

Carlos Jahn | Sebastian Saxe

# Digitalization of Seaports – Visions of the Future



# **Digitalization of Seaports – Visions of the Future**

Contact address:

Fraunhofer Center for Maritime Logistics and Services CML  
A unit of the Fraunhofer Institute for  
Material Flow and Logistics IML  
Am-Schwarzenberg-Campus 4  
21073 Hamburg, Germany  
Telephone +49 40 42878-4451  
Fax +49 40 42878-4452  
E-mail [info@cml.fraunhofer.de](mailto:info@cml.fraunhofer.de)  
Website [www.cml.fraunhofer.de](http://www.cml.fraunhofer.de)

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Fraunhofer Information-Centre for Regional Planning and Building Construction IRB

P.O. Box 80 04 69, D-70504 Stuttgart

Nobelstrasse 12, D-70569 Stuttgart

Phone +49 (0) 7 11/9 70-25 00

Fax +49 (0) 7 11/9 70-25 07

E-Mail: [verlag@fraunhofer.de](mailto:verlag@fraunhofer.de)

URL [www.verlag.fraunhofer.de](http://www.verlag.fraunhofer.de)

Dr. Sebastian Saxe

Prof. Dr.-Ing. Carlos Jahn

Editors

## **Digitalization of Seaports – Visions of the Future**

FRAUNHOFER VERLAG

## Preface

### Frank Horch

Senator for the Ministry of Economy, Transport and Innovation of the Free and Hanseatic City of Hamburg



Dear readers,

Society and business world are currently undergoing a digital transformation and all areas of life are influenced by advancing digitalization. Everyone knows and experiences this development. Societies and economies have undergone various transformations throughout history. Already in the 1980s, computerization and the implementation of different data processing systems created the basis for the information age and digitalization. Societal changes are nothing new. Also, the much-discussed disruptive elements of new technologies can be included in the process of 'creative destruction', which the well-known economist Joseph Schumpeter already described in 1942.

Nevertheless, the process of digital transformation implies new qualities. The acceleration of innovation speed enabled by the technological connection of people and objects, the enormous potential of data collection and analytics, and the mobile accessibility to literally any place in the world holds possibilities that we as a society and as economic actors have to develop.

I am convinced that a smart digital transformation will significantly contribute to our prosperity. Through future-oriented policies and innovations we are already shaping this development. Due to the digital transformation's great potential for change, we must continue to intensify our efforts in the future. The digital transformation requires that we discard blinders, leave old paths, and develop new solutions.

This book deals with these new directions. It describes the impacts of digital change on maritime logistics. Worldwide trade and global logistics flows are already experiencing changes resulting from the digital transformation. It creates new parameters for transparency, efficiency and collaboration opportunities, which holds great potentials for all actors involved. This is particularly true for ports as global logistics hubs. Against this backdrop, the concept of the interconnected ports described in this book is an important contribution to shaping the global transformation of a whole industry.

I wish you an exciting reading!

Senator Frank Horch

**Jens Meier**

Chairman of the Management Board of the Hamburg Port Authority



Dear readers,

Digital change poses major challenges for the Port of Hamburg. Ports have always been an inhomogeneous, but closely intertwined network of shipping companies, terminals, ship brokers, freight forwarders, Port Authorities, and other commercial companies in the port industry. This applies in particular to the Port of Hamburg as a multi-purpose port. Previously, and today, the interfaces between individual actors within the port area are clearly defined. Processes have been similar for years or decades and are gradually being optimized by IT, but never completely changed. Economic activities are also characterized by long-established collaboration. Now, current developments in globalization and digitalization question these structures. New alliances are emerging and new digital business models turn old processes upside down. Well-established business models change or are even replaced by new, disruptive ones. These developments will have huge impacts on current port operations and procedures. We must therefore react to emerging megatrends in digitalization to remain competitive.

Hamburg's smartPORT initiative was a first response to this development. In order to increase the productivity of the port in a sustainable way, traffic and goods flows must become more efficient and the shore-side areas of the port should be used optimally. The evolution of the Port of Hamburg towards a 'Smart Port' has shown that collaboration, synergies and an open exchange of ideas with economy, society and politics hold enormous potential. When looking at global maritime logistics as a value chain, it becomes clear that the networking and digitalization of even only one link in the chain has an enormous development potential. However, digitalization will fundamentally change the value chains within global logistics chains.

We must therefore think further and transfer the concept of the Smart Port to the entire maritime logistics chain. In order to make the processes in the individual ports

more intelligent and efficient, it is necessary that all supply chain partners work together. Everyone is asked to contribute his part to the big picture in order to achieve the greatest possible effects. Very important is the transparency of information relevant to all processes of the supply chain. This information must be integrated into a shared platform where it is analyzed in order to identify optimization potentials. Only user specific information is distributed afterwards. In the future, digital platforms are responsible for the success and relevance of a port.

The threats e.g. produced by digital platforms based on disruptive business models from other sectors force ports to push the digitalization of processes within and between ports and to align their individual strategies with a global port strategy. Participation in the network of connected ports offers ports around the globe the opportunity to jointly influence the ongoing transformation in ports worldwide.

I hope you enjoy reading!

Jens Meier

**Dr. Sebastian Saxe**

Member of the Management Board and Chief Digital Officer of Hamburg Port Authority

**Prof. Dr.-Ing. Carlos Jahn**

Director of the Fraunhofer Center for Maritime Logistics and Services CML and Head of the Institute of Maritime Logistics at Hamburg University of Technology (TUHH)



Dear readers,

Inspired by digital pioneering companies such as Airbnb, Uber, Facebook, Alibaba, etc., customers all over the world are now looking for products and services tailored to their individual needs. At the same time, they are more impatient concerning delivery times and less willing to accept mistakes. Moreover, they are less loyal to brands and are more willing to accept new suppliers. Companies that best meet customer requirements will be the winners of this change. As a result, this leads to buyer's markets, a much stronger volatility of demand, and a greater variety of product types.

At the same time, companies are increasingly forced to align their strategy to a global market presence, also in production. The geographical shift in demand increases this complexity even further. As a result, this development requires an expansion and flexibilization of the supply chain. This concerns the coordination of the supply chain of individual components, the production as well as the distribution of the finished products alike.

The overall goal of Industry 4.0, Logistics 4.0, Port 4.0 and Maritime 4.0 and thus the goal of the Port Authorities of ports around the world is the further improvement of efficiency and effectiveness. The long-term vision is a global network of Smart Ports. It is expected to be an informal network of independent

Smart Ports, sharing real-time information concerning the maritime supply chain and fostering the development and implementation of innovations. By joining this network of Smart Ports, seaports also benefit from optimized transport flows. Exemplary methods for increasing efficiency are more transparency and higher process speed, automation of processes, and the avoidance of errors. An increase in effectiveness can be achieved by improving the flexibility and adaptability, services, processes, and products.

Agility is becoming the decisive competitive advantage in the supply chain in the Port Authorities' environment. To meet these growing requirements, supply chains need to become more agile to enable port companies in general and in particular Port Authorities to maintain their competitiveness. But what exactly is meant by the term 'agile' that is increasingly referred to as a relevant success factor for supply chains? Is it merely a hype that has already been run together with the term supply chain management 20 years ago, or is it a real change?

Agility primarily means being able to anticipate rapidly changing market and demand conditions and react immediately across the whole value-added chain. In contrast to classical supply chains, agile supply chains are therefore able to achieve the greatest possible flexibility along the value chain without adversely affecting the efficiency of the partners. Agility is based on the availability of real-time information throughout the supply chain, ensuring better collaboration and cooperation between the parties involved. Agility gives companies the opportunity to increase the flexibility of all business processes. It includes the variety of offered products, the production as well as the delivery. This leads to an increase in efficiency and thus to a growing competitiveness.

So much for the theory – but what does this mean in practice? What are the possibilities for port companies and Port Authorities, and how can these be anchored as optimally as possible in the companies? A key component is the digital transformation of processes, systems and organizations. It is only with the help of new technologies that the required networking can be established and the flood of data can be handled in an effective way.

Digital technologies become the key enablers for agility. With technologies like RFID and GPS digitalization has long been entering supply chain management in the maritime world, making supply chains more transparent, accessible, and agile. For example, already today automated vehicles find their way independently through the supply chain and can be localized in real-time. One example are automated guided vehicles (AGVs) used on the Container Terminal Altenwerder (CTA) in Hamburg. At the same time, material and information flows are synchronized across the entire supply chain – from the supplier to the retail salesmen. This increases the flexibility for all parties, costs are reduced significantly, and the speed of the supply chain is increased.

Digitalization will therefore significantly increase the procedural and organizational agility in the future. The control and planning of the supply chain is also lifted to a different level due to comprehensive information and data flows as well as the possibility of processing the enormous amounts of data generated by technologies like Big Data. In the future, real-time control will no longer be a foreign word and will enable to adapt the ever more rapidly changing needs of customers to the globally distributed production and logistics capacities in the entire supply chain as quickly as possible. The interaction of various digital technologies and processes pushes the maritime supply chain to a new level. Agility becomes reality. Digitalization plays a decisive role in the implementation of agile value chains in ports worldwide.

### **Digitalization - the key challenge**

Digital technologies are the basic prerequisites for the implementation of agile digital structures across the whole supply chain. The technologies these enablers are based on have already been discussed for a long time and have been used widely. Cloud computing and Big Data solutions are on everyone's lips and are already used in many areas. However, the technologies and applications are often used as isolated solutions. The expected success and penetration of these solutions in the port industry is missing so far.

The real enabler and main success factor for increasing agility is the continuity of data flows across the entire supply chain from capturing to processing and storage. This is an indispensable prerequisite for establishing real networking and realizing the resulting advantages such as real-time transparency of containers.

From our point of view, the challenge lies not only in the use of digital technologies but also in the implementation of open standards within companies as well as throughout the maritime supply chain. A first step in this direction is the initiative for the development of a global Smart Port network.

An agile supply chain can only be realized with an entire target image. Starting points for a discussion in the maritime world are the pictures of the future given in this publication.

The digitalization of the maritime supply chain and the associated effects are a broad field that requires scientific structuring and prioritization.

In projects for the customers, the Port Authorities for example often experience the fact that they are reluctant to act because they lack a framework that gives orientation and helps answering the following questions:

- What is the company's digitalization strategy?
- What products and services will the company offer in the future and what supply chain is needed?
- What are the strategic objectives of my (planned) pilot projects for digitalization?
- How do I have to align the company's processes, organization and technologies in the future in order to achieve the desired effects?

This book aims to highlight the necessity for the formulation of digitalization strategies in seaports.

Now we wish you great pleasure in reading!

Dr. Sebastian Saxe

Prof. Dr.-Ing. Carlos Jahn

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## List of abbreviations

2X	Communication to everything (Vessel-to-X, Truck-to-X, Rail-to-X)
AGV	Automated guided vehicle
AI	Artificial Intelligence
AIS	Automatic Identification System
API	Application Programming Interface
AR	Augmented reality
ASC	Automated stacking crane
ATM	Asynchronous Transfer Mode (broadband switching and transmission technology)
AV	Automated vehicle
B2B	Business to Business
B2C	Business to Customer
B-AGV	Battery-electric automated guided vehicle
BAP	Battery-assisted passive
BI	Business Intelligence
BPaaS	Business Process as a Service
BRIC	Brazil, Russia, India and China
CDMA	Code Division Multiple Access
CI	Collaborative Intelligence
CSR	Corporate social responsibility
CTA	Container Terminal Altenwerder
DaaS	Data as a Service
ECA	Emission Control Area
eCommerce	Electronic commerce
EDI	Electronic Data Interchange
EM	Electromagnetic
EPC	Electronic Product Code™

EPCIS	EPC Information Services
ESPO	European Sea Ports Organization
ETA	Expected time of arrival
EU	European Union
FDMA	Frequency-division multiple access
FCL	Full-container-load
FTL	Full-truck-load
Gbps	Giga bit per second
GmbH	Gesellschaft mit beschränkter Haftung
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HFO	Heavy Fuel Oil
HPA	Hamburg Port Authority
IaaS	Infrastructure as a Service
ICD	Infrastructure Control Department
ICT	Information and communications technology
ID	Identity
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
ISDN	Integrated Services Digital Network
IT	Information technology
ITF	International Transport Forum
LCL	Less-than-container-load
LED	Light Emitting Diodes
LiDAR	Light Detection and Ranging
LNG	Liquefied natural gas
LoRa	Long Range

## List of abbreviations

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LoRaWAN	Long Range Wireless Area Networks
LR-WPAN	Low-Rate Wireless Personal Area Network
Ltd	Limited Company
LTE	Long term evolution
LTL	Less than Truck Load
M2M	Machine-to-Machine
mCommerce	Mobile commerce
MEMS	MicroElectroMechanical System
MRO	Maintenance, Repair, and Overhaul
NFC	Near Field Communication
OFDMA	Orthogonal Frequency-Division Multiple Access
ONS	Object Name Service
PaaS	Platform as a Service
PCS	Port Community System
PDA	Personal digital assistant
PSTN	Public Switched Telephone Network
PTC	Port Traffic Center
QR	Quick Response
RFID	Radio Frequency Identification
Ro-Ro	Roll on - Roll off
SA	Société Anonyme
SAaaS	Sensing and Actuation as a Service
SaaS	Software as a Service
SCM	Supply chain management
SECA	Sulfur Emission Control Area
STS	Ship-to-shore
TaaS	Things as a Service
TCP/IP	Transmission Control Protocol/Internet Protocol