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Published in:
Procedia Computer Science

DOI (link to publication from Publisher):
10.1016/j.procs.2021.01.224

Publication date:
2021

Document Version
Publisher's PDF, also known as Version of record

Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 181 (2021) 722–729

Procedia Computer Science

www.elsevier.com/locate/procedia

CENTERIS - International Conference on ENTERprise Information Systems / ProjMAN - International Conference on Project MANagement / HCist - International Conference on Health and Social Care Information Systems and Technologies 2020

Information Exchange and Block Chains in Short Sea Maritime Supply Chains

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Abstract

This paper describes the challenges of the maritime supply chain compared to land transport and discusses the new digital initiatives to simplify the processes and enable a better plan for the entire supply chain. First, the background is outlined with an example of the extensive admin processes in maritime transport compared to road transport, followed by a case example presenting the processes of a booking. The case study concludes that the lack of integration is costly in terms of both admin resources, as well as lost capacity on some ships and missing capacity on others. Finally, the evolution of new digital initiatives are discussed, both in general and in terms of competing "alliances" as seen in the airline industry. The paper concludes that the information exchange in the maritime industry has moved drastically in the last 3 years and that one initiative, TradeLens, seems to have gained a position as maritime standard despite a problematic start with many competing initiatives.

Keywords: Maritime Supply Chains, Short Sea Shipping, Information Exchange, Blockchain, Transport, ICT

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10.1016/j.procs.2021.01.224

1. Background

Short sea shipping is maritime transport of goods over relatively short distances as opposed to deep-sea shipping, which is maritime transport across the oceans that connect different continents. The European Commission defines short sea shipping as maritime transport in geographical Europe including EU maritime countries, candidate countries, EEA countries (Iceland and Norway), and ports located in the Mediterranean Sea, the Black Sea and the Baltic Sea due to their proximity to the European coastline [1]. Short sea shipping can be seen as motorways of the sea and thereby a transport alternative for trucks and trains.

Paixao and Marlow [2] define short sea shipping as three segments: feeder services, intra-European services, and cabotage services. The feeder market represents transport to and from the ports that are connected to deep-sea shipping routes [1]. The intra-European market is defined as maritime freight transport in geographical Europe, where the goods are not intended to be transported on from Europe. Cabotage services include the return of empty containers to the ports from which new goods are to be loaded and transported.

Short sea shipping made up close to 59 % of the total sea transport of goods to and from the main EU ports in 2018 and is steadily growing [3]. The largest share of this cargo moves through the heart of Europe on rivers and not oceans. Over the last decade, Short Sea Shipping has evolved more broadly to include point-to-point freight on inland waterways as well as inland to coastal/seaports for transshipment over oceans. In the latter situation, larger ports (hubs) connect the routes of large container ships with smaller feeder ships that sail the containers to several smaller ports (spokes) [4]. In this way, shipping companies, such as Maersk, can achieve economies of scale by using large container ships to sail between hub ports, where a large volume of containers are transported across the oceans. However, the disadvantage of this type of network is that more resources are spent on handling the containers in the hub ports from which the containers are loaded onto the feeder ships compared to a container route where the container is only transported by one ship [4]. In cases where a container route transports the cargo directly from one port to another without being loaded into other ports, the network type is called point-to-point [5].

Meeting the problem of container handling which is the costly link for multimodal/combined transport in general and e.g. using only point-to-point route is not always economically rational. When there is return cargo out of the same port it can go, but if a port in an "end" point does not have return cargo and the ship must, therefore, sail empty to a new port, to get a new cargo for a new "end" point, etc., it is not economical. This routing mode means that the ship has poor utilization and efficiency and is not competitive.

The single market is one of the most famous successes in the European Union. This is a key element of the EU's growth agenda. It is clear, however, that the internal market remains incomplete and dysfunctional in some sectors. This is especially true for shipping. Shipping is disadvantaged compared to other modes of transport. In many cases, goods transported by ships between EU ports lose EU status. This entails a high administrative burden involving several authorities and intermediaries. In addition to numerous cargo-related reporting procedures and requirements, there are also a large number of vessel-related reporting procedures and requirements to be met. These are not only complex and repetitive but even worse, they are completely unharmonized throughout the European Union.

To illustrate the high admin burden of sea transport, an example from the European Community Shipowners' Associations (ecsa.eu) of transporting one container from Nijmegen in The Netherlands to Borås in Sweden is brought forward. For road transport, only one document (a CMR letter which is an international agreement that contains the rights and obligations of parties involved in road transport.) is required. For maritime transport, a multitude of documents and processes are required as listed below [6]:

1. Transport to the port of loading where the driver issues a note
2. The consignor declares community status of goods
3. The shipping company enters the container in the port community system at the port of loading terminal
4. The shipping company submits a bill of lading to the terminal and declares community status of the goods
5. The port terminal checks the documentation of community status of the goods
6. The manifest of the ship is being updated by the shipping company including information about the status of the goods
7. The ship issues the required IMO FAL forms to the different Dutch authorities and the Port of Rotterdam before departure. This covers the *International Maritime Organisation's* FAL convention for 7 standardized

forms being: a) IMO General Declaration, b) Cargo Declaration, c) Ship's Stores Declaration, d) Crew's Effects Declaration, e) Crew List, f) Passenger List, and g) Dangerous Goods [7].

8 The ship submits data to the Swedish National Single Window before and after arrival to Gothenburg and at the time of departure

9 The shipping company enters the container in the Swedish customs system by submitting the manifest

10 The shipping company declares community status of the goods in the port system in Gothenburg

11 The port terminal checks the documentation of community status of the goods

12 Transport from the port of discharge where the driver issues a note

A comparison of the air emission factors for truck, rail, and maritime transport from OECD [8] is shown in table 1 below and illustrates that maritime (and rail) outperforms road transport with a factor 5 to 10. This indicates that the admin and logistics burden or maritime transport versus road transport is highly inappropriate from an environmental point of view as this indirectly discourage maritime transport.

Table 1. Air Emission Factor Ranges for Truck, Rail, and Marine, in grams/tonne-km. [8]

Pollutant	Truck	Rail	Marine
CO	0.25 - 2.40	0.02 - 0.15	0.018 - 0.20
CO2	127 – 451	41 – 102	30 – 40
HC	0.30 - 1.57	0.01 - 0.07	0.04 - 0.08
NOx	1.85 - 5.65	0.20 - 1.01	0.26 - 0.58
SO2	0.10 - 0.43	0.07 - 0.18	0.02 - 0.05
Particulates	0.04 - 0.90	0.01 - 0.08	0.02 - 0.04
VOC	1.10	0.08	0.04 - 0.11

2. Case Study

The case study uncovers the flow of information in a maritime supply chain in terms of an order flow at a carrier where a customer makes a booking on a shipment from one port to another. The flow and the respective challenges are based on collected information and forms as well as interviews with three people at the case company. There are 8 steps in the process from booking to shipment:

1) The booking is created by the customer. It can be changed either manually by contacting the carrier, for example by mail or phone, or by sending a UN/EDIFACT message, which automatically updates the booking. This stands for the United Nations Rules for Electronic Data Interchange For Administration, Commerce, and Transport and is a type of message whose structure is standardized and determined by UNECE [9]. The standardized structure makes it possible to exchange information automatically, thereby ensuring that computer systems can read the messages in a standardized way. However, the automatic updates are only possible until the ship arrives in port and starts loading. Subsequently, changes in a booking must be manually passed on to the carrier, which will determine whether it is possible to update the requested data.

2) The booking and any updates to the terminal will then be sent back using a CODECO message. This stands for COntainer DEparture COnfirmation and is a UN/EDIFACT message that the terminal sends as confirmation that carrier booking information is understood and approved [10].

3) Before the ship's departure, a stowage plan is made on where to place the containers on the ship. The stowage plan must subsequently be sent to the ship's staff, who can make changes to the plan if it is in their interest. The ship's ability to make changes is crucial because there may be conditions on the ship that the administrator of the carrier is unable to take into account.

4) After the ship approves the stowage plan, it is sent to the terminal for them to plan the operations to be undertaken during the loading of the ship. If the terminal is unable to load the ship in the manner requested by the

carrier, the terminal has the option of rejecting the request. If this is the case, a new stowage plan must be made and re-approved by the ship's personnel.

5) 24 hours before the ship's departure, customs and dangerous goods authorities must approve all consignments before they can be loaded. For shipments to be transported to a hub port, this only applies in some cases because shipping carried from a hub port may already have been approved by the authorities of the previous port. Customs authorities must ensure that the consignments sent comply with the customs rules applicable in the area. The hazardous service authorities must be informed of the content of a shipment for safety reasons, for example, if explosive substances are transported.

6) Once a shipment is approved, it is given an MRN number, which is a customs ID that follows that shipment from the first port of shipment to the last port of unloading (note that the MRN number may already be given if transported from a hub port). Once the MRN number is created, this is sent to the customer, who thereby has an ID for his shipment.

7) Once the ship has sailed, the terminal sends a confirmation of the final stowage positions to the carrier, who then can pass relevant information on to the customer.

8) This information includes details to be used for loading/unloading in the following port, as well as other documents relevant to the container's onward transport. Before filing the booking, a bill is sent to the customer, which specifies details of the settlement of the service performed.

The challenges experienced in the booking process are compiled below

- Problems sending Dangerous Goods Documents (DGD) to the ships have been reported often due to slow/outdated systems on the ships. The ship must be able to present the documents if requested by the authorities.
- Missing information from the terminal as to whether the containers booked have arrived and whether the necessary information is available. If containers are shipped from a hub port, they have not necessarily arrived the day before. In these cases, the carrier keeps up to date with the ocean-going ship's time of arrival. The terminals do not automatically send the information. Instead, the carrier itself must compare its own information on container bookings with the system used by the port, and these systems can differentiate from port to port.
- The information flow is hampered by data being sent in different formats, which require many different interfaces. Besides, it is necessary to transform the information received into a uniform structure to make the internal processes more efficient.
- In some countries, information must be provided on paper forms. This affects the flow of information in the way that time is spent printing the documents in question and sending them or sending information in a printable format. Even though Europe is relatively far in its technological development compared to, for example, Africa, some countries like Lithuania, Latvia, and Russia still require paper-based forms.
- The UN/EDIFACT bookings have been analyzed over 13 months and found to constitute 80-85% of the total number of bookings. The remaining 15-20% is handled by a full-time employee who (manually) transform and convert information to and from the portals.
- On the planning side, the case company lacks information from supply chain partners on the volume of containers going from one port to another. In most cases, the company has to forecast the volume even though the containers are being processed. This is caused by lacking information sharing among partners, probably not caused by a lack of interest in sharing the information but instead the bad integration among the many actors. The consequence is lost capacity on some ships and missing capacity on others.

The latter point emphasizes that UN/EDIFACT messages can help streamline and automate the flow of information, but far from all actors can use these standards. It should be said that the messages still require manual resources as collaborators do not insert the information in the same way in the messages and may have different views on what the content of the messages means. Therefore, the carrier is obliged to also convert the UN/EDIFACT messages received, but once this is clarified for a given actor, the process can be set up so that it runs automatically. It has a particularly significant impact if bookings from the ocean-going shipping companies were received solely as UN/EDIFACT messages. This is because the booking from the customer contains information to be used in the remaining information flow. Besides, customers using UN/EDIFACT messages can update booking information automatically until the ship's departure, which does not require the same work as updates/changes that are received manually.

The case company would like to eliminate manual paperwork through one standardized interface for external parties and receive information about the arrival of containers in a better time and in a more consistent way. However, this is only possible if all external parties are willing to adapt and change the rules and procedures that prevent the real cause from being resolved.

3. Digital Solutions

The trends in digital solutions for the maritime supply chain have the last approx. 5 years more or less been associated with Blockchain. According to Yli-Huumo et al [11], more than 80% of the research in Blockchain focuses on bitcoin. It was not until 2017 that the use of Blockchain for other purposes such as maritime (transport) bookings, medicine tracing, etc came into the public eye. This is supported by Diordiiev [12] who states that shipping has not yet seen many examples of the actual use of blockchain, but the potential is great. McCrea [13] discuss the use of cloud solutions and the use of blockchains in Global Trade Management Systems and finds that compliance is one of the most critical issues.

Maersk initiated a blockchain initiative titled Global Trade Digitization (GTD) intending to share information between maritime parties which in many cases consists of E-mails and phone calls [14]. GTD aimed to create a hub for the information that the actors shared, thus making the flow of information more uniform as illustrated in figure 1.

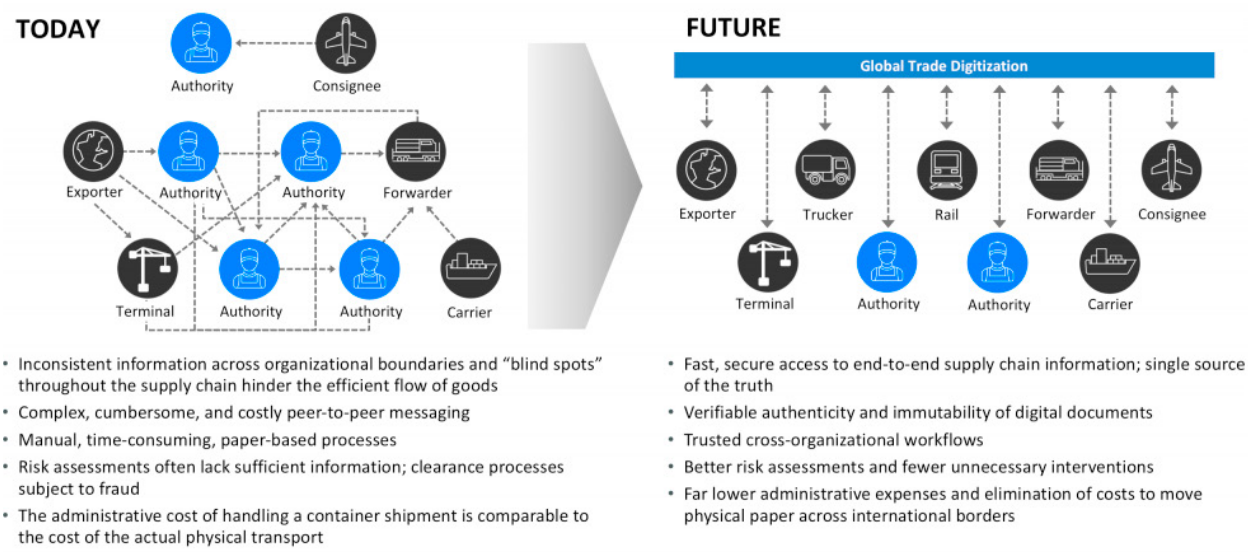

Figure 1: The basis rationale from IBM-Maersk with their Global Trade Digitization initiative [15]

GDT was to have two main elements: 1) *Shipping Information Pipeline* to enable secure information sharing between all parties that are part of the platform, and also provide the parties with an overview of how each shipment is handled and 2) *Paperless Trade* to digitize the manual paperwork that is currently needed to handle a shipment and enable the parties to follow how they are processed.

3.1. Other Maritime Blockchain Initiatives

Several other major maritime players started similar initiates in 2017. *MOL, NYK-Line, and K-Line* announced on August 30, 2017, their participation in a consortium of a total of 14 companies called consortium to develop a trade data sharing platform using blockchain technology due to "*the great potential to streamline the existing supply chain* *by digitally making manual paperwork*". In addition to the three shipping companies, this consortium included other companies dealing with various aspects of the trade, including a bank and an insurance company [16]. The purpose of the platform was strikingly similar to the intentions of GTD although they did not target to build an industry-wide standard.

Pacific International Lines (PIL), Port of Singapore Authority (PSA), and IBM announced in August 2017 that they have partnered on a proof of concept project to explore how BC technology can help establish better safety, efficiency, and transparency in the supply chains that handle shipments. PSA is a global port group that handles operations at around 40 terminals in 16 different countries. The project was based on the BC framework Hyperledger Fabric [17].

Compagnie Maritime d'Affrètement – Campagnie Générale Maritime (CMA-CGM) partnered in 2017 with Infosys to develop CMA's IT applications [18]. Infosys is part of the Ethereum Alliance for Blockchain, an association of companies working with experts in the BC platform Ethereum to explore how BC systems can be used in an industrial context [19].

Finally, Hyundai Merchant Marine (HMM) joined a consortium in May 2017 titled the Shipping and Logistics Blockchain Consortium, with a group of Korean parties using Samsung SDS and their BC framework called Nexledger. The intention was to develop a platform that allowed documents to be shared securely between stakeholders and also remove manual paperwork, which in the project is called paperless operation, to make operations more efficient [20]

All in all, a majority of the largest maritime operators initiated or joined blockchain consortiums in 2017 as seen in figure 2.

	Rank	Operator	Teu	Share
→	1	APM-Maersk	3,521,625	16.5%
	2	Mediterranean Shg Co	3,142,388	14.7%
→	3	CMA CGM Group	2,497,512	11.7%
	4	COSCO Shipping Co Ltd	1,812,125	8.5%
	5	Hapag-Lloyd	1,516,652	7.1%
	6	Evergreen Line	1,073,892	5.0%
	7	OOCL	680,278	3.2%
	8	Yang Ming Marine Transport Corp.	575,484	2.7%
→	9	Hamburg Süd Group	565,485	2.6%
→	10	MOL	548,607	2.6%
→	11	NYK Line	538,915	2.5%
→	12	PIL (Pacific Int. Line)	370,247	1.7%
	13	Zim	363,991	1.7%
→	14	Hyundai M.M.	348,673	1.6%
→	15	K Line	341,746	1.6%
	16	Wan Hai Lines	216,957	1.0%
	17	X-Press Feeders Group	150,644	0.7%
	18	KMTC	121,202	0.6%
	19	Antong Holdings (QASC)	104,694	0.5%
	20	SITC	97,675	0.5%

Figure 2: Blockchain initiates reported in the literature in 2017 among the 20 largest container shipping companies indicated by arrows. Volume from Alphaliner [21]

3.2. Status in 2020

After making the conceptual design of the GTD initiative, Maersk teamed up with IBM in 2017 [21]. The application is now titled Tradelens [22] and seems to progress very well. The TradeLens partners constitute 15 ocean carriers (most importantly 4 of the 5 largest) covering more than 50% of the total market (see figure 3) as well as approx. 15 ports, 150 terminals, 12 government authorities as well as 40 intermodal providers and depots [23].

Alianca	Ocean Network Express
CMA	Pacific International Lines
Hamburg-Sud	Seaboard
Hapag Lloyd	Safmarine
Maersk Line	Sealand
MSC	SPIL
Namsung	ZIM
Unifeeder	

Figure 3: TradeLens ocean carriers in May 2020. 4 of the 5 largest carriers being CMA, MSC, Hapaq Lloyd and Maersk (including Hamburg-Syd) constitute alone more than 50% of the maritime market [23]

By comparing figure 2 and 3 it becomes clear that several companies such as PIL and CMA-CGM who started developing blockchain systems in 2017 now has teamed up with IBM/Maersk's TradeLens system. The other initiatives from 2017 such as Hyundai Merchant Marine have been difficult harder to study than Tradelens, probably because they were targeting a system for internal usage and not an industry standard like TradeLens.

4. Conclusions

The conducted case study supports the findings of a previous research project (NOKSII) as well as the general view from conference presentations, namely that companies are forced to spend a huge amount of time collecting, restructuring, and supplying information to and from partners. This has been known and accepted for decades, but in 2017 a large number of maritime companies initiated projects to digitalize the information flow. Surprisingly, Maersk decided to develop a generic platform without support from the other major carriers who either proceeded as usual or started other blockchain initiatives. 3 years later, the Maersk/IBM TradeLens seems to have formed an industrial standard while the competing initiatives seem to have terminated. This is surely a step towards seamless integration throughout the transport supply chain, and a chance for maritime transport to expand on the feeder side towards the last-mile deliveries which, to a large degree, is handled by road transport. Further, the admin burden of maritime transport is far more time consuming and disrupted when compared to road transport. As maritime transport are far more environmentally friendly than road transport, this is a bad side effect of the current lack of cross-border governmental integration and calls for further global initiatives.

Acknowledgments

The authors also gratefully acknowledge INTERREG OKS for financial support of the project as well as the case company for sharing the information with us.

Disclaimer

The views expressed in this paper are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

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