack of a single dominant standard in most industries further increases the challenge [16].

In most organizations, Enterprise Resource Planning (ERP) systems account for an important part of the systems landscape or even form the backbone of the architecture [17]. Such systems have usually not been designed with seamless integration in mind. As a result, connecting legacy and ERP systems of various partners is technically highly complex. Enterprise Systems Integration projects may take years and huge investments to complete. The resulting "hard-wired" links often do not enable agile business networks that allow business partners to quickly connect their business processes [18]. Based on a Delphi panel study, Daniel and White [19] concluded that "ERP systems may be reaching a structural limit concerning their capabilities and adjunct technologies will be required to integrate multiple inter-organizational operations".

While agile business networks have been described in several conceptual studies, the lack of suitable ICT support has been a key hindrance to their success in practice. Traditional ICT support for connecting the nodes in business networks has been limited to the (often cumbersome) static horizontal and vertical integration of enterprise systems. The IT links established are usually limited to coordination and control at the operational level in the context of fixed collaboration patterns.

Theories and classifications can help in understanding the rich set of IT technologies and systems that are available to enable business network agility. In Table 5.2, we combine the well-known operational, tactical and strategic management decision levels with the typical phases of an inter-organizational transaction: search (finding a business partner), contract (setting up the agreement for value exchange), execute (running the inter-organizational process and exchanging value) and settle (providing a usually financial award for the services delivered). These four phases are similar to business action theory [20].

From Table 5.2, it is apparent that a single inter-organizational business transaction, such as the procurement of a series of valves from a sub-contractor for the manufacturing of an engine, can be supported by a variety of system functions and technologies. Typically, in each of the 12 areas of Table 5.2, some level of system support is present. This may range from very basic interaction and coordination using standard tools such as email and exchanges of text files and spreadsheets, to advanced supports using artificial intelligence, semantic integration technologies, robotic process automation and alike.

Experiences show that there often is a mis-alignment between IT and business [21]. This may even be more so in the IOSs sphere. In some areas, businesses may have adopted

Table 5.2 Classification and examples of systems supporting value networks

	Search	*Contract*	*Execute*	*Settle*
Strategic	Credit and reliability rating, risk management systems	Negotiation support systems, group support systems	Supply chain collaboration platforms	Supply chain finance systems
Tactical	Social media, information retrieval and search engines, text mining and analytics, communities of practice, e-markets	Contract management systems, business analytics, exception management	Inter-organizational process, performance monitoring	e-factoring, e-dispute and conflict handling, bonus and claims processing
Operational	Service and API catalogues and directories, search engines, service and data platforms	Business process execution systems, business process Rule engines, e-markets, smart contracts	Inter-organizational process integration platforms, e-markets	e-invoicing and e-payment, reconciliation

state-of-the art technologies where other inter-organizational processes may be largely manual or supported by basic email-based integrations that easily lead to errors and lack of oversight. Also, what links in the business network are supported by IOS and to what extent often seems arbitrary. In [15], based on a study among Chinese firms, the breadth and depth of IOS support is linked to organizational performance. The study concludes that "the balanced alignment between IOS depth and IOS breadth contributes to the firm's competitive performance, which implies that the firm gains long-term competitive advantage by maintaining balanced development in IOS depth and IOS breadth".

While business opportunities and technologies for business networking receive ample attention, many firms have only recently started to recognize the importance of a strategic view on IOS for supply chains. The structured and long-term assessment of IOS current and future developments for business networks are not often part of the strategic agenda. Some of the larger and innovative companies are taking initiatives in this area. Also, third parties, adopting e-commerce sharing and coordination models, are aiming at taking up coordination roles in the supply chain. Many projects run in this space are pushed by innovation projects, industry sector organization initiatives or R&D subsidized programs. Hopefully, more knowledge and experiences from these projects will lead to a higher priority for IOS, and more mature design and implementation practices.

In the following sections, we review strategies toward IOS implementation for business networks and give examples to illustrate opportunities and complexities.

5.4 Inter-organizational governance and configurations

IOSs can emerge on an ad hoc basis. While incidental successes can be achieved, a wide range of risks will threat the continuing collaboration. In [22], four types of risks are listed that may occur in IOS use. (1) Overgrazing: business partners may overuse the IOS, thereby degrading the service levels of other connected businesses. Fair use policies or pricing schemes can be introduced to manage this risk. (2) Fouling or contamination of the IOS: dumping incorrect data, missing data, incomplete transactions, etc. may all pollute the IOS, decreasing its value and trust that partners have in the IOS. Data integrity, data quality monitoring and transaction monitoring can be put in place to manage this risk. (3) Poaching: partners may poach common resources for their private gain against the original goals of the IOS. This risk can be managed by putting in place identity management, authorizations and security, and keeping logs of data access and updates. Repetitive audits or even continuously auditing IOS use can prevent this from happening. (4) Stealing: this related risk concerns outright abuse. Advanced security and access control including four-eye procedures can reduce this risk.

To ensure sustainable collaboration in value networks, some type of governance needs to be in place. The paradigm of the governance of collaboration is shifted from a static perspective toward a dynamic context-dependent perspective. For appropriate governance, the parties involved and their role need to be recognized and a governance process needs to be set up. Chandra and van Hillegersberg, based on the analysis of several Supply Chain Collaborations (SCCs), propose five general roles. These can be used to analyze the collaboration context to communicate the collaboration design, business model and governance to the potential business partners. The five roles are [23]:

- Member – Entity that is a member of a collaboration involved in the operational, tactical or strategical activities of the collaboration. They adopt shared services to support their supply chain activities. In order to maintain their access to these services, the members can invest into the IOS or pay per transaction.

- IOS provider – Providers deliver the IOS, either software and/or platform as a service, for supporting the coordinated supply chain activities enabling the collaborations. They are responsible to manage and maintain the IOS according to Service Level Agreements (SLAs) with its members.
- Partners – Outside the collaborations there may be companies that perform supply chain activities to support the collaboration. These companies are not direct members of the collaborations, but may get access to the shared system to fulfill their supporting role. However, their benefits are not a priority for the collaboration.
- Supporting partners – Other partners are typically sub-contracted. These are companies that support the IOS besides the partners and IOS provider(s). Examples of companies with this role are internet providers, IS developers to whom IOS providers outsource part or all of their software and/or platform development, universities, research institutes, associations and employee organizations.
- Orchestrator – Organizations that coordinate the supply chain activities inside the collaborations. These can be a separate third party, a joint venture, a virtual organization staffed by the partners involved, etc.

These roles can be assigned to separate organizations, or multiple roles could be performed by a single organizational unit. As the complexity of the collaboration quickly grows as the collaboration activities expand in breadth and depth, applying some form of inter-organizational governance is advisable. This can be achieved through applying a combination of formal and informal governance mechanisms.

Formalized governance mechanisms can take the form of contracts, regulations, policies and procedural approaches. Informal mechanisms are characterized by relationships rather than by bureaucratic structures. Examples are emerging relationships and norms, commitments and trust.

5.4.1 Configurations for inter-organizational collaboration

While the terminology in use is not always consistent, there are four basic configurations for inter-organizational collaboration. These are shown in Figure 5.1. These configurations each require governance. The type of governance that will be effective is related to the model used.

The description of the four types below is based on [24].

- Market, formed by contractual relationships between suppliers and buyers [25]. A market has certain features such as multiple suppliers of the same product or service and short-term partnerships which mainly occur during the transaction [26]. In this governance model, IOS providers can be seen as suppliers of a coordinating service and members can be seen as customers.

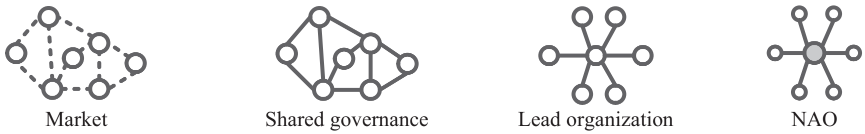

Figure 5.1 Types of configurations for inter-organizational collaboration

- Shared governance, in which members participate in network governance without a separate and unique governance entity [27]. 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 [27]. 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 IOS could be used by the leading member to gain a competitive advantage.
- Network Administrative Organization (NAO), which is a separate entity that is established to govern the network [27]. The NAO model provides inter-organizational collaborations with the benefits of having a neutral governance entity.

We follow [28,29] in viewing inter-organizational governance as a dynamic process and adopt a lifecycle view. In a way this is similar to the four-phased view of process transactions, though one has to keep in mind that IOS governance takes place at the network level, and thus is directing and steering the inter-organizational processes discussed before.

The governance lifecycle of inter-organizational collaboration follows these four phases [24,29].

5.4.2 Pre-partnership collaboration

Partnerships can be initiated in a variety of ways. Generally, the drivers for supply chain integration are at play. A business case can trigger the exploration of collaborative business initiatives, or external events, such as new regulation that requires value chain coordination, may trigger the pre-partnership phase. Markus and Bui [30] observe three ways to attract member participation in this phase. Drawing owners from all major segments of the community, providing for participants to have a say in decision-making, ensuring that owners do not profit financially at the members' expense. Ideally, in this phase already the appropriate mix of formal and informal governance mechanisms is initiated.

5.4.3 Partnership creation and consolidation

In this phase, the partnership between the organizations intensifies to prepare for the program delivery. During this phase, the alternative services, breadth and depth of collaborative services and processes are assessed. At the end of this phase, the selected service and related inter-organizational processes should be implemented and made ready to be used. The success of collaborations in this phase depends on the members' willingness to contribute financial, manpower and knowledge resources to the set-up as well as the willingness to exchange their information with other partners. This phase is crucial to the success of the next phases.

5.4.4 Partnership program delivery

In this phase, the services and inter-organizational processes are executed. Formal and informal governance mechanisms that have been defined are effectuated, evaluated and fine-tuned where needed. Payment schemes including transaction costs, incentive schemes, penalties and so on are settled. Decisions to adapt the partnership, such as the entry/exit of partners, are carried out. During the partnership delivery, service innovation projects can be started to extend and improve the collaboration and implement new services and processes.

5.4.5 Partnership termination or succession

There are several reasons for a partnership to end. The collaboration may have been set for a fixed time frame. Alternatively, the exit of partners or disrupted key resources may make the partnership no longer valuable. Despite formal or informal agreements, conflicts may occur and in the worst case these lead to termination of the partnership. Regulators can also make a partnership redundant. A changing law may take away the need for collaboration, or collaborations that are becoming too tight may turn out to be undesirable from an anti-trust law perspective. It is also possible that better alternatives become available and the current partnership becomes obsolete.

5.5 Role of IT in IOS and inter-organizational governance

As shown earlier (see Table 5.2), a variety of IT and systems can play a role in making inter-organizational integration happen. It is our view that the better the alignment between inter-organizational processes and IT, the more effective the partnership can be governed and the higher the chance for sustainable success. IOS governance is thus dependent on and influenced by the technologies that make IOS linkages happen. Since the rise of networking and Electronic Data Interchange (EDI) in the last decades of the previous century, methods and ITs that add to the possibilities for IOS have been introduced to make integrations easier, faster, smarter and agile. Without trying to give an exhaustive overview of the vast developments in this space, we illustrate some in this section.

The web service paradigm offers a set of technologies that directly enable agile business networks. Core to web service is the idea that organizations offer their services on the web in machine-readable format and accessible format on the Internet. The web service paradigm fundamentally offers a vision where anybody should be able to trade with everybody. While a range of specific technologies was introduced, the generic principles and elements are surveyed in [31]. The authors state that web service technology should offer semantic web technology to enable finding and comparing services and offers of vendors worldwide and negotiate and contract delivery conditions. Furthermore, ontologies should be incorporated to deal with the semantics of the business language and varying standards. While it is very likely that multiple semantic standards will be used, the web service technology should include ways to (semi-)automatically map between these standards. Finally, the varying business logics and rules should be supported. To make this all work, a web services framework should offer a way to describe the web service goal, semantics, ontology, pre- and post-conditions, input and output data, composition and flow details such as what other services area called or need to be called before and after the service. In addition, execution details such as error messages and performance and scalability need to be specified. Integrity needs to be assured such that invoked services notify that they have understood the message call and are able to execute the service request. In the case of a failed service, some sort of compensation (or roll-back) needs to be available to make complex message orchestrations possible.

Clearly, these goals are very ambitious. Still, over the last decades the services paradigm has evolved and promising methods, tools and applications have become available.

Large tech-companies and innovative organizations have published web service APIs that are often heavily used and have become an important part of their business services portfolio. Think of the Google maps and Google translate API, Amazon books API and Twitter data API. Also, in business, basic web services APIs have become commonplace. In areas such as finance and banking and mobile services, web services have become standard for services such as stock trading or getting currency exchange information, interest rates, etc. [32].

SMEs offering specialized services have also started to explore the opportunities of the web service paradigm. In [33], a scenario is developed where warehouse space is found and contracted through web services across multiple vendors automatically. In a recent study, an architecture and prototype is developed to show how ecommerce companies can integrate to logistics companies using web services to integrate the return process of shipments [34]. 12Returns.com is a company that commercializes such a scenario by handling returns of goods for ecommerce companies through a set of Cloud-based services. The web services offered by 12Returns connect to the ecommerce client and logistics companies that support in handling the returns [35].

Web services can also bring advanced capabilities and knowledge to the value network of companies that would not be able to afford this in-house. In [36], the authors show that the latest advances in sales forecasting algorithms can be seamlessly integrated in ecommerce planning processes using services-based integration. A service provider can offer a customized forecast based on product and historical sales data, and return the forecast to the service requester. Such a service is clearly positioned higher in the value chain than standardized fully automated services.

The integration of services is greatly simplified if a business ontology is available that defines core business terms, their meaning and relationships. Using such ontologies, semantic standards for business interoperability can be defined and services can use these to specify the joint business process and service specifications. XML is often used as a language as a basis for these standards. In many industries, such standards are developed. Depending on the industry and parties involved, the quality varies. Standards can be in a rudimentary phase, offering only support for the most basic processes, or standards may have matured offering a wide range of process and data definitions. The complexity of semantic standards or too many alternatives to choose from may hamper integrations. Still, it is advisable to scan the market for available semantic standards. A lot of efforts and knowledge has usually gone into their development and they can give a project a kick start [37].

Cloud computing and various orchestration solutions offered in the Cloud can aid in facilitating inter-organizational collaboration [34]. In particular, the emergence of iPaas, Integration Platform as a Service, offers Cloud-based integration services that bring many benefits of previously complex and expensive enterprise integration platforms to the Cloud. Using flexible pricing models and scalable architectures, iPaas can evolve with business integration offering also a low entry point for Small and Medium Enterprises. In [38], iPaas is defined as: "a suite of cloud services that enable users to create manage, and govern integration flows connecting a wide range of applications without installing or managing any hardware or middleware". While iPaas are still emerging, required core functionalities include the ability to interface to a variety of web service and API technologies, providing support for security, compliance and synchronization when setting up and executing web service orchestrations [39]. Moreover, iPaas can support in joint governance, data sharing policies and business model execution of the collaborative business.

5.6 Portbase: an example of an integration hub

To illustrate the theories and technologies discussed, we give the examples of Portbase, its governance and how it provides business integrations.

Portbase provides logistics services around the port of Rotterdam. Our description here is a summary of [24] that gives a more detailed case study based on an interview with the managing director and secondary sources. The collaboration has a fairly long history and has evolved over time into delivering a rich set of services supporting collaboration among hundreds of companies around the large sea-port.

Over the years, Portbase has connected an increasing number of 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. By the end of 2016, Portbase had 3,900 companies as members and 14,000 users who were involved in 82 million transactions within the system. Today, Portbase's 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.

Portbase has four functions: dangerous goods declaration, customs, logistics and navigation. The services are used in all Dutch ports to guarantee synchronized data between its *members*. Nowadays, Portbase offers 43 services to support its community. Through these services, Portbase provides standardization of information that is being exchanged in the port community. The services provided through each function are available by using several application modules contained in a modular architecture approach. Services are built using a platform, which is developed by Oracle frameworks and tools. Portbase *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 that support its *members*. The *members* pay Portbase access fees based on their transaction for exploitation and development of the services on Portbase's platform. *Members* can choose for relatively high transaction fees, or subscription fees plus lower transaction fees. Portbase's balance sheet is break-even and proves its standing as a non-for-profit company. Portbase issues monthly invoices for the *members*.

Portbase is in the *partnership program delivery phase*. Ownership is shared between the Port of Rotterdam Authority (75%) and the Port of Amsterdam Authority (25%). Both port authorities are represented on the *Supervisory Board*, together with other Portbase's main business partners (Figure 5.2).

Portbase can be viewed as an orchestrator connecting processes between partners such as the shippers and forwarders, logistics companies and government agencies. Portbase has an Advisory Board and the Supervisory Board that enables stakeholders to be involved in decision-making. Both the port authorities of Rotterdam and Amsterdam invest in Portbase. Portbase offers two financial plans for funding the *operational cost* that gives the *members* flexibility in deciding on the plan that fits their needs.

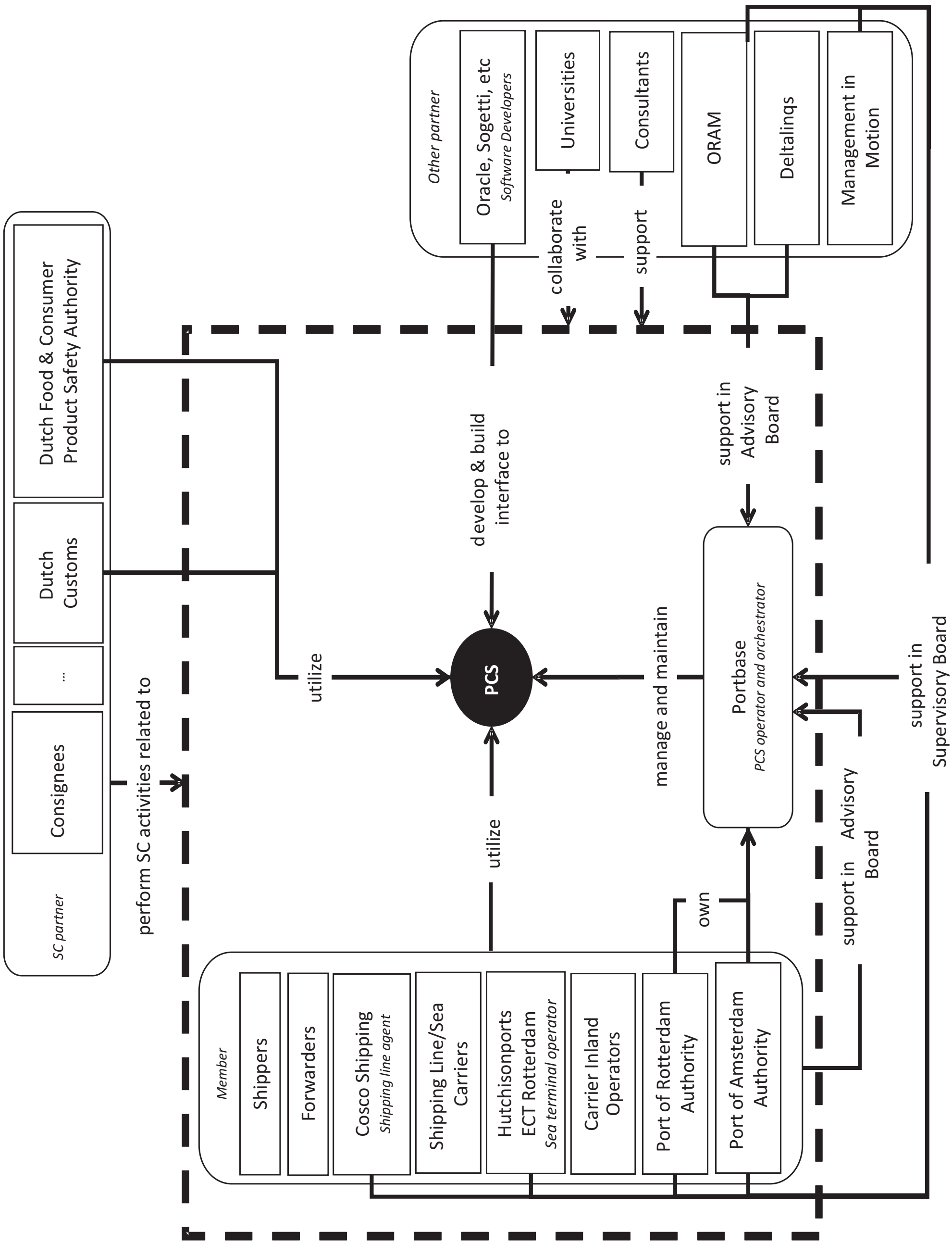

Figure 5.2 Governance structure of the port community system

5.7 Discussion and conclusion

A range of drivers causes business networks and supply chains to form often complex and dynamic network structures. Horizontal and vertical linkages are needed to coordinate, share risk, innovate and generate optimal value. While IT and systems can both be an enabler and a disabler of smooth collaboration, it has often been the latter. Complex architectures and legacy enterprise systems have made cross-organizational integration a cumbersome job. Moreover, organizational challenges are complicating matters further. Still, value that can be generated if borders can be crossed trigger many projects to build IOSs.

Design and implementation projects can benefit from a clear positioning of the processes and systems to be built. The transaction phase (search, contract, execute and settle) and level (operational, tactical and strategic) can help to identify the goal and development path of the joint services, processes and systems.

Any IOS requires governance. Governance is needed to ensure sustainable operation, monitor performance and facilitate high-level decisions regarding the collaboration. A mix of formal and informal mechanisms can be designed. Through the phases of collaboration, governance can evolve and mechanisms can be evaluated and adjusted.

Modern IT and systems offer more possibilities to build IOS that can be efficiently operated and effectively governed. The web service paradigm is evolving and especially integration platforms as a service fit well to the increasing need for agile collaboration. Especially as semantic standards are becoming available, efforts to build semantic integrations are less difficult to engineer.

The Portbase example illustrates how both technology and governance can evolve over decades to keep on adapting to the changing needs of the stakeholders and actors involved. It shows that careful design of the governance structure and mechanisms ensures that many companies can benefit.

The field of IOS can benefit from several recent developments. Robotic Process Automation (RPA) offers an alternative way to APIs as RPAs can mimic labor-intensive integration tasks that human users used to perform. The RPA Bot can operate on top of existing user interface screens of legacy systems. While perhaps not the most elegant solution, the RPA does not need extensive work on defining and building services and APIs [40].

Blockchain technologies can provide a secure and neutral way to record distributed transactions between organizations. Future research and field tests need to demonstrate in what scenarios this will generate value and how these technologies fit in the toolbox of the IOS systems engineer. Semantic web technologies enabling linking open data sets offer an alternative way to created pooled resources that can solve part of the integration puzzle. Decades after their inception, IOS continue to be the champions' league of systems design and governance, requiring high skills, high stakes and high rewards.

References

1. Kedia, B.L., Mukherjee, D.: Understanding Offshoring: A Research Framework Based On Disintegration, Location and Externalization Advantages. *J. World Bus.* 44(3), 250–261 (2009).
2. Kotlarsky, J., Oshri, I., Hillegersberg, J. van, Kumar, K.: Globally Distributed Component-Based Software Development: An Exploratory Study of Knowledge Management and Work Division. *J. Inf. Technol.* 22(2), 161–173 (2007).
3. Cruijssen, F., Cools, M., Dullaert, W.: Horizontal Cooperation in Logistics: Opportunities and Impediments. *Transp. Res. Part. E. Logist. Transp. Rev.* 43(2), 129–142 (2007).

4. Khan, H., Hussainy, S.K., Khan, A., Khan, K., Farooq, U., Mir, M.M.: Drivers of Outsourcing and Selection Criteria of 3rd Party Logistics Service Providers. *Oper. Supply Chain Manag. Int. J.* 10, 240–249 (2017).
5. Brewer, B.L., Ashenbaum, B., Carter, J.R.: Understanding the Supply Chain Outsourcing Cascade: When Does Procurement Follow Manufacturing Out the Door? *J. Supply Chain Manag.* 49(3), 90–110 (2013).
6. Murthy, C., Padhi, S.S., Gupta, N., Kapil, K.: An Empirical Investigation of the Antecedents of Value Co-Creation in B2B IT Services Outsourcing. *Bus. Process Manag. J.* 22(3), 484–506 (2016).
7. Mowshowitz, A.: Virtual Organization: A Vision of Management in the Information Age. *Inf. Soc.* 10(4), 267–288 (1994).
8. Heck, E., Vervest, P.: Smart Business Networks: How The Network Wins. *Commun. ACM* 50(6), 28–37 (2007).
9. Hartman, P.L., Ogden, J.A., Hazen, B.T.: Bring It Back? An Examination of the Insourcing Decision. *Int. J. Phys. Distrib. Logist. Manag.* 47(2–3), 198–221 (2017).
10. The Global Logistics Business Is Going to Be Transformed by Digitisation. https://www.economist.com/briefing/2018/04/26/the-global-logistics-business-is-going-to-be-transformed-by-digitisation
11. Lahiri, S.: Does Outsourcing Really Improve Firm Performance? Empirical Evidence and Research Agenda. *Int. J. Manag. Rev.* 18(4), 464–497 (2016).
12. Kumar, K., van Dissel, H.G., Bielli, P.: The Merchant of Prato-Revisited: Toward a Third Rationality of Information Systems. *MIS Q.* 22(2), 199–226 (1998).
13. Van Oosterhout, M., Waarts, E., Van Hillegersberg, J.: Change Factors Requiring Agility and Implications for IT. *Eur. J. Inf. Syst.* 15(2), 132–145 (2006).
14. Gunasekaran, A., Lai, K., Edwin Cheng, T.C.: Responsive Supply Chain: A Competitive Strategy in a Networked Economy. *Omega* 36(4), 549–564 (2008).
15. Zhang, C., Xue, L., Dhaliwal, J.: Alignments between the Depth and Breadth of Inter-Organizational Systems Deployment and Their Impact on Firm Performance. *Inf. Manage.* 53(1), 79–90 (2016).
16. Ahn, H.J., Childerhouse, P., Vossen, G., Lee, H.: Rethinking XML-Enabled Agile Supply Chains. *Int. J. Inf. Manag.* 32(1), 17–23 (2012).
17. Kumar, K., van Hillegersberg, J.: Enterprise Resource Planning: Introduction. *Commun. ACM* 43(4), 22–26 (2000).
18. Hillegersberg, J. van, Moonen, H., Dalmolen, S.: Coordination as a Service to Enable Agile Business Networks. In: Kotlarsky, J., Oshri, I., Willcocks, L.P. (eds.) *The Dynamics of Global Sourcing Perspectives and Practices*, pp. 164–174. Springer, Heidelberg (2012).
19. Daniel, E.M., White, A.: The Future of Inter-Organisational System Linkages: Findings of an International Delphi Study. *Eur. J. Inf. Syst.* 14(2), 188–203 (2005).
20. Lind, M., Goldkuhl, G.: Coordination and Transformation in Business Processes: Towards an Integrated View. *Bus. Process Manag. J.* 14(6), 761–777 (2008).
21. Suh, H., Hillegersberg, J., Choi, J., Chung, S.: Effects of Strategic Alignment on IS Success: The Mediation Role of IS Investment in Korea. *Inf. Technol. Manag.* 14(1), 7–27 (2012).
22. Kumar, K., Van Dissel, H.G.: Sustainable Collaboration: Managing Conflict and Cooperation in Interorganizational Systems. *MIS Q. Manag. Inf. Syst.* 20(3), 279–299 (1996).
23. Chandra, D.R., Hillegersberg, J. van.: The Governance of Cloud Based Supply Chain Collaborations. In: *2015 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*, pp. 1608–1612. IEEE Press, New York (2015).
24. Chandra, D.R., Hillegersberg, J. van.: Governance of Inter-Organizational Systems: A Longitudinal Case Study of Rotterdam's Port Community System. *Int. J. Inf. Syst. Proj. Manag.* 6(2), 47–68 (2018).
25. Lowndes, V., Skelcher, C.: The Dynamics of Multi-Organizational Partnerships: An Analysis of Changing Modes of Governance. *Public Adm.* 76(2), 313–333 (1998).
26. Grant, G., Tan, F.B.: Governing IT in Inter-Organizational Relationships: Issues and Future Research. *Eur. J. Inf. Syst.* 22(5), 493–497 (2013).
27. Provan, K.G., Kenis, P.: Modes of Network Governance: Structure, Management, and Effectiveness. *J. Public Adm. Res. Theory.* 18(2), 229–252 (2008).

28. Chandra, D.R., van Hillegersberg, J.: Governance Lifecycles of Inter-Organizational Collaboration: A Case Study of the Port of Rotterdam. *Proc. Comput. Sci.* 121, 656–663 (2017).
29. Wilding, R., Pilbeam, C., Alvarez, G.: Nestlé Nespresso AAA Sustainable Quality Program: An Investigation into the Governance Dynamics in a Multi-Stakeholder Supply Chain Network. *Supply Chain Manag. Int. J.* 15(2), 165–182 (2010).
30. Markus, M.L., Bui, Q.: Going Concerns: The Governance of Interorganizational Coordination Hubs. *J. Manag. Inf. Syst.* 28(4), 163–198 (2012).
31. Fensel, D., Bussler, C.: The Web Service Modeling Framework WSMF. *Electron. Commer. Res. Appl.* 1(2), 113–137 (2002).
32. Data, Financial, Analytics API Categories See Big Growth. https://www.programmableweb.com/news/data-financial-analytics-api-categories-see-big-growth/research/2018/05/21
33. Hillegersberg, J., Boeke, R., Heuvel, W.-J.: The Potential of Webservices to Enable Smart Business Networks. In: Vervest, P., Heck, E., Pau, L.-F., Preiss, K. (eds.) *Smart Business Networks,* pp. 349–362. Springer, Heidelberg (2011).
34. Aulkemeier, F., Paramartha, M.A., Iacob, M.-E., van Hillegersberg, J.: A Pluggable Service Platform Architecture for E-Commerce. *Inf. Syst. E-Bus. Manag.* 14(3), 469–489 (2016).
35. 12Return Developer Portal. http://developer.12return.com/
36. Aulkemeier, F., Daukuls, R., Iacob, M.-E., Boter, J., van Hillegersberg, J., de Leeuw, S.: Sales Forecasting as a Service. In: Proceedings of the *18th International Conference on Enterprise Information Systems*, pp. 345–352. SCITEPRESS, Portugal (2016).
37. Folmer, E., Oude Luttighuis, P., van Hillegersberg, J.: Do Semantic Standards Lack Quality? A Survey among 34 Semantic Standards. *Electron. Mark.* 21, 1–13 (2011).
38. Serrano, N., Hernantes, J., Gallardo, G.: Service-Oriented Architecture and Legacy Systems. *IEEE Softw.* 31(5), 15–19 (2014).
39. Theilig, M.-M., Pröhl, T., Zarnekow, R.: Requirements Analysis for an Open iPaaS: Exploring the CSP, ISP, and SME View. *AMCIS 2018 Proc.* (2018).
40. Suri, V.K., Elia, M., van Hillegersberg, J.: Software Bots – The Next Frontier for Shared Services and Functional Excellence. In: Oshri, I., Kotlarsky, J., Willcocks, L.P. (eds.) *Global Sourcing of Digital Services: Micro and Macro Perspectives,* pp. 81–94. Springer, Heidelberg (2017).