

# Digitalization of Sea Transports – Enabling Sustainable Multi-Modal Transports

Full Paper

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## Abstract

*In today's industries requirements are put upon that the different actors integrate their performance for the purpose of the transportation system as a whole. Door-to-door processes, seamless integration, and multi-modal integration are expressions for such movement where the requirements of the beneficiaries are put at the core. Digitalization could enable such movement. For mid- and long-range transports, sea transports has proven to be a sustainable mean of transport, but it needs to be integrated in a larger transport chain to reach its full effects. In this paper the concept of Sea Traffic Management is introduced as a way to enable integration by an increased degree of digitalization in the shipping industry and further on to the transportation system as a whole. By looking upon sea transports from a multi-organizational point of view and episodic coupling, information sharing processes in which actors' intentions and performances (states) are shared, has been identified.*

## Keywords

Sea Traffic Management, Data Streams, Value Chain, Value Network, Episodic Coupling

## Introduction – Digitalization for Sustainable Sea Transports

Empowered by digitalization, traditional industries become reconfigured and there relies great opportunities to meet goals that stretches beyond the desires of the single organization (Adner, 2006). As more and more devices become connected, new business opportunities arise. On the other hand this connectivity also require that engaged co-producing actors take a joint stance for the production of value for the beneficiaries they share. This is in order to avoid sub optimization and fragmented distribution of value to the beneficiaries they serve all together. Typically, the transport industry builds upon that multiple producers create value in a coordinated and integrated way for beneficiaries in order to meet the increasing demands in multi-modal transportation processes. Due to the legacy of the maritime industry enhanced collaboration enabled by digitalization is to be promoted (IMO, 2013).

As sea transports have become an environmentally sustainable transport mean for mid- and long-term transports, this type of transport need to be integrated in a larger transportation chain (IMO, 2013). Sea transports, and the multi-modal transport chain as a whole, do however need to meet the three pillars of sustainability (c.f. e.g. Elkington, 1988) by seamless integration and integrated performance. However, the legacy bound to today's processes in the shipping industry stretches many 100 years back in time where much of the logic is built around the fact that “the earlier you arrive to port the better quality of the tea will be loaded onto your vessel”. Much of the contracts of today involving shipping companies build upon this logic resulting in that vessels gather outside the port and wait until possibilities to berth are given. If the vessel needs to wait, means that it, in some cases, could have been driven more slowly and thereby reducing the consumption of bunker. From a sustainability point of view this means that the environment is polluted more than necessary and that the business revenue for a particular sea transport become lower than necessary.

Supported by a cost benefit analysis an average reduction of 1% sailed distance per ship within the Baltic Sea Region, would save approximately € 100 million on a yearly basis for traffic sailing in the region. Approx. half of the savings are due to less emissions cost for society, and the other half are fuel and other costs for the ship owners (Andersson & Ivehamar, 2014). Baltic Sea traffic makes up approx. 10% of the

European total sea traffic (Stnkiewicz et al, 2010), and these findings give an indication of the potential savings within European shipping and further on for the global shipping industry.

However, even if the business logic would be changed to that mariners were driven by contracts prioritizing just-in-time operations and avoiding unnecessary waiting times, other actors in different process steps would need to provide solid predictions of when value-adding services could be provided. This especially concerns (marine) ports that regulate when vessels are desired and expected to be at berth. Due to that many ports of today lack estimation for the vessel departure from berth, predictions for approaching vessels becomes a challenge. Such increased knowledge can be enabled by digitalization by actors sharing information to a larger degree. Today, a lot of digital data streams exist in the shipping domain, yet there are no standards for these streams and no central directory for locating them and the associated documentation.

The purpose with this paper is to provide an understanding of challenges that the shipping industry is facing and how digitalization can be used as a mean for meeting a higher degree of sustainability. The empirical basis for the paper is founded in the authors' efforts in acting as action- and design researchers in the design, realization, and evaluation of Sea Traffic Management (STM) within the MONALISA 2.0 (ML) project ([www.monalisaproject.eu](http://www.monalisaproject.eu)). The research is case driven guided by a theoretical lens based on a perspective, and related to the IS discourses, on multi-organisational business processes and episodic tight coupling. STM has the overall goal of contributing to more safe, environmentally sustainable, and operationally efficient sea transports. Taking the possibilities from digitalization for the purpose of sharing information enables STM.

Following this introduction a theoretical lens will be provided covering value chains in value networks governing integrated performance in multi-organizational business processes and episodic coupling. Then, STM as a coordinative approach for just-in-time operations in shipping and its interface to port operations will be introduced. This is followed by the identification of challenges and possibilities with digitalization in enabling just-in-time operations related to shipping. The same section also covers the role of digital data streams for enabling distribution of data throughout the transportation system contributing to a higher level of integrated performance. The paper is concluded by some reflections on how value creation by value chains in value networks could be empowered by digitalization.

## **Theoretical framework**

### ***Value Creation in Multi-Organizational Business Processes***

Within the management literature different ways of framing value creation have been proposed (Peppard & Rylander, 2006). Initiated by Porter (1985) the value chain model was the first step towards portraying the "chained linkage of activities that exist in the physical world within traditional industries, particularly manufacturing". Taking this point of departure the different steps that a sea voyage could be divided into (including port operations) would be one natural conception of the physical transformation that is covered by moving goods and/or people from one location to another.

This manufacturing metaphor has however been challenged by numerous scholars looking upon networks (c.f. e.g. Allee, 2000; Håkansson & Snehota, 2006) and thereby introduced the notion of the value network concept: "The focal of the value chain is the end product and the chain is designed around the activities required to produce it. The logic being that every company occupies a position in the chain; upstream suppliers provide inputs before passing them downstream to the next link in the chain, the customer. With the value network concept, value is co-created by a combination of players in the network." (Peppard & Rylander, 2006, pp. 131). The process of sharing information becomes an important enabler for such co-creation of value. In contrast to a focus on the role of the single company in a value chain, this shift from value chain to value network, put focus upon the value-creating system itself in which several actors co-produce value. Due to the distributed nature of sea transports, with autonomous actors, there is a need to adapt a multi-organizational perspective in which each actor's role is positioned in the overall value creation.

Contrary to the value chain, a value network consists of specific roles and value interactions oriented towards the achievement of a particular task or outcome. The notion of relationship is the key in value networks. "From a network perspective relationships are viewed as part of a larger whole – a network of

interdependent relationships [...]. These relationships are ‘connected’ since what happens in one relationship affects positively and negatively in others.” (Peppard & Rylander, 2006, pp.133). The value network perspective is promising, but do however reject a value chain perspective, by e.g. claiming that “is it not of interest to focus upon actions performed in business processes”. Allee (2000, pp. 439) claims “Value network analysis provides an opportunity to overcome the “split” in business management practices where human interactions and relationships reside in one world of models and practices and business processes and transactions reside in another”. A value network is therefore to be seen as “any purposeful group of people or organizations creating social and economic good through complex dynamic exchanges of tangible and intangible value” (Allee, 2000, pp. 429). Allee (2000, pp. 439) further claim that “reorienting toward networks means supporting people in wearing different ‘hats’ and filling roles in multiple value creating networks”.

It would however be natural to combine these two since both have their merits. The value chain perspective provides a structure for changes in the physical world, while the value network ensure essential relationships to meet the expectation of changes in the physical world. Building on both these complementary views on creating value, a multi-organizational perspective conceives value creation structured as value chains in value networks, meaning that value are created both in actor relationships, in interactions, and in the actions performed. A multi-organizational perspective on value creation in business processes argues that all these value components and their interrelations are required to conceive value creation in multi-organizational settings. Multi-organizational business processes builds upon that different organizations, by undertaking different actor roles, co-produce value. A multi-organization perspective does thus have to build on a pragmatic conception on business processes, reflecting both transformative and coordinative dimensions of organizational work, the definition of a multi-organizational business process reads as follows. Confer Haraldson & Lind (2010; 2011ab) for further elaboration on the conception of multi-organizational business processes).

### ***Episodic Coupling***

As claimed above “connected” relationships are essential. However, as the shipping industry, and many other industries, build upon that each actor involved in producing value are autonomous rational agents it cannot be guaranteed that the relations are connected over time. It has been claimed that the shipping industry is a complex adaptive system (c.f. Cashili & Medda, 2012) with a large number of self-organizing autonomous agents where there exists variation in coupling (from loosely to episodic tight coupling). We conceive relationships as expectation of future acts based upon historical interactions. In shipping the captain of the ship is the master and also responsible for the vessel propulsion. This would mean that different couplings would exist between the different actors over time. Watson & Boudreau (2011) have formulated the principle of episodic coupling as follows: “The disparate systems and individuals within society can coordinate their actions through the sharing of information about those episodes when they want to interact, such as catching a bus, going to the cinema, and finding a convenient flight. The two entities want to coordinate their actions for an episode or an event”. This means that the distribution of data about intentions, as e.g. when certain waypoint is expected to be reached, becomes essential together with status updates, as e.g. when a waypoint is reached. Watson & Boudreau (2011) further claim “having the ability to learn what other entities are doing across a wide variety of timelines, from seconds to years away, enables people and enterprises in a highly decoupled society to coordinate their actions. Often this coordination is invisible to one of the parties, and there is no reason for it to be visible”. This would then mean a need for integration between the different actors, such as e.g. the vessel operator and the port of destination. This would however mean that agreements need to be made upon measures to share data about and that these measures have the same meaning for participating actors.

Watson & Boudreau (2011) further claims that “inter-organizational systems typify episodic coupling. By sharing data, firms can create tighter coupling of their activities. Just-in-time (JIT) is one of the well known applications of episodic tight coupling. Firms in a supply chain share their input needs for a specific time so that suppliers can deliver as needed.”

## The concept of Sea Traffic Management (STM)

### *Increased collaboration and information sharing by STM*

Sea Traffic Management (STM) is a proposed concept for enabling a higher degree of integrated performance within the sea transport system. Its goal is to increase safety, environmental sustainability, and operational efficiency of sea transport. STM relies upon involved actors sharing their short- and long-term intentions (e.g., estimates of when a state is to be reached) as well as information about reached states. STM is realized by four key concepts (c.f. Lind et al, 2014); 1) **Strategic Voyage Management (SVM)**, 2) **Dynamic Voyage Management (DVM)**, 3) Collaborative Decision Making within and in relation to ports (**PortCDM**), and 4) **Flow Management**, all supported by a fifth concept; 5) a sea system **wide information management (SeaSWIM)** sharing of data in a common information environment and structure (e.g., Maritime Cloud, digital data streams, and Open Bridge Platform (OBP) (c.f. Lind et al 2014). The content and development of these technologies have been inspired from the SESAR program and Airport CDM, which contribute to greener, safer, and more efficient flight operations (EU, 2014). STM requires the engagement of many actors. Important enablers are an increased degree of connectivity, increased possibilities of digital collaboration, seamless interoperability between systems, and highly distributed coordination (i.e. each actor taking responsibility for its actions) in sea transportation. This is enabled by episodic tight couplings. This presents an opportunity to move away from a traditional approach to traffic management with a central governance unit. STM will involve and engage multiple actors on multiple levels and will require new procedures for information sharing in a distributed manner within each stakeholder's action scope. Adopting such a modern approach to traffic management, as proposed by STM in ML, enables and requires that each involved actor is engaged as a *traffic management co-producer*. Consequently sea STM will be performed on different actor levels contributing to the overall performance of the transportation system. The co-production of STM will be designed to enable the involved actors to optimize their operations. Such optimization, both for the performance of individual actors and for the integrated performance of the transportation system as such, requires stakeholders to share relevant information related to a *shared common object* of interest (Adner, 2006).

Transportation systems are ecosystems involving different actors performing different tasks based on episodic shared common objects and actions of interest. The common object of interest in STM is efficient, safe and sustainable sea transport. While the various stakeholders share this common interest, they interact episodically. The shipping industry operates as a series of episodically tightly coupled events when parties tightly coordinate their resources and then return to operating independently or tightly couple with another party. The involved actors have to arrive at a consensus regarding the performance targets that govern the performance of the different focus *areas*. As mentioned previously, three areas of focus are *safety*, *environmental sustainability*, and *operational efficiency*. Furthermore, performance targets within one area affect performance targets of other areas.

Consequently STM, as conceptualized in ML, explores alternatives to a centralized Sea Traffic Coordination Centre. Even though ML is inspired by Air Traffic Management the objective of ML is to contribute to the establishment of a distributed traffic management rather than rely on a "EuroControl" for Sea Operations. Such a distributed approach recognizes that the culture and history of shipping results in that the various parties have a high degree of autonomy, which is anathema to centralized control and command. A distributed data sharing design also gives room for new actors to enter the domain by providing new services building on data made available from the various stakeholders. Hence, STM favors a cooperative and coordinating model of data sharing which fits the historical *modus operandi* and culture of shipping.

As inspired by Svallvåg 2013 (Södahl et al, 2013), information sharing for STM in Intermodal Sea Transport could be expanded to include other transport means and thereby cover multimodal transport processes. Hence, STM needs to become an integral part of the (distributed) management of the total chain of operations in multimodal transportation processes. The proposed distributed data sharing design can readily accommodate the inclusion of more stakeholders as higher levels of integration are sought.

Inspired by the definition of e-Navigation by IMO, the initial STM definition by the Swedish Maritime Administration, and the thoughts of modern traffic management as a distributed phenomena, the

following definition of STM (Lind et al, 2014) is proposed within ML 2.0: **Sea Traffic Management (STM)** is a concept encompassing all actors, actions, and systems (infrastructure) assisting maritime transport from port to port. STM is a part of the multimodal logistics chain, encompassing sea as well as shore-based operations. STM is a network-based approach for optimal Intermodal Sea Transport. STM is performed on multiple actor levels, where each engaged actor co-produces traffic management. These actors contribute to the integrated performance of the realization of the performance targets of intermodal Sea Transport as the shared common object of interest of the ecosystem constituting Sea Transport. STM puts an emphasis on interoperable and harmonized systems allowing a vessel to operate in a safe and efficient manner from port to port with a minimal impact on the environment. STM secures sea traffic flow and capacity optimization.

### Information sharing processes in STM

Various operational (acting) units, key actors, are engaged in sea transportation, where all operations highly influence the performance of the ecosystem as a whole. Each operational unit is seen as a “point of interest” collecting several actors acting on behalf of this “point of interest”. Examples of “point of interests” related to STM are vessels, ports, authorities, and ship-owners. These points of interests involve numerous actors that provide and utilize information to perform their tasks. Optimally, each operational unit manages data sharing between different actors by collecting information from providers and enabling information utilizers to access needed data. This means, for example, that ships would collect all relevant information from different sources on-board (e.g., the engine, the bridge etc.), distribute the obtained information to different personnel on-board the vessel as well as to other operational units on other vessels or onshore. Collaborative data sharing by all parties is an essential key success factor. An ecosystem, where the performance of an individual party relies on the integrated performance of different entities, requires information to be exchanged between entities efficiently and seamlessly (Lind et al, 2014).

The voyage order is the backbone of the process of information exchanges within STM (Figure 1). A particular voyage is initiated by a voyage order directed to the vessel from the operator (e.g., the shipping company or the charterer). This order includes a unique voyage number (Voyage-ID), which will be used to identify the voyage, and store information related to its performance, throughout its different steps. Access rights will be granted to different actors to the data associated with a voyage. This is done based on who is involved with the specific voyage (the relevant Sea Traffic Coordination Centre (STCC), VTS, ports etc.). This means, for

example, that the relevant STCC will automatically have access to relevant data for vessels with a route passing through its area of operation.

For the vessel operator, the voyage order forms the basis for providing a dynamic voyage plan transferred through a Maritime Cloud (based on information in the ECDIS system). The design idea of STM is that this dynamic voyage plan is published in a maritime cloud (supported by SeaSWIM). Additional information related to the voyage is continuously

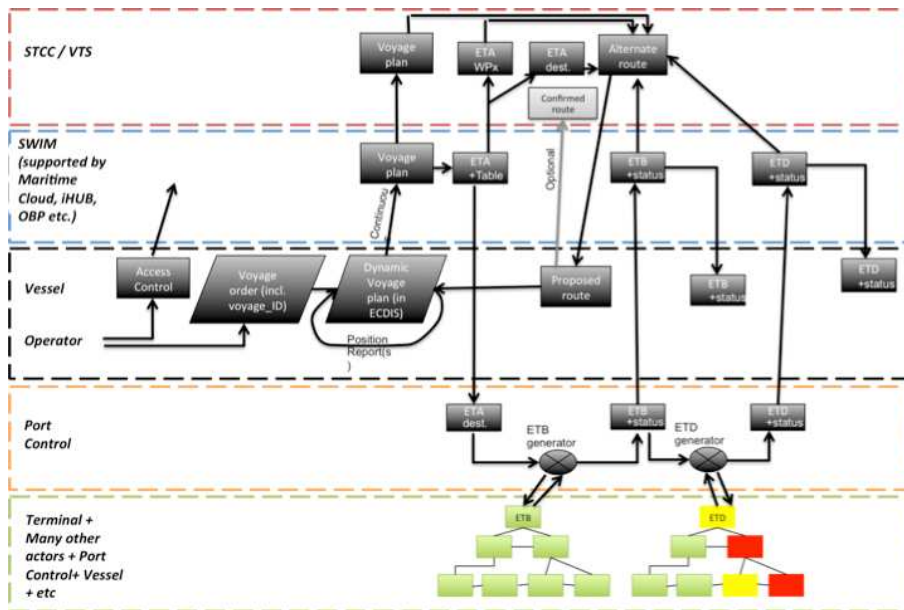


Figure 1: Information sharing processes within STM (c.f. Lind et al, 2014)

updated/ confirmed through continuous automated position reports, also leaving the necessity for noon and arrival reports obsolete. This dynamic voyage plan also consists of several ETA, as an ETA-table, for different waypoints as well as the ETA for the destination.

In STM this (published) dynamic voyage plan (including the ETA-table) is used as basis for a STCC to propose optimized route (including time slot allocation with speed adjustments) for the vessel to take in order to reach its destination at the expected time. Proposed routes from the Dynamic Route Planning Process (managed by a STCC) and other influencing factors are the basis for updating the dynamic voyage plan (potentially this proposed route is also confirmed back to a STCC by the vessel). Note that STCC is one basis for providing optimization of the voyage plan. The Captain and the shipping company might also use other suppliers of information for voyage optimization. This means that the decision of changing a published voyage plan will be made by the Captain. The port of destination will subscribe to data that are related to the port. The time of when the first ETA notification reaches the port, triggers the “ETB (Estimated Time of Berth (ALL FAST)) generator” to generate an instance of an ETB tree. In parallel, the “ETD (Estimated Time of Departure) generator” generates an instance of an ETD tree. Actors subscribe to relevant measures enabling them to bid for, agree upon, and plan for future operations.

**Integration towards port operations**

Ports, serving as departure and arrival hubs for different means of transportation, require a coordinated transportation system addressing the goals of the transport system as a whole with smooth and seamless operations at sea, at port (reaching the port, departing from port, performing loading and unloading operations –and sometimes other maintenance and extraordinary administrative tasks) as well as connections to hinterland transportation.

Seamless and sustainable transport enabled by STM requires a collaborative port. Inspired by airport CDM, PortCDM has been identified as a key enabler for reaching the full potential of STM. The purpose of PortCDM is to provide a basis (processes, content etc.) for the collaboration between key actors within the port and between the port and its surroundings. The overall goal of PortCDM is to support just-in-time operations within ports and in relation to other actors being coordinated by an efficient and collaborative port. PortCDM constitutes the interface between ports and STM. One driver for PortCDM is to enable high accuracy in predictability leading to, among other effects, optimal berth productivity (as the number of cargo operations divided by the time at berth) (Tirschwell, 2013). Thus, essential boundary objects between sea and port are Estimated/Actual Time of Berth (ATB/ETB) and Estimated/Actual Time of Departure (ATD/ETD). ATB is defined as the time when the vessel is All Fast (at berth) and ATD as the time when the vessel is All Loose (from berth) (see above). Governance towards ETB and ETD give rise to green / slow steaming as well as reducing unnecessary waiting times enabling substantial environmental and financial effects.

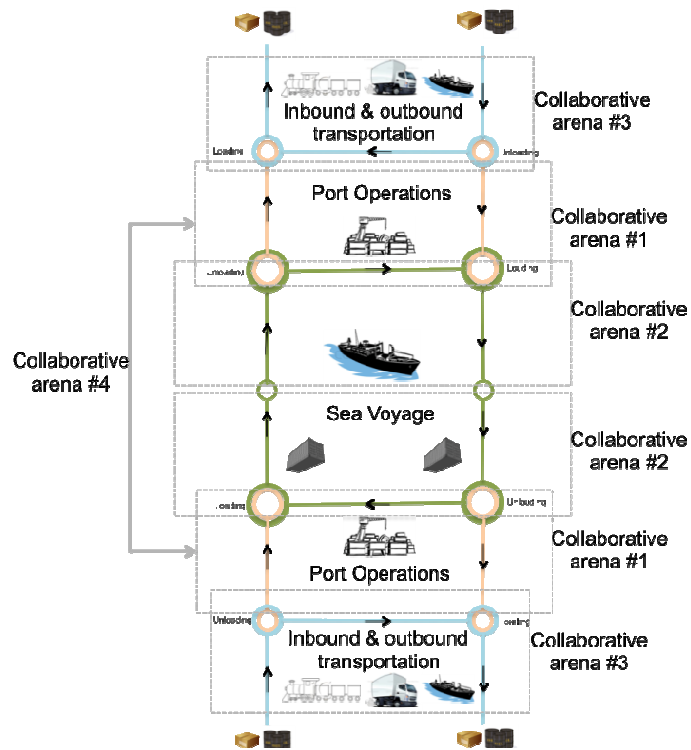


Figure 2: Four collaborative arenas for multi-modal integration

PortCDM functions for enabling four collaborative arenas enabling sustainable transports as a whole (c.f. Figure 2) (Lind et al, 2014). Within each collaborative arena, PortCDM should support the development of efficient operations (e.g. integrating processes in the port (collaborative arena #1) so that the port is prepared for arriving ships, creating conditions so that a sea voyage will be as efficient as possible (just-in-

time arrival) (collaborative arena #2) etc.). PortCDM, as a common measurement, collaborative decision, and information sharing system would support the integration of different processes and enable areas of collaboration to be performed with high efficiency resulting in just-in-time operations within and between the collaborative arenas.

PortCDM builds upon different measures used as a basis for information sharing and making agreements around, such as Estimated Time of Arrival (ETA) and Estimated Time of Departure (ETD), where the overall goal is to arrive as close as possible to the provided ETA ( $ETx - ATx$  should be as close to zero as possible). The resulting deviation represents the predictability of the port as such (as a representation of an ecosystems of actors), and represents a measure of how well a port performance in a synchronized transport chain (enabled by STM). This in turn would enable different actors to optimize their operations and their utilization of physical infrastructure and variable resources. To reach the full effects of STM, and thereby enable sustainable sea transport processes, high accuracy (based on systematic estimation procedures) related to berthing, unloading, loading, and departure, becomes necessary. Reliable estimates for a sea voyage can be established by enabling high accuracy of the arrival, operations at port, and the departure of a vessel. Different planning horizons are associated with different levels of tolerance for deviation between the estimated and actually reached state (the outcome) as depicted in figure 3 (Lind et al, 2014b). The deviation should be diminishing with time; the closer to the Execution Phase the smaller the tolerance for deviation should be, until the actual moment of occurrence is reached for a certain state. This allows for the planning process, performed by the different actors, with different time horizons (i.e., long-term, mid-term, and short-term planning) to be performed optimally, based on information about the interval of the outcome (e.g. a time span of when a certain state is reached). Sea transportation is a multi-organizational business with numerous actors positioning and coordinating their performance in relation to different control points. In line with the ambitions of the ML project and amongst other factors, STM will be realized by sharing information about the status and values related to identified control points for a particular voyage.

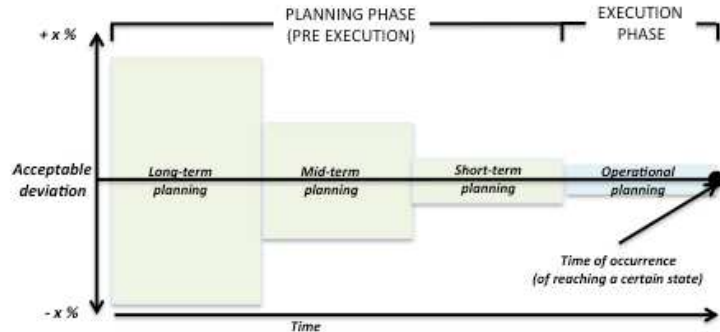


Figure 3: Acceptable deviation between estimate and actual occurrence (in different time slots)

## Enabling integrated performance by digitalization

Vessel movements within EU waters, or anywhere in the world for that matter, generate a flow of information in the various stages of each single movement. For instance, information is often required by Vessel Traffic Services, Custom Authorities, and Ship and Cargo Owners. This creates a heavy administrative burden. Information also flows among vessels moving within the same geographical area (Brödje et al, 2010). At the core of the information flow is most commonly the ships master, which is best visualized in figure 4 (Svedberg, 2013). The shipping master is at the core of the current information flow within the shipping industry. This is a heavy and time-consuming burden for a ship's master. Handling this information flow competes for the master's attention to such critical tasks as navigational safety.

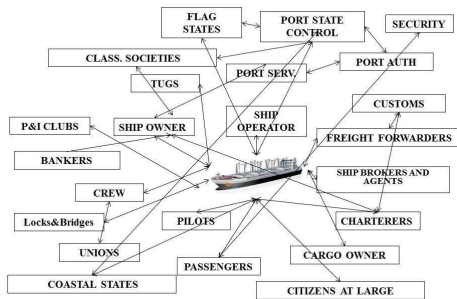


Figure 4: The information flow to/from a vessel

A vessel's voyage information is produced as well as held by a number of institutions, organizations, and individuals. These stakeholders all have different and sometimes diverging interests in the shipping industry (Österman, 2012) due to their various areas of business. The ship's master often facilitates the information flow between these stakeholders while the ship is at sea. As the ship nears its port of destination, the information flow often moves somewhat towards a shore based ship agent. In both cases,

most information commonly retrieved and distributed manually by the use of emails and phone calls. The digitization of shipping information is very much in its infancy. At sea, satellite communication is used and often sparingly because of the cost.

In order to enable integrated performance the approach adopted for distributed exchange/sharing of real-time data using data streams relies on the following design principles. The development of these design principles has been informed by Watson (2014) contextually adopted to the maritime sector (c.f. Lind et al, 2014). Inspired from the aviation sector the concept framing this approach has been coined as system wide information management (SeaSWIM):

- *Digital data streams can be open, proprietary, or hybrid.* The digital infrastructure adopted cannot rely on a fully open data architecture. The intentions and performance of ship-owners operations can represent the competitive edge of the company thus such data can be very sensitive.
- *Common standardized data format for all data streams in a common repository.* A data stream that is SeaSWIM-enabled (i.e. connected to SeaSWIM) must provide data according to the (SeaSWIM) defined data standard.
- *Standardized API for accessing data streams to support interoperability.* A data stream provider must provide a stream according to standardized definitions via a standardized SeaSWIM API. A fairly comprehensive inventory of needed data services enabled by SeaSWIM should be exposed.
- *Accessibility: The data stream owner should govern the data access.* The provider of the data assigns and manages access rights for a specific use of the data distributed in data streams, such as the voyage, to the requestor. Subsequently, there is a need for a central repository of actors, which can be used by the data provider to assign access rights for the use of the data (i.e., by whom it should be used and under which conditions).
- *Discoverability: The existence of a data stream should be informed by a discoverability mechanism.* SeaSWIM should contain mechanisms allowing a requester to learn about available data streams and access procedures. There is thus a need for a mechanism pointing at the existence of, and how a particular data stream can be found (e.g. data on a specific voyage, geographic area or port). The discovery mechanism should automate connectivity to the desired data stream.

## Conclusions – the role of digitalization in value creation

As claimed by Watson & Boudreau (2011) “information enables episodes of self-managed episodic tight coupling in a society whose constituent elements are highly decoupled”. By adopting a multi-organizational perspective and structures for enabling single reporting and by that reducing the administrative burden, enabling continuous updates on intentions and state changes, sharing of real time data in the right time through data streams, and meeting the challenges with episodic connectivity (due to that the vessel is not continually connected). A higher degree of openness and transparency, and supported by data streams, marketplaces for bidding and agreeing on assignments, is expected to become established. As explored in this paper an increased degree of digitally shared information supported by STM looks at creating the following effects:

- higher berth efficiency by enabling that ETD – ETB is performed as fast as possible by the initiation as early as the first voyage plan is submitted and published.
- the status of the planning / agreement process concerning ETB and ETD will be published continuously for others.
- actors enabling berthing (with the state of “All Fast” as the end state of berth) and Departure (with the state of “All Loose” as the end state of Departure) would be committed to established terms of condition enabled by an open market place.
- green steaming would be enabled by route optimization and highly accurate ETB and ETD.
- higher accuracy of ETB and ETD enabling management of multiple instances of berthing and cargo operations in a seamless and smooth way.



Based on this paper it is to be acknowledged that the IS-community have substantial contributions for the development of a sustainable shipping industry empowered by digitalization. The research discussed in this paper is pointing at the necessity to empower multi-organizational collaboration enabled by an increased systems interoperability, processes for episodic tight coupling, and data streaming. As basis for further research the notion of these concepts should be explored in a maritime informatics setting whereas the application of these concepts would provide additional empirical basis for the scientific development within these discourses in the IS-community.

## REFERENCES

- Adner R. (2006) Match Your Innovation Strategy to Your Innovation Ecosystem, Harvard Business Review
- Allee V. (2000) Reconfiguring the value network, Journal of Business Strategy, July/August 2000
- Andersson, P., Ivehammar, P.. (2014). Economic Impacts - Cost Benefit Analysis of Implementing Dynamic Route Planning at Sea. Norrköping, Sweden: MONALISA Project Bureau.
- Caschili, S., & Medda, F. R. (2012). A review of the maritime container shipping industry as a complex adaptive system. *Interdisciplinary Description of Complex Systems*, 10(1), 1-15.
- Elkington, J., (1998). *Cannibals with Forks: the Triple Bottom Line of 21st Century Business*. New Society Publishers
- Håkansson H., Snehota I. (2006) No business is an island: the network concept of business strategy. *Scandinavian Journal of Management* 22(3), 256–270.
- Haraldson S., Lind M. (2010) The Emergence of a Multi-Organizational View on Business Processes – Experiences from a Double-loop Action Research Approach, AMCIS, Lima, Peru, August 12-15, 2010.
- Haraldson S., Lind M. (2011a) Value Chains in Value Networks: A Multi-Organizational Business Process Definition, Australian Conference on Information Systems, Australia
- Haraldson S., Lind M. (2011b) Dividing Multi-Organizational Businesses into Processes: Capturing Value Creation in Assignment Structures, Australian Conference on Information Systems, Australia
- IALA. (2008). *IALA - Vessel Traffic Services Manual*. Saint Germain en Laye, France: International Association of Marine Aids to Navigation and Lighthouse Authorities.
- IMO. (2013). A concept of sustainable maritime transportation system. Retrieved 2014-08-30
- IMO. (2014). AIS transponders. Retrieved 2014-06-11, 2014
- Lind M., Brödje A., Watson R., Haraldson S., Holmberg P-E., Hägg M. (2014) Digital Infrastructures for enabling Sea Traffic Management, The 10th International Symposium ISIS, Hamburg
- Peppard J., Rylander A. (2006) From Value Chain to Value Network: Insights for Mobile Operators, *European Management Journal*, Vol. 24 (2-3), pp. 128-141
- Porter M. E. (1985) *Competitive Advantage – Creating and Sustaining Superior Performance*. Macmillan, NY
- Södahl, B, Hanning, A., Hult, C., Garne, K., Hindrum, K.. (2013). *Svallvåg 2013 - Svensk maritim forsknings- och innovationsagenda*. Gothenburg, Sweden: Chalmers University of Technology.
- Stankiewicz, M., Backer, H., Vlasov, N. . (2010). *Maritime Activities in the Baltic Sea – An integrated thematic assessment on maritime activities and response to pollution at sea in the Baltic Sea Region* *Baltic Sea Environment Proceedings*. Helsinki, Finland: Helsinki Commission.
- Svedberg, U. (2013). *Sharing of Complex Maritime Information*. Paper presented at the e-Nav Underway 2013, Copenhagen, Denmark.
- Tirschwell, R. (2013). *Key Findings On Terminal Productivity Performance Across Ports, Countries And Regions*. New Jersey, USA: JOC Inc.
- Watson, R. (2014). *Are You Ready to Profit from Real-Time Digital Data Streams?* MIS Department. University of Georgia.
- Watson, R. T., & Boudreau, M.-C. (2011). *Energy Informatics*. Athens, GA: Green ePress.
- Österman, C. (2012). *Developing a Value Proposition of Maritime Ergonomics*. (PhD), Chalmers University of Technology, Gothenburg, Sweden.