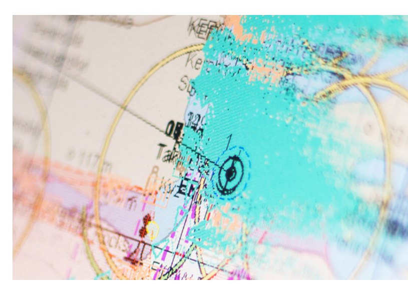
International Transport Forum

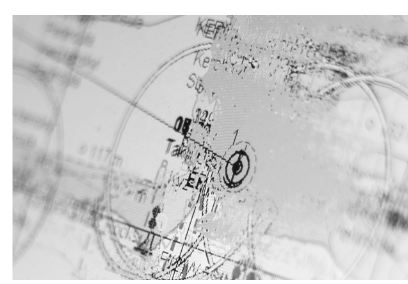
Information Sharing for Efficient Maritime Logistics



Case-Specific Policy Analysis

OECD

Information Sharing for Efficient Maritime Logistics



Case-Specific Policy Analysis

The International Transport Forum

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Case-Specific Policy Analysis Reports

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Executive Summary

Background

This report assesses the opportunities and challenges related to data sharing in the maritime logistics chain. It is based on desk research and benefits from interviews with selected stakeholders and a discussion within the framework of the Global Maritime Logistics Dialogue.

Findings

Information sharing presents a huge potential to the maritime logistics sector. It can reduce cost, cut delivery times and generally improve resource efficiency. Information sharing across the logistics chain thus offers interesting business opportunities. Already, the maritime sector is harnessing data via digital technologies for greater insights into the logistics chain in order to improve logistics processes. The areas of application of digital technologies for the collection, exchange and analysis of information range from management and transactional purposes to more technical, operative applications. Effective integration of data-driven systems crucially depends on the quality of their implementation and on smooth collaboration between stakeholders along the logistics chain.

New technologies will transform logistics processes. Numerous logistics applications exist for innovations such as highly sophisticated sensors for data collection, advanced data analytics tools and advanced concepts such as the Internet of Things (IoT), blockchain (distributed ledgers) or artificial intelligence. Better integration of supply chains via technologies has many challenges, however. Sharing of data is the main one. Fully exploiting their potential is another. Main obstacles are limited trust and lack of coordination among actors with different roles in the supply chain and differing size, operational or strategic objectives. Commercial sensitivities and the question of data ownership also matter.

Some challenges relate to the way logistics adopt data-enabled innovation. First, relying more and more on digitalisation and system integration can expose the entire chain to cyber security risks. Second, many emerging data networks are proprietary systems. This raises the possibility of future data oligopolies dominated by a small number of private supply chain integrators. Open standards could address this issue, but the balance between proprietary and open systems remains to be defined.

Recommendations

Support the emergence of open standards in maritime logistics

The lack of industry standards for data sharing can act as a hurdle to establishing common platforms for information sharing and collaboration. Public authorities should support the creation of open standards in maritime logistics to develop a configuration that is useful to all players in the supply chain. In this context it is important to clarify what should be standardised, whether standardisation should be publicly or industry-driven, and how the implementation of standards will be organised.

Ensure interoperability between public and private systems for the exchange of logistics information

Close collaboration between public and private actors is needed for the smooth data exchange that will enable faster cross-border interactions. In addition, effectively organising the interaction among companies and the public sector will address costly inefficiencies resulting from a lack of cross-border data sharing. Consultations of maritime logistics stakeholders along with pilot projects and testing will help public authorities to determine best practices for setting up public-private data pipelines.

Support ports in creating co-ordination platforms and Single Windows

Reducing unpredictability for port operators means a more efficient use of public infrastructure. This, in turn, benefits the environmental performance of the sector. Although ports of the same region often compete, combined efforts to providing digital solutions for stakeholder coordination could generate efficiencies from which all participating ports benefit. Governments should thus support ports' efforts to better coordinate public and private maritime stakeholders through information platforms. In addition, government agencies, maritime stakeholders and the port communities need to intensify their collaboration in implementing single entry points for administrative services, so-called Single Windows.

Ensure that digitalisation in the maritime logistics chain occurs in a competitive environment

The emergence of proprietary data-enabled systems could potentially concentrate market power. Such private platform monopolies or oligopolies could lock users into a limited number of solutions to choose from. Governments should closely monitor the technological developments for implications on competition. They should seek to maintain a healthy balance between innovation and competition, for instance by supporting open standards in logistics.

Closely monitor cyber security vulnerabilities in maritime logistics

Cyber-attacks can disrupt supply chains on a global level. Governments must ensure that vertically integrated logistics operations are resilient to such attacks and have systems in place that limit knock-on effects throughout the entire supply chain in case of an incident. Setting minimum cyber security standards for logistics organisations and systematically raising awareness can address this issue.

Introduction

Many efficiency bottlenecks in the maritime supply chain are related to co-ordination issues between different stakeholders. For instance, about 48% of container ships arrive more than 12 hours behind schedule and congestion exacerbates costly waiting time in ports (McKinsey, 2017). According to the ESCAP-World Bank Trade Cost Database, about 60-80% of trade costs worldwide are non-tariff measures of which transport services represent an important part (ESCAP/World Bank, 2015). Related inefficiencies, such as trade procedures, business and regulatory practices and constraints, or the insufficient availability and use of information and communication technologies (ICT) contribute to these costs. In terms of paperwork, there may be up to around 200 interactions involving documentation along the supply chain, and the shipper and consignee may deal with as much as 20-30 entities to arrange a shipment (Porter/Lloyd’s List, 2017). Many of these interactions are time-consuming and often still take place via phone, fax or email. In this context, the lack of co-operation and data sharing makes it difficult to forecast or make effective operational decisions (Kenyon et al., 2017).

This report focuses on system integration and information sharing between main stakeholders in maritime logistics to reap efficiency gains in the supply chain. Information sharing is a process potentially enabled by digitalisation, which implies an increased use of Information and Communication Technology (ICT). Digitalisation – the increase or adoption in use of ICTs by an organisation or industry – can be implemented in varying degrees, as it depends on the organisation’s digital strategy and the breadth and quality of implementation. Digital strategies are associated with the purposes and ways of adopting digital technologies. In the context of broader system integration and interoperability, information sharing can be part of organisational digital strategies to simplify, speed up or automate processes related to facilitating a shipment from A to B. This also includes the use of interfaces between businesses, individual customers and public entities. A parallel trend is the datafication of maritime logistics. Digital technologies allow for capturing data on a range of processes where previously data had not been collected, or only collected intermittently.

Businesses in the maritime logistics sector have realised that sustainable competitive advantage increasingly depends on the effective use of existing information and the acquisition of consistent data along the entire supply chain. Digitalisation is seen by many as a panacea or necessary step in order to stay competitive. Some have recognised that “getting smarter” is more important than growing in size. The kind of vertical collaboration that improves co-ordination at the intersection of different transport modes is increasingly seen as the new efficiency frontier in maritime logistics. New ICTs such as sensors, communications or software can play a major role in improving this co-ordination.

With the possibilities provided by technologies and new data sources, maritime transport stakeholders are seeking new opportunities to extract value-added from more integrated services that cover the entire supply chain. Some of the major players in the shipping industry strive to become integrators of the entire chain, as some carriers seek to take on the role of freight forwarders and further consolidate their position as logistics operators (Maersk, 2016; CMA CGM, 2018). The rationale for vertical integration is obvious as it becomes more and more difficult for shipping companies to generate sustainably competitive margins by reducing maritime costs through bigger vessels (ITF, 2010).

Port authorities around the world increasingly embark on digital strategies to evolve from renters or asset managers to active digital communities. With the need for more efficiency-enhancing co-ordination in supply chains, port authorities increasingly grow into hubs of physical and information flows between different stakeholders. In the light of growing worldwide competition, ports see the necessity to become more dynamic actors in order to avoid the risk of decreasing significance. As public authorities, some see their natural role as a neutral platform that facilitates co-ordination between different stakeholders.

In the first section, this report assesses the opportunities of new ICTs in maritime logistics and looks at current strategies of maritime stakeholders to make use of new data sources to enhance supply chain efficiency. The uptake of ICTs in maritime transport is taking place in a number of different domains, ranging from commercial or transactional purposes to technical and operative aspects (see Table 1). These ICTs can assist stakeholders in broader data collection, information sharing and system integration. While information sharing is not itself dependent on new technologies, it can be facilitated by the latter if commercial or operational processes evolve at the same time. In the second section, the report therefore assesses some of the prevailing challenges in making use of data. ICTs can provide the necessary infrastructure, but the creation of community information systems is dependent on effective internal change management and stakeholder collaboration addressing legal and commercial concerns of data exchange. There is a distinction between harnessing data to reduce costs and data as a means to build new business models and explore new sources of revenue. Both are subject to conditions in the organisational setup of the value chain to work properly. Based on these obstacles, the report formulates a range of preconditions for efficient, data-enabled maritime logistics.

Trends and opportunities for information sharing

The demand for fast delivery, as well as supply chain predictability and reliability are strong incentives for shippers and logistics providers to improve the speed and quality of their services. Reliable supply chains are predictors of high logistics performance in general (World Bank Logistics Performance Index, 2016). In turn, effective cross-border logistics are an indicator for the ease of doing business in a country, as reflected by the Trading across Borders indicator of the World Bank Doing Business Index.

Information visibility and supply chain flexibility are two of the main advantages of digitalisation facilitated by ICTs (Kenyon et al., 2017). A variety of hardware and software allow decentralised data collection that can be made available via centralised databases and platforms, which in turn provide intelligence at the local decision nodes. Such platforms help create more transparent transport flows, allowing for more adaptability to changing conditions. Currently however, visibility into the supply chain from the perspective of the client or shipper is relatively short and often limited to approximate ship arrival time and loading information (Gagatsi et al., 2013). In the absence of a global authoritative information system, no single stakeholder has all the information that would be required for all to carry out transport activities in the most efficient way. This highlights the lack of a holistic freight transport system in which stakeholders collaborate to facilitate smooth interactions, enabled by technological solutions (e.g. as described by the concept of synchromodality, Box 1).

The use of ICTs can significantly improve control and efficiency of supply chains in a variety of ways and contexts of application. A range of technologies are contributing to the digital transformation of maritime logistics (Table 1). Although their purposes are quite diverse, they can be divided into analytical (control, analysis and forecasts), transactional (administration and documentation), and operative (physical and technical) systems that can be used in parallel and which overlap in logistics processes. Application of those according to different purposes results in the digital strategies adopted by different actors in the maritime logistics chain, which are set out below.

Box 1. Synchromodality in containerised transport

Synchromodality refers to an optimally efficient and sustainable transportation in a network of different modes and routes, by making use of all transportation options in the most flexible way.

This ideal concept of intermodal logistics requires the use of ICTs for real-time planning and updating modes and routes as new information comes in. Online flexible planning and seamless exchange of data between transport companies, terminals, container depots, customs and other stakeholders could improve operational performance and reduce costs by adapting transport to changing conditions.

Obstacles to this approach however include the absence of one single “orchestrator” of the supply chain, a lack of real-time multidirectional information flows, and customers’ reluctance to accept flexible and changing transportation planning.

Source: TU Delft (2017); Riessen et al. (2015).

Overview: Digital transformation in five main areas

Digital technologies have a potential to significantly alter the way in which administrative, logistics, ship, terminal and port operations function together, in at least five areas (Table 1). These areas include the administrative procedures related to a shipment where for instance technologies such as distributed ledger technologies (DLT) could help to make processes in the maritime logistics chain smoother. A second area of deployment for new technologies is overall supply chain oversight and control, i.e. by providing visibility via storage systems such as cloud-based platforms, and hardware and software that allow cargo tracking and real-time status updates. Navigation and maintenance of vessels can profit from a variety of technologies, such as Internet of Things (IoT) applications (Box 2) that are based on connected sensors for instance on vessel equipment. This could become useful for diagnostics, navigation, maintenance, and scheduling of arrivals at ports to allow for more predictability.

Port operations and co-ordination, as well as the interface between port and inland, will similarly profit from IoT applications and other technology that allows leveraging more data, such as temperature, tidal data or pollution levels. Shippers and freight forwarders could most likely profit from the innovation in all five categories (see Table 1), whereas carriers would benefit most from opportunities in administrative tasks, booking allocation, ship management, navigation and maintenance. Carriers could also harness the direct benefits of better information sharing, notably when better voyage planning and lower waiting times can lead to fuel and energy savings. In the five main areas listed in Table 1, selected examples of hardware and software could allow for broader data collection, data analysis, and information management (Table 1).

Box 2. The Internet of (maritime) Things

The Internet of Things refers to a network of interconnected physical devices and objects using wired and wireless connections. Services and applications harnessing IoT are driven by the data collected from these devices.

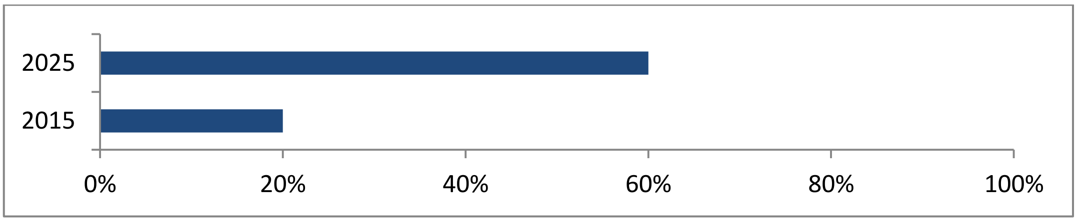
Maritime IoT applications have a particular potential for efficiency gains, considering the need to manage complex transport and supply chain systems, including both technical-operational and co-ordination efficiency. The importance of harnessing the Internet of (maritime) Things increases as commercial shipping appears to be on the verge of the adoption of autonomous ships and the implementation of e-navigation (OECD, 2017a).

Many gains from IoT can be achieved when different concepts complement each other. IoT emerges within a shared technology ecosystem complemented by cloud and big data analytics, considering that the enormous amount of data collected from different sources will need to be processed and analysed in a timely manner. This ecosystem can also include combinations of satellite technologies and Telematics, which, in the maritime context, have the potential to considerably improve navigation, safety, remote monitoring and maintenance, communication and environmental efficiency. For example, while telematics include real-time transmission of data from a device back to a receiver, IoT represents the broader concept connecting these physical objects to facilitate real-time communication between sensors, applications and people.

Supporting technologies of this ecosystem include Radio Frequency Identification (RFID) and sensors. A related field is machine-to-machine communication (M2M), which implies autonomous data exchange between devices with limited human interference. Table 1 shows selected examples of applications in the industry by field of application.

In terms of financial impact, the World Economic Forum (2016) estimates that USD 1.5 trillion is at stake for logistics companies as a result of digital transformation of the sector worldwide through 2025. For maritime freight companies, they estimate potential savings of operating costs at USD 50 billion as a result of the adoption of analytics. The study expects a threefold increase of the use of analytics by 2025 (Figure 1). Wide-spread use of control "towers" with centralised monitoring and control functions[1] are expected to lower total waiting times by around 25% and lead to additional savings for the maritime transport sector of around USD 20 billion (WEF/Accenture, 2016). However, there are some challenges attached to estimating the financial impact of the adoption of ICTs, especially since the deployment of ICTs depends to a large extent on the definition of the scope of application and the potential of organisational adaptation. Reaping the financial benefits of the adoption of advanced ICTs is dependent especially on the ability to effectively share information and better integrate and harness information among a variety of maritime logistics stakeholders.

Figure 1. Estimated adoption rates of analytics in the maritime freight sector



Source: World Economic Forum/Accenture (2016).

Table 1. Areas of deployment and corresponding selection of examples of technologies, software and services

Areas of deployment	Rates, booking, documentation, legal, customs	Supply chain control/visibility	Ship technology, equipment conditions, schedules, pilots	Port automation, operational, port services co-ordination, yard planning	Interface port/inland, gate planning, stowage
Examples of technologies/ digital solutions	Predictive analytics to forecast demand cycles, booking allocation management, vessel deployment, … Rate analytics and instant freight quotes Online booking e-B/Ls, e-CMR Blockchain for smart contracts, insurance and financial transactions Paperless customs administration Radiation, visual software for customs load identification	Cloud-based technology (data from the extended supply chain and real-time status updates across the value chain) GPS tracking, real-time visibility of container movements and forecasts Sensors for remote temperature or humidity monitoring (cold chain)	Internet of Things (sensors for self-diagnosis and reporting capability of equipment, i.e. for predictive maintenance and remote support) Satellite technologies, Automatic identification systems (AIS) (communication, remote sensing for optimal paths, navigation, weather conditions) Telematics (tracking and diagnostics, fuel management, health and safety management, dynamic scheduling, etc.)	IoT/Sensor networks, "intelligent" buoys (collection of tidal data, temperature, pollution levels) Radio Frequency Identification (RFID) Robotics, automated stacking or STS cranes Air and underwater drones for inspection	Gate automation systems Real-time data on traffic and algorithms to operate traffic lights, to lift bridges, etc. Slot management based on forecasts Shared warehouses, storage capacity sharing Autonomous trucks
New business models and data-enabled services (examples)	Booking platforms (Inttra); Rates technology platforms (CargoSphere with confidential rates information transmission, Coyote with crowdsourced open rates); Smart contracts/blockchain (Ethereum); Paperless processing of cargo information (Dubai Trade platform); …	Software as a service (SaaS); Cloud-based collaboration platforms (GT Nexus); Predictive analytics; Procurement platforms (MM4); Tracking services (ATTI, Detrack, Fleetmatics, Traxens, etc.); Cloud-based optimisation (Berlinger); …	IoT Applications for ships (IBM, Hyundai Heavy Industries); Ship information management systems (SIMS) as open platforms accessible by third parties; …	Automated Terminal (APM TerminalMaasvlakte 2 Rotterdam); Terminal Operating Systems (Octopi); Port Community Systems (Port Authority of Singapore, National Trade Platform); Single Window (Jebel Ali); Port authorities as digital service providers (Hamburg smartPORT); …	Vehicle automation in ports (Battery-electric automated guided vehicle, Terminal Altenwerder CTA, Hamburg); Gate automation (i.e. DP World Jebel Ali); Multi-user warehouses; …
Value-added and benefits (examples)	Faster booking, reduction of paperwork, better co-ordination of administrative processes	Transparency on shipments, reduced handovers, waiting times and handling costs	Better visibility on equipment conditions, safety, environmental efficiency, better coordination with ports/pilots, …	Optimises berth usage, reduce number of moves in container handling, maximise yard and equipment usage, better control of waterside processes	Better visibility into planned truck or rail movements, exploiting underused storage capacity, …
Industry implications	Confidentiality constraints on rates might be hard to maintain with increased crowdsourced and "leaked" rates.	Might allow new service providers to enter the market; new job profiles and qualifications needed; …	Change of job profiles and requirements; in the long run: possible automation and transfer of responsibility to a remote command or control centre; more environmentally efficient navigation; …	Role of ports and terminals further changes from asset management to serving clients and creating additional value.	Exploiting underused capacities in ports brings opportunities for platform business models.

Note: The table is not exhaustive and examples are mentioned for illustrative purposes. Different technologies and software are mentioned without implying any hierarchy. They can overlap and are not confined to one category. (For instance, data generated by sensors on a ship are important for supply chain control, etc.).

Digital strategies

Carriers

A big part of data innovations in maritime logistics have developed in silos, often in the form of partnerships consisting of businesses and IT firms or technology start-ups, via procurement, or through degrees of vertical integration (i.e. between carriers and terminals). As part of their "digital strategies", carriers have teamed up with IT companies to put in place new systems (Maersk-IBM joint venture; CMA CGM partnership with SAP and Infosys), integrated e-commerce platforms (COSCO or CMA CGM with Alibaba, OneTouchPlatform), and have invested in digital container tracking platforms (i.e. Traxens involving CMA CGM, MSC and France's state-owned railway company SNCF). Notable examples are the use of distributed ledger technologies (DLT) piloted by a number of carriers (Box 3) to reduce inefficiencies linked to the number of parties involved and the amount of paperwork related to organising a shipment. Other carriers have made investments in technology start-ups, specifically to integrate technical know-how and get access to new data. In particular, acquiring a start-up company with the appropriate digital skills and business model is a current trend that has proven to be faster and less costly than developing a solution involving in-house R&D capacities in a less "lean" and flexible corporate environment. Another option to avoid high upfront costs of purchasing or developing new software systems is the Software as a Service (SaaS) or Infrastructure as a Service (IaaS) models, which allow companies to use systems on a subscription basis and scale services up and down according to varying requirements. In this model, the client does not directly manage the underlying infrastructure. Costs often reflect the amount of resources consumed rather than charging upfront system development.

Box 3. Distributed ledger technology (DLT)

The potential for the use of distributed ledger technology (DLT), most notably blockchain, is currently being explored by players in the transport industry. While blockchain is a type of DLT, other models emerge in that category as variations of the initial Bitcoin blockchain model. Advantages of blockchain include its function as distributed ledger that enables proof of ownership and the transfer of ownership between stakeholders without requiring a third party intermediary usually needed to verify transactions.

While companies already keep track of events and monetary assets associated to transactions, a number of inefficiencies usually occur in the system. Companies for instance keep a ledger of the owner, origin and destination of a shipment, which vessel or container has been used, and whether the transaction has been paid. However, this typically involves out-of-date computer systems and unique data formats, often with low interoperability outside the system. Centralised ledgers are also faced with the risks of a single-point of failure in the supply chain and reliance on intermediaries for validation can create inefficiencies and delays.

DLTs can improve processes by recording events that occurred in the real world and endowing them with an immutable time-stamp to establish authentic sequencing of events, triggering or allowing a subsequent event or transaction to take place. DLTs have no central administrator. Before a new block of transactions is added, all parties must give their consensus. Similarly, rules regarding data access, permissions and sharing in a cloud-based system are determined by internal protocols agreed by all users. Hence, in the case of blockchain, a full copy of the chain will have a record of every transaction ever completed in the network.

Currently supply chains still rely heavily on paperwork. This makes the information flow not only inefficient, but also vulnerable to potential alterations or to information being lost. The permanence and immutability of decentralised data records makes DLTs relatively resilient to manipulation for fraudulent purposes. While there is no complete immutability, the control required over computers or nodes in the distributed network, as well as the mathematical task and computing power required to make changes makes modification nearly impossible. Everyone with access to the DLT can verify the data stored and transactions can thus be made more transparent. Due to their decentralised governance structure DLTs are more resilient to cyber-attacks than traditional centralised ledgers that could be stopped entirely just by an attack on a single server.

While traditional contracts are most effective in governing a small number of parties and straightforward relations, DLT-enabled contracts can more efficiently cover large, multi-party networks, such as complex supply chains. These "smart" contracts can execute themselves based on a set of rules and algorithms defined by their parties. Once a set of conditions are met, the algorithm triggers transactions between the nodes. In combination with robust authentication mechanisms, DLT-based contracts can yield significant efficiency improvements. "Smart" contracts are immutable and as such they cannot be altered without consent. For instance, confirming delivery of a container at the port of origin can automatically trigger change of ownership and payment between the parties involved.

In shipping, DLT pilot projects have been carried out by the Israeli carrier ZIM, consortia in South Korea and Japan, as well as Maersk and IBM. The International Port Community System Association (IPCSA) is currently running a blockchain pilot, aiming to establish a paperless Bill of Lading and to develop an open standard for the maritime industry with the Port Community Systems (PCS) operators.

A broader debate on DLTs and their application in transport can be found in ITF (2018).

Shippers and freight forwarders

Shippers and freight forwarders have increasingly focused on the development of digital platform technology to achieve more efficient inter-modality, supply chain visibility and end-to-end services (i.e. DHL and GT Nexus, or Kuehne + Nagel and Orange Business Services). Owing to datafication of physical processes, as well as user data generated as an externality of online activity (queries, reactions, interactions, etc.), big data is increasingly considered "a new asset class" by major players in the industry.[2] To solve the logistics between data source and data consumer, data extracted from various sources can either be stored as one fixed central database or in a decentralised storage system enabled by cloud computing. In a cloud, rather than sending information upon request, required data can be pulled anytime by various actors depending on their access rights. Service and hardware related to storage could be provided by a third party or developed in-house by one or several of the supply chain nodes. Depending on the degree of collaboration and concentration, these efforts could lead to the emergence of either a great variety of limited individual solutions and joint ventures, or, at the other extreme, to the emergence of one single all-encompassing platform.

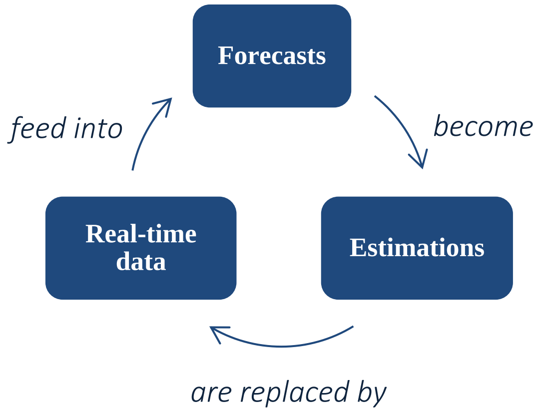
In logistics and forwarding, digital technologies offer increased opportunities for innovative business models, which harness the data and information gaps and asymmetries that exist in the current logistics set up. While established firms have started pilots in their specific business context and aim to keep up with current technological developments, new market entrants might propose more disruptive modes of supply chain organisation. Serving the customers' demand for more integrated services, new shipping tech start-ups have emerged to provide superior market transparency and are able to leverage higher quantities of data. New market players include digital freight forwarders (Flexport, Freight Filter, Shippabo, Kontainers, iContainers, etc.), rate analytics services (Freightos, Logistitrade, Transporteca, Xeneta, etc.), booking, collaboration or exchange platforms (Inttra, GT Nexus, Cargoclix, Cargomatic, China Spark, etc.), tracking platforms (ATTI, Detrack, Fleetmatics, Traxens, etc.), or service fulfilment networks (i.e. Amazon Fulfilment, Shipping with Amazon, SWA).

Public stakeholders: Customs and port management

Public stakeholders are exploring uses for digital technologies to improve information exchange, notably for customs and transactional purposes in line with governments' trade facilitation efforts. In the European Union, authorities have been easing customs formalities through a harmonised electronic cargo declaration and the e-Manifest. Under the EU Reporting Formalities Directive (RFD) of 2010, which is currently under revision, ships are supposed to deliver digital submissions to National Single Windows adapted to harmonised reporting formalities (European Commission/BALance Technology Consulting, 2017). For customs, the use of DLT can help access shipping, financial and consignment data remotely, for instance to reduce fraud or illicit trade, as well as systematic inefficiencies that otherwise drive up transactional costs of cross-border trade.

Digital transformation has similarly gained importance for port authorities. At the interface of sea and land, information sharing might help improve capacities of stakeholders to better schedule processes. Real-time data analytics and modelling help forecast and monitor the expected arrival and departure times of vessels in ports; this enables flexible and more efficient utilisation of assets in terminals (Figure 2). Better vessel traffic management systems that allow synchronising data from different sources (vessels, sensors on buoys, etc.) can increase both efficiency and safety. In terms of data-enabled maritime surveillance, the EU Maritime Information and Exchange System (SafeSeaNet) requires regular electronic data transmission from member countries to the platform. With the Integrated Maritime Data Environment, the European Maritime Safety Agency (EMSA) has attempted to incorporate different data sources and create a more complete overview of maritime activity for actors involved in maritime surveillance (European Commission, 2014). Other types of recent EU-wide standardisation projects include electronic tagging or labelling of maritime devices to replace the equipment conformity wheel-mark.[3]

Figure 2. Flexible scheduling allows anticipating demand, adapting and planning operations



Port management requires a high degree of visibility on movements (incoming or outbound ships, trucks, trains) and the operative environment (cargo handling, processing, customs clearance, etc.). These port functions could be greatly facilitated by ICT applications, especially if they allow for streamlining of operational processes and real-time communication between stakeholders. For instance, the Port of Singapore has developed an electronic information exchange system that aligns different functions including a Port Community System, a Port Management System, a National Single Window, and a logistics platform (Kenyon et al., 2017). Other digital solutions have been developed only for specific uses, such as terminal operations. Jebel Ali Terminal 3 Dubai, Pusan Newport and others are for instance using Java open platform architecture to ease congestion taking into account all port infrastructures, including berths and gates.

The benefits of digital platforms generate new opportunities for ports to create value-added and extract revenue from service provision. In terms of "sharing economy", the application of ICTs allow creating synergies between different actors of the maritime supply chain by pooling and sharing of resources instead of owning the assets. As an additional benefit, shared assets and resources also increase environmental efficiency (Jahn and Saxe, 2017).

Port authorities could greatly benefit from new possibilities of exploiting data to improve their efficiency. The automation of the supply chain process makes raw data available that could be easily used by port authorities to explore new ways of value creation from services for various stakeholders of the maritime supply chain. This mainly entails acquiring a better understanding of data collection and analysis in order to improve their visibility of incoming and outgoing transport flows. Ports could further explore possibilities to expand Port Community Systems to a larger service model based on effective data management and take on a role of leaders of initiatives to synchronise participating actors. For example, port authorities could expand their capabilities in traffic management and provide services to customers that combine IoT sensor networks with platforms enabled by cloud-computing (Jahn and Saxe, 2017). Table 1 illustrates ways in which datafication (harnessing new large data sources) can transform the functioning of Port Community Systems (PCS).

New software business models have made it easier to implement new tools. Ports and terminals have found more flexible solutions to adopt software without a large organisational change. For example, ports have looked into possibilities to use Software as a Service (SaaS) with subscription fees rather than purchasing licenses, hosting and managing software themselves. Furthermore, cloud-based applications do not require them to host a large data centre. Organisations looking into modernisation of their ICT equipment should bear in mind that new technology might not solve the most urgent issues. Although the use of new technology is desirable for most, many of the "older" existing tools already "get the job done" and problems of implementation are often linked to low interoperability, defunct processes and broader management issues (WEF/Accenture, 2016).

Box 4. Port Community Systems (PCS)

A Port Community System (PCS) is an electronic platform which connects the multiple systems operated by a variety of organisations that make up a seaport, airport or inland port community. The port community is usually formed by the private and public actors of a given port logistics chain who act as the shareholders of the PCS. Its objectives are to provide a neutral public-private platform to optimise and automate port and logistics processes and achieve compliance with national legislation. The community agrees on a lead by one operator who sets up the PCS. Revenue streams can consist of annual or monthly subscription fee by services, fees per unit charge (tonnage, Customs declaration, TEU, barrel, vessel, hour, etc.), a fee per stakeholder, etc. While Port Community Systems have existed since the 1970s and 1980s, PCSs are now principally based on electronic data exchange. PCS operators are public, private or public-private entities. Some Port Community Systems have been criticised by other supply chain actors that they would charge for using a system that uses data owned by the stakeholder.

Port Community System operators from different countries have organised on an international level, i.e. via the International Port Community Systems Association (IPCSA), formerly the European Port Community Systems Association (ECPSA), founded by port operators in France (SOGET), the UK (MPC Plc Felixstowe), Spain (PORTIC), the Netherlands (Portbase) and Germany (DAKOSY, dbh). The Association lobbies for the adoption of PCSs and has developed a shared standard, based on a common digital interface and a trusted network. Some Port Community Systems have been criticised by other supply chain actors that they would charge for using a system that uses data owned by the stakeholder.

Source: International Port Community Systems Association and Accenture/SIPG (2017).

Table 2. Integration of big data in a Port Community System

Step	Components
Data collection	Collecting telematics information: Machine-to-machine (M2M) communicators Sensors Tags Electronic interfaces
Data communication	Transmitting information: Radio Frequency Identification (RFID) Cellular networks (GSM) Satellites
Data storage	Hybrid central database Connection to existing third-party information systems (banks, insurers, manufacturers, etc.)
Data management	Online platform for single-point access with function-specific dashboards
Data analysis	Analytical tools and methods by which the data are prepared for their user

Source: Separation of steps based on a case-study included in Kenyon et al. (2017).

Challenges in digitalisation, data collection and governance

Although possibilities and efficiency of ICT applications in maritime transport and logistics have increased in recent years, supply chain co-ordination and transparency still remain challenging issues to be tackled. While technologies and advanced concepts such as machine-to-machine communication, DLT and artificial intelligence are set to bring about transformative changes in logistics processes, many challenges still remain in adopting them, and especially in sharing and making full use of the data they generate and require. This section gives an overview of some of the challenges and risks attached to fully adopting digital solutions in the maritime logistics sector.

Alignment across various nodes of the supply chain

Consistent data has become a crucial element for effective management of maritime supply chains, but the current state of supply chain fragmentation does not allow full alignment and integration of different data sources. Table 3 summarises main operational bottlenecks that represent opportunities for the application of ICTs and data sharing.

The lack of interoperability and the use of disparate standards and IT systems apply to both internal and inter-firm co-ordination. For example, electronic data interchange (EDI) is used only in a few business areas of maritime logistics. EDI involves sending or receiving business information in a standardised format which allows its automatic processing without the individual information being manually entered. Even within the same organisation, the use of different IT systems can obstruct synchronisation efforts. According to a study by the World Economic Forum and Accenture (WEF), 70% of companies in the logistics sector lack basic data transparency and consistency. Consequently, while data sharing among members of supply chains has a high potential, the success of such collaboration is affected by conditions in the actors' internal organisation (Heaver, 2015).

In ports, the lack of integration between various stakeholders and port functions leads to significant inefficiencies (see Table 1). Several parallel systems ensure the functioning of port operations, including terminal operating systems, custom management systems, fleet management systems, etc. Although these systems might be efficient in their specific domain, they are rarely aligned between themselves. Ports such as Singapore or Hamburg have therefore invested in ambitious information exchange platforms integrating various functions. Nonetheless, these platforms often do not take into account data from third parties, such as banks, insurers, or manufacturers to reach a truly transparent system (Kenyon et al., 2017).[4]

Table 3. Main operational challenges linked to low levels of digitalisation and information flow

Function	Frequent issues
Stowage	Poor alignment of stowage plans Lack of synchronisation between mother and feeder vessels
Cargo Information	Insufficient or inaccurate information on cargo content, weight, shipper, consignee, etc. Difficulties in dealing with dangerous cargo or in identifying non-compliance
Transactions	The channel to transmit notifications is slow Traditional non-digital communication (phone, fax) Difficulty in achieving smooth end-to-end services Low public-private collaboration and slow customs processes
Voyage and navigation	Difficulty in dealing with contingencies or concerns with equipment and machines
Berthing	Uncertainty about ship arrival times Serious congestion problems Underutilisation of resources
Port processes	Lack of coordination with piloting services Lack of efficient resource planning Idle time and underutilisation of assets/infrastructure Unplanned disruptions and reactive decision making

Note: This table includes some common issues. In reality, a number of additional micro factors can cause inefficiencies.

Source: Based on issues discussed in Pernia and Perez (2015).

Limited inter-firm collaboration results partly from a reluctance to share data due to fears of losing a competitive advantage (see also the sub-section on risks) or due to risks related to anti-trust legislation. Sharing sensitive data is rarely seen as a win-win situation in practice. The assumption that self-interested individuals will not act collectively to achieve their common or group interest applies specifically in very diverse and heterogeneous interest groups. This situation prevents the emergence of a harmonised logistics system and acts effectively as a barrier to unify standards in data collection and multidirectional information sharing. Furthermore, while freight forwarders might attempt to become supply chain integrators by providing digital platform services, it might be difficult for freight forwarders to integrate the services and physical assets of carriers. Those might be reluctant and might obstruct the integration process of their services, since they compete with freight forwarders to become supply chain integrators (Baker, 2017). It remains an open question how to best address data confidentiality and usage of sensitive data; how to overcome fragmentation of information and systems between different operational silos (cargo data, service data, traffic data); how to design and test smarter and holistic data collection and management processes, etc. (ALICE, 2016).

Some industry actors suggest widespread use of open standards in logistics to prevent lock-in and other artificial barriers to interoperability (i.e. FEPORT, 2017). Others argue for proprietary systems in order to benefit from adequate compensation for efforts and investments. It is often not clear in how far standard-setting should be an industry-driven activity or led by governments and supra-national governance entities.

Complexity and big data

Highly qualified staff and analytical tools are essential to reap benefits from big data. Although improvements in data collection will flow from progress in ICT, new concepts such as big data are also prone to increase the quantity of data and the level of complexity in analysis in which traditional data processing applications become obsolete. Since big data in maritime transport can contain a variety of sources, such as voyage data, machinery data, automatic identification system (AIS)[5] data, weather and business data, and other information, processing becomes more complex and needs adaptation of organisational processes and capabilities. According to the World Bank Logistics Performance Index (2016), new ICT developments exceed the competencies of most of the existing workforce. Management of big data will therefore require highly qualified staff to filter crucial information from noise and powerful analytics tools that can process large amounts of data and events generated by the diversity of sensors and other devices.

Achieving competitive advantage through a successful digital transformation strategy requires technical competencies, but first and foremost an organisational culture that allows for innovation and a change in mind-set. This includes testing methods and technologies on a small level and thoroughly assessing those in order to be able to evaluate what works. Firms could also engage in better links with applied sciences and universities to recruit their workforce or develop innovations. Companies could seek dialogue with the public sector in order to define and support digital skills that need to be taught or developed when it comes to training and reskilling employees that work in shipping, logistics and ports.

The maritime sector contains a large number of potentially connectable items and equipment, a factor that represents a great potential for the use of the Internet of Things (IoT). According to DHL/Cisco, IoT utilisation in supply chain and logistics are estimated to generate USD 1.9 trillion in value globally over the next decade (DHL/Cisco, 2015). However, the Internet of Things is still facing issues with regards to global harmonisation of standards, although some industry-driven initiatives have already started to spread the use of Electronic Product Codes (EPC) and the use of Radio Frequency Identification (RFID).[6]

As for digitalisation in general, connecting “things” is a means to an end and does not create additional value without the resulting insights. Thus the use of analytics and complementary applications (i.e. visualisations) is necessary to make sense of the data generated from connected devices. This requires organisational adaptation. However, the number of physical assets and the high fixed costs suggest that the maritime transport sector does not count among the most flexible industries. Furthermore, some organisations in the sector seem to have a relatively hierarchical setup that might not be adapted to fast changes (WEF/Accenture, 2016). Currently, the degree of digitalisation within organisations in the maritime sector remains low. Considering for example the level of paper and phone use in shipping transactions, basic digital trade seems to remain a long-term objective for the industry. Particularly, the OECD ICT database shows large digital adoption gaps between large and small firms. For example, while the costs of adopting basic digital technologies have fallen dramatically, small firms with 10-49 employees are only half as likely as large firms to have business websites.

Several additional obstacles impede the wide-spread use of quality data. In many cases organisations are not particularly transparent on where information is stored and who has access to it. According to a survey by DNV GL, data owners in shipping companies were often not aware about origins, context and legal or contractual obligations of data they were dealing with. In addition, they found that in all 30 pilot projects where big data was used in analysis, there were issues of data quality. The collected data often did not necessarily stem from the sensors installed on equipment, but from the way they were coded or tagged (DNV GL, 2017).

Box 5. From Internet of Things to Internet of Everything

Whereas the Internet of Things (IoT) mainly connects devices and objects, the Internet of Everything (IoE) is a broader concept. Beside technology, it is supposed to bring "people and process" into the equation. IoE networks can include machine-to-machine (M2M), machine-to-person (M2P), or person-to-person (P2P) interactions. IoT can be seen as a subset of the IoE, as it represents a main technological feature of IoE. Other technological enablers of IoE are big data, cloud computing, P2P virtual collaboration, mobility and security.

This model can be beneficial to a variety of areas in maritime logistics, such as operational and environmental efficiency, location and performance of assets, safety and security, maintenance, communication, customer services, etc. Applications can be found the private and public sectors. For instance, the Hamburg Port Authority has developed a strategy to implement a holistic Internet of Everything model (smartPORT) taking into account not only the combined management of waterway, road and rails, but also staff and customer communication technology and the port environment. Many organisations in the sector still struggle to apply IoE concepts to their operations: IoE demands a high degree of transparency, up-front investments, staff training and organisational flexibility.

Source: DHL/Cisco (2015).

Policy and regulatory issues

Efficiency of the global maritime logistics network does not only flow from performance of private actors, but it is also dependent on regulatory conditions, as well as national policies regarding digital cross-border trade. As the UN Global Survey on Trade Facilitation and Paperless Trade Implementation 2017 suggests, worldwide paperless trade systems remain mostly at a pilot stage. Findings show that while developing countries have not yet fully implemented electronic systems, paperless systems of developed economies do not work efficiently due to harmonisation issues and fragmentation of different services and agencies (ESCAP, 2017). In the EU, the Reporting Formalities Directive was adopted with the aim to simplify and harmonise administrative procedures for maritime transport. However, the preliminary results of an evaluation of the Directive show that the legislation has not delivered the expected results, leaving shipping operators with a high administrative burden (i.e. ships are requested to submit the same data to several authorities) (European Commission, 2017).

On an international level, performance of public authorities in terms of digitalisation can be compared with sub-indicators of the OECD Trade Facilitation Indicators, which show a high degree of heterogeneity of automation between countries worldwide. According to the UN Global Survey on Trade Facilitation and Paperless Trade Implementation 2017, most economies are actively developing basic IT infrastructure for paperless trade. However, more advanced digitalisation measures remain at a very early stage. 60% of the economies worldwide have committed to creating an electronic single window but very few have fully-operational systems in place (ESCAP, 2017). So far, there are two global customs data standards: the World Customs Organisation's (WCO) data model and the Core Component Library of the UNECE Centre for Trade Facilitation and Electronic Business (CEFACT). More could be done in terms of international standardisation efforts, i.e. through the IMO (International Maritime

Organisation), ISO (International Organization for Standardisation), the IEC (International Electrotechnical Commission), the European Union Customs Code, or the WCO SAFE Framework of Standards, etc. (UNCTAD, 2017).

States have not yet succeeded in adapting legislation to changing technological realities. Many areas of law, including (but not limited to) civil law, IT and data protection law, product liability law and intellectual property law, have yet to be revised or adapted to increase coherence with the current state of innovation. As they are relatively new, most DLT applications still lack an appropriate legal and regulatory framework, i.e. concerning the legal recognition and enforceability of "smart" contracts. Some DLTs could be in conflict with privacy legislation, such as the right to be forgotten that is applicable in the European Union under the EU General Data Protection Regulation. It would need to be established which jurisdiction applies to transactions, as the data stored in the blockchain could be located in any country, or stored in many countries simultaneously, an issue that applies to all cloud-stored data. Further, there are open questions of liability once a problem occurs in the blockchain.

Digitalisation and automation also imply changes in qualification profiles and the labour market. This makes it necessary to strengthen profiles of workers potentially displaced by automation and reinforce their abilities to acquire qualifications in working with new technologies (human-machine interface, data management, etc.). On a general socio-economic level, there is a need to better understand how technologies in logistics may impact aspects, such as environment, energy, safety and security, employment and growth (ALICE, 2016).

Risks

Increasing reliance on computerised systems and ICTs are raising new concerns such as increased cyber security risks. Especially the shipping sector has been slow in acknowledging these risks, as shown by the cyber-attacks in June 2017 that temporarily paralysed terminal operations in several countries, and from which Maersk has yet to fully recover. The cost of the cyber-attack was estimated at up to USD 300 million.[7] Beside terminal operations and cargo handling, attacks can also hit vessel technology, which poses a threat to safe navigation and propulsion. In addition, cyber risks can emanate from extreme weather conditions causing partial or total destruction of facilities. In these cases, the challenge is to ensure that data is secure and systems can resume quickly after such events.

According to UNCTAD, low levels of cybersecurity preparedness and sense of urgency are partly due to the fact that international regulations, risk assessments and management focused primarily on physical security in ships and ports (i.e. the IMO International Ship and Port Facilities Security Code) (UNCTAD, 2017). An analysis of cyber security aspects in the maritime sector by the European Network and Information Security Agency (ENISA) identified several other reasons, such as:

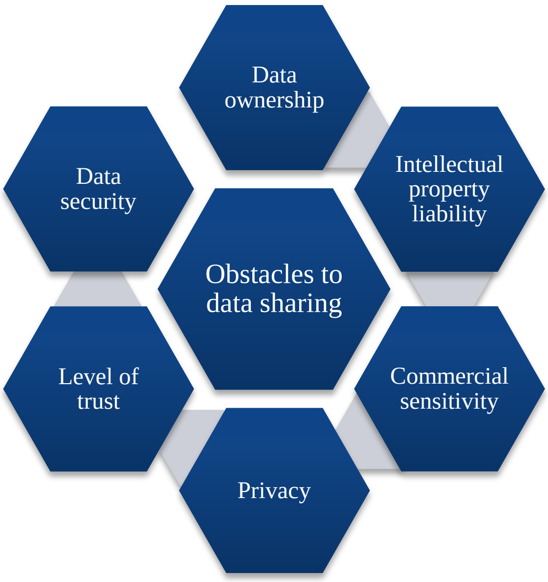
- the complexity of the maritime ICT environment
- fragmented governance and inadequate co-operation of international public stakeholders
- inadequate consideration in maritime regulations
- lack of holistic approaches instead of ad-hoc measures
- lack of private collaborative initiatives (ENISA, 2011).

Only very recently, the IMO has issued the Guidelines on Maritime Cyber Risk Management (2017), which comprise five elements, namely to identify, protect, detect, respond and recover.

In addition, despite the new possibilities that technologies, such as distributed ledger technologies, might offer for supply chain management and encoded "smart" contracts, there are some remaining concerns regarding its use that involve infrastructure, trust issues (fraud), authentication management, adaptation of the code to evolving legislation, or the protection of privacy or financial information (UNCTAD, 2017). In terms of security, users need to be sure that the data added to a blockchain is valid and follows the same standard. In terms of infrastructure challenges, open or large private DLTs cannot always guarantee for the highest efficiency due to the proof-of-work verification, which involve an important amount of computational power and time necessary to "mine" and process blocks. Open and "trustless" DLTs like Bitcoin therefore face a challenge of scalability. This issue can be circumvented however in smaller or permissioned DLT applications. Those permissioned or tangled DLTs however are sensitive to severe security breaches.

Currently, some cloud-based approaches are not trusted for the transmission of commercially sensitive data. Significant effort is yet needed to address issues of data governance between organisations, particularly with regards to security, ownership and intellectual property liability, commercial sensitivity, privacy and trust (ALICE, 2016). One of the solutions to data ownership issues is the implementation of systems that allow stakeholders to control the flow of data and manage fine-grained authorisations for other companies in accessing this data. An example is the "safe answers" concept that makes a data repository send back information ("answers") to a specific query, but never a full set of raw data, avoiding complete disclosure of a data set.

Figure 3. Key concerns of supply chain actors with regards to data sharing



Although standardisation is accepted as a useful tool for increasing efficiency, a range of risks are associated to standardisation in proprietary systems. Following the logic of platforms, Amazon or Alibaba distribute and provide digital services, but also allow others to join and sell under their "umbrella" of uniform logistics. As actors join the network, the system allows for digitalising, streamlining, standardising and sharing resources, which increases efficiency and value for their customers via network effects. However, these forms of networks are proprietary systems where only one player owns the administrative rights, and which might favour the formation of an oligopoly where a few players dominate e-commerce and shipping (Ballot, 2016). The digital economy features large economies of scale, potentially creating “winner-takes-most” dynamics (e.g. in case a provider acquires an unmatchable advantage over rivals through its exclusive control over important supply chain data, etc.). Furthermore, huge amounts of data concentrated in the hands of a few industry players might create imbalances and weaken the bargaining power of smaller actors in the supply chain. OECD data has shown that there is a significant gap of adoption of advanced ICT, called the “digital divide”. Applications such as enterprise resource planning software, cloud computing and big data are used only by some businesses, typically the largest ones. As the most ICT-intensive firms tend to concentrate in a few regions, a digital divide is also opening up between regions (OECD, 2017c). This risk is exacerbated by growing concentration in some logistics chains, e.g. for containerised shipments, which has witnessed tendencies of both horizontal and vertical integration.

Preconditions for efficient, digitally enabled maritime logistics

In an ideal scenario, maritime logistics chains could become more performant if each stakeholder encourages collaboration with others. Many potential benefits could be harnessed if…

- …freight forwarders and shippers update their systems to become real-time data platforms with improved visibility and control, including data from third parties.
- …carriers integrate software that allow for better navigation, vessel performance, forecasts and stowage planning, and share real-time data with ports and other actors.
- …ports and terminals get improved access to the necessary information to better plan resources and asset deployment, orchestrate various actors and optimise handling and storage.
- …policy makers support digitalisation strategies in maritime logistics, overcome internal agency fragmentation and adapt regulatory frameworks with regards to simplification and developments in digital technology.

These scenarios require a number of steps that begin with mapping data requirements of different supply chain actors. A successful outcome is also conditioned by both inter-firm co-ordination, as well as internal organisational adaptation.

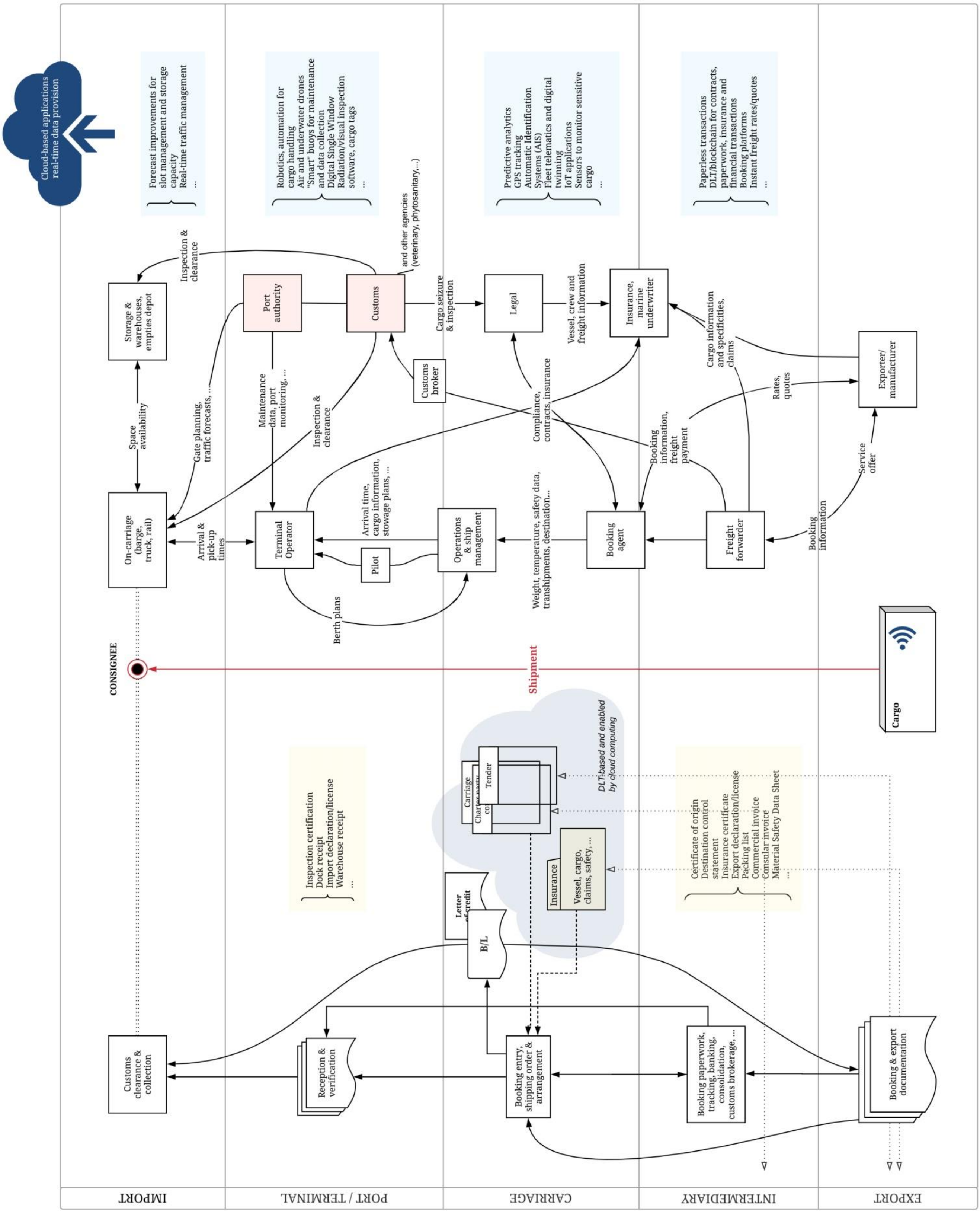
Mapping nodes of data exchange and prerequisites for successful co-ordination

Our simplified maritime logistics model in Figure 4 shows that three simultaneous movements are needed for an international shipment from point A to point B: cargo (centre), financial (left) and data flows (right). The yellow boxes list the documents and paperwork required at each stage. The financial flow is illustrated in the form of contractual elements, guarantees and documentation related to the payment and insurance of a shipment. "Data" are depicted as information flows on the arrows between two different nodes. The blue boxes list potential technological innovations that are or will become available to increase the efficiency of the logistics chain at each stage. While the figure does not purport to be exhaustive, it gives an indication of the diverse levels of interaction in maritime logistics. Depending on the level of fragmentation, one single shipment can require sign-off from around 30 individual organisations and up to around 200 communications (IBM/Maersk, 2017). Further, the figure illustrates two sides of digitalisation: first, the process of dematerialisation and datafication,[8] and second, information corridors and data pipelines via which digital documents and information migrate back and forth.

While an effective way of making this information available could be via cloud-based platforms, this raises the issue of data access and ownership. Data ownership basically defines who generates, modifies, shares and restricts access to data. As various stakeholders in the supply chain are developing data services as part of their business model, this also raises the question of financial value of this data. Successful supply chain co-ordination is thus conditioned by the variety of previous agreements needed among supply chain actors, i.e. on an adequate definition of data ownership, setting up revenue or cost sharing mechanisms for data provision and consumption, different levels of access and authentication mechanisms, as well as on the security and confidentiality of inter-firm (or public-private) data transmission. For companies to agree to share the information needed to make such applications work, they must be confident that liability, costs, authentication and access to data are securely and fairly managed in order to reconcile different interests in the supply chain. This means that participants need to feel they are getting a fair share of benefits from platforms or information services relative to their data input. As discussed above, data pipelines are becoming commodities provided by different competitors. Hence, open, collaborative platforms would need to appropriately compensate their members in order to win support for this model.

Further, there will be necessary policy and regulatory adaptation to reflect the adoption of new technology, but also to ensure emerging business models can yield the desired benefits. As multiple platforms are currently emerging to solve supply chain co-ordination and visibility, it is crucial to monitor which platform model will ultimately dominate. Governments should be aware that monopoly or oligopoly style platform models bear risks such as lock-in, poor innovation and anti-competitive behaviour (ITF, 2018). A problem of lock-in could potentially be solved by the conception of universal open standards. However, this would require an effective initiative and broad collective action involving the private and public sectors, including an investigation and agreement on best practice, dissemination and worldwide implementation. This means that without an international playing field and harmonised standards, interoperability also remains a collective action issue, as engaging with competitors and the public sector requires an extra effort from companies. Relevant actors will also need to agree whether co-ordination processes should be facilitated or guided by public (or public-private) initiatives that aim to play a neutral part in the debate. In turn, governments or supra-national bodies should evaluate the necessity and benefits of facilitating such an exchange (Figure 4).

Figure 4. Mapping the nodes of data exchange in maritime logistics



Digitalisation and organisational adaptation

Beside the required inter-firm collaboration, firms will also need to adapt internal processes to drive the efficient use of ICTs to harness and share information. A range of dos and don'ts collected from a variety of sources would favour the efficient use of digital technologies and data sharing (Table 4).

Table 4. ICTs and organisational adaptation: Dos and don'ts

Dos	Don'ts
Simplify…	…instead of rendering management processes even more complex with additional ICT architecture.
Thoroughly analyse bottlenecks and define which problems need to be addressed in priority…	…instead of adopting digital technology for the sake of it.
Decide which metrics really matter based on objectives by talking to employees dealing with operational issues…	…in order not to collect data that is not necessarily needed.
Simple insights and statistics are often sufficient to gain an insight.	Sophisticated modelling exercises – even though valuable – are not always cost-effective with regards to the objective.
Start on a small level and build on methods or technologies that work and provide a real value-added proven by thorough evaluation…	…instead of embracing every tech innovation (or outsourcing digital services).
Reap the benefits of big data with the adequate analytical capacities to extract meaningful information…	…instead of losing the bigger picture (big data can also add more noise and complexity).
Collect operational performance data along the entire value chain.	Scattered data is unusable, gathering information only makes sense if data is consistent and aligned.
Proactive policies to enhance the quality and competitiveness of logistics services…	…not without adapting to new realities.
Take a long-term perspective with regards to training and mind the scarcity of properly qualified IT staff…	…instead of maintaining a passive HR strategy.
In terms of cyber security, focus on holistic approaches based on sound risk management…	…instead of implementing ad-hoc measures.

Source: Suggestions compiled from the references used in this report.

Questions for further research and discussion

This report has set out some of the trends, opportunities, challenges and preconditions for successful supply chain co-ordination, data sharing and digitalisation in the sector. Three strands of discussion could emerge from these insights, namely on technology, standards and information pipelines. The following indicative list of questions can guide further discussions and possible work in the future:

- What incentives exist to enhance collaboration between different stakeholders? How to effectively organise the interaction among heterogeneous industry groups and the public sector?
- What examples could be drawn from other sectors such as tourism or aviation in order to improve supply chain co-ordination?
- What can policy makers do to address issues of data-enabled efficiency and co-ordination?
- How should standards develop and who defines them? Should they be open? How can standardisation happen without the formation of a global oligopoly of supply chain integrators? Which roles for the public and private sectors?
- What would be needed to generate balanced co-ordination between supply chain actors that properly takes into account their individual interests and data security/confidentiality needs? How can co-ordination mechanisms develop a truly global character?
- Which initiatives are needed to share good practice? What kinds of internal, intra-firm adaptation processes are necessary for successful data sharing and digitalisation?
- Where does standardisation begin? Which platforms can bring together actors to do investigative work about what works best? How to gather experience and practice at the highest standards and their subsequent dissemination?
- Supra-national/EU level: What would be needed to facilitate the connection of various PCSs and NSWs into a complete and harmonised European Maritime Single Window environment?
- Which tools would be needed to increase awareness, training and capacity building of national customs officers in order to increase efficiency of cross-border logistics? How can frameworks, certifications, norms and standards be harmonised and simplified on a supra-national level using Information and Communication Technology (ICT)? How to achieve regulatory rationalisation on a national and international level?

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Notes

1 The concept of logistics control towers, as described in WEF/Accenture (2016), refers to a variety of centralised functions of planning, analytics, tracking and tracing, control, alarm generation, payments, sourcing, process optimisation, etc. One example of a port-based control tower is the recent project by MGI in Marseille to establish a system functioning in real-time using decision-making tools based on Artificial Intelligence for cargo management in port communities (MGI, 2017).

2 According to a senior manager at Maersk Tankers, big data is now so valuable to shipping that it constitutes a new asset class. Osler, D. (2017), Data is 'new asset class', claims Maersk Tankers chief, Lloyds List Maritime Intelligence, 7 November 2017. https://lloydslist.maritimeintelligence.informa.com/LL112234/Data-is-new-asset-class-claims-Maersk-Tankers-chief

3 The Wheel Mark (Mark of Conformity) is the European regulatory marking of all marine equipment, as defined in the Marine Equipment Directive, 96/98/EC.

4 For example, customs agencies often detain cargo due to a lack of information on financing of a shipment, as they are unable to quickly verify banking or insurance information of the shipment. Furthermore, booking information collected by commercial agents of the transport company are often incomplete or unprecise.

5 The information and frequency of AIS data provided depend on the class of the vessel and may contain up to 21 types of information. They are sent either every 2-10 seconds (depending on speed), or every 3 minutes (if at anchor) or every 6 minutes (static vessel information). See SOLAS Convention, Chapter V, https://mcanet.mcga.gov.uk/public/c4/solas/solas_v/Annexes/Annex17.htm

6 One example of industry-led initiatives is the GS1 Initiative, EPCglobal, https://www.gs1.org/epcglobal.

7 Maersk experienced a major IT shutdown in June 2017 due to a NotPetya ransomware attack, which, according to Lloyd's List Maritime Intelligence cost the group up to $USD 300 m. See Porter, J. (2017).

8 Datafication describes the process of harnessing new potential information sources (i.e. physical conditions of machines or objects, browsing behaviours, etc.) and transforming them into computerised data. This can include measurement and evaluation of actions, behaviours or physical objects, often generating large amounts of data, so-called "Big data". The concept is associated to the fact that any aspect of our lives can represent a potential data source and can generate valuable data (leading to a commodification of data).

Information Sharing for Efficient Maritime Logistics

This report presents policy options for encouraging information sharing along the maritime supply chain. It maps the current use of digital technology and information sharing in maritime logistics and highlights the potential for making door-to-door cargo flows more efficient. It also examines the numerous challenges from interoperability issues to lack of collaboration.

This report is part of the International Transport Forum's Case-Specific Policy Analysis series. These are topical studies on specific issues carried out by the ITF in agreement with local institutions.

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