

Böse, Jürgen W.; Jahn, Carlos; Sarin, Raman

Conference Paper

Vision of a Service Value Network in Maritime Container Logistics

Provided in Cooperation with:

Hamburg University of Technology (TUHH), Institute of Business Logistics and General Management

Suggested Citation: Böse, Jürgen W.; Jahn, Carlos; Sarin, Raman (2014) : Vision of a Service Value Network in Maritime Container Logistics, In: Kersten, Wolfgang Blecker, Thorsten Ringle, Christian M. (Ed.): Next Generation Supply Chains: Trends and Opportunities. Proceedings of the Hamburg International Conference of Logistics (HICL), Vol. 18, ISBN 978-3-7375-0339-6, epubli GmbH, Berlin, pp. 87-110

This Version is available at:

<https://hdl.handle.net/10419/209202>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by-sa/4.0/>

Vision of a Service Value Network in Maritime Container Logistics

Jürgen W. Böse, Carlos Jahn and Raman Sarin

Abstract

Against the backdrop of stagnant or slow volume growth in the international container transport, liner shipping companies make considerable efforts to reduce costs and provide better service quality. Due to the strategic character of decisions associated with the implementation and reorganization of liner services, solution approaches that enable a substantial reduction of total round-trip time without appreciable extra costs are regarded as promising. For this purpose, the authors develop the idea of a Maritime Service Value Network representing cooperation among container terminals as well as at least one ship routing company and one meteorological service provider. The network aims at acceleration of container liner services with (ideally) cost-neutral operations measures. The proposed concept can provide the container terminals with considerable competitive advantages and simultaneously put the liner shipping companies in a strong position for successful integration in global supply chain networks. The full paper gives an estimate of the magnitude of existing time saving potential and the associated economic and operational impact. Additionally, a rough description of the network idea is presented and obstacles for network coordination are highlighted.

Keywords: container liner service, service value network, time savings, weather routing

1. Introduction

Stagnant or slow volume growth in many parts of the world leads to overcapacities in the maritime container transport and is associated with fierce competition among shipping companies. As a result, the companies make considerable efforts to reduce their costs and provide services differentiating them from the products offered by competitors (Asteris et al., 2012). Against this background, quality criteria of transport services are becoming more and more significant. Recent studies show that beside the meaningful criteria "freight rate", the importance of criteria like "transport punctuality and time" or "port call frequency" has increased in container shipping (e.g. Gailus and Jahn, 2013). For container terminals functioning as major service providers for shipping companies at ports, a change in vessel handling requirements arises from this development noting that the time-related service aspects are of high relevance (Lu et al., 2011).

In this regard, measures taken by a container terminal individually have a small chance to succeed due to limited controllability of factors that are relevant to the competition. Considering that the round-trip times of global liner services can amount to two months (or more) and the number of port calls partly is binary, the share of handling time of one port in the total time is just as modest as its importance for the competitiveness of the liner service. Additionally, the acceleration of vessel handling processes is not necessarily beneficial in all the cases, e.g., the dependency of a port on tides can promptly "destroy" the newly gained time advantage. In other words, isolated efforts of single terminals to improve their ability to compete by means of process acceleration might cause limited benefits in particular situations, yet this approach is far from being termed as a good or effective solution. Due to the strategic character of decisions associated with the implementation and reorganization of liner services, solution approaches that lead to substantial reduction of total round-trip time of liner vessels and induce additional costs (not relevant for competitiveness) seem to be promising.

In the light of the foregoing discussion and inspired by emerging global terminal networks of large shipping companies (Notteboom and Rodrigue, 2012), the authors develop the vision of a MARITIME SERVICE VALUE NETWORK (MSVN) consisting of container terminals, a ship routing company and a globally active meteorological service provider. The objective of the cooperation is to accelerate both vessel handling at ports and the sea voyage between them through highly cost-efficient measures. By time-related integration of accelerated processes at ports and on sea, the achievement of appreciable composite effect of time savings is ensured for the round-trip of liner vessels.

2. Loops and liner services under investigation

2.1 Structure of interregional loops and choice made

In container shipping, the origin port of a voyage ordinarily corresponds to the destination port, i.e., the vessel paths take the form of vast loops connecting specific ports in the same region (feeder or regional services) or in different regions of the world (global or interregional services). A container vessel usually calls the ports of a loop in a defined sequence being termed as "string".

		Interregional distance ¹	# loops	# ports per loop ²	round-trip time ²
Asia-Northern Europe	Nibeerik Line	19.850 km ³	4	19 ... 20	76 ... 83
	CMACGM		7	9 ... 18	70 ... 84
	Hapag Lloyd		5	10 ... 13	74 ... 75
West Coast North America-Northern Europe	Nibeerik Line	6.425 km ⁴	3	5 ... 10	27 ... 34
	CMACGM		4	5 ... 11	28 ... 42
	Hapag Lloyd		8	3 ... 12	17 ... 41
West Coast South America-Northern Europe	Nibeerik Line	10.230 km ⁵	3	10 ... 13	43 ... 49
	CMACGM		3	11 ... 15	42 ... 56
	Hapag Lloyd		2	8 ... 14	47 ... 52

¹ one way, ² from ... to, ³ Hamburg - Shanghai, ⁴ Hamburg - Newark, ⁵ Hamburg - Rio de Janeiro

Tab. 1: Characteristics of loops from and to Northern Europe (CC, 2014; HL, 2014; ML, 2014)

For analyzing the effects of acceleration measures in container shipping, the focus is on loops with ports located in Northern Europe (NE) as well as in other regions of the world. Due to the kind and volume of foreign trade of Central European countries, most and largest loops exist on the routes to Asia, North

America and South America. Table 1 shows characteristics of such loops operated by major shipping companies. The paper composes appropriate study design based on Maersk Line loops as the shipping company provides comparatively comprehensive information about its liner service network and the underlying loop structure via internet (ML, 2014). Table 2 shows the loops under investigation with few important characteristics. For each route, two loops are considered except for the Intra-European route. Always a loop with comparatively many ports and a loop with comparatively few ports are considered for each route. So the related loops primarily differ in their string length (number of loop ports) and loop length (total travel distance).

		Maersk loop								
route	region of origin	TA2	TA4	AE10	AE10 _{short}	Levant	Levant _{short}	Samba	Samba _{short}	BGF-NIT ¹
	region of destination	WCNA ¹		Far East		Near East		WCSA ²		NE
ports	# ports in origin region	3	3	7	6	3	3	4	3	4
	# stopover ports ³	0	0	4	4	5	2	2	2	0
	# ports in destin. region	9	2	9	3	3	1	7	1	0
	# loop ports	12	5	20	13	11	6	13	6	4
region of origin	total travel distance (km)	855	1.080	3.340	2.850	840	840	1.440	1.440	2.338
	avg. interport distance (km)	428	540	557	570	470	470	480	480	585
	% of travel distance	4.0%	7.6%	7.5%	7.2%	6.1%	6.6%	5.4%	6.3%	100%
region of destination	total travel distance (km)	8.280	1.665	10.960	5.600	1.730	0	4.015	0	0
	avg. interport distance (km)	1.035	1.665	1.324	2.800	346	0	809	0	0
	% of travel distance	38.3%	12.0%	23.7%	14.1%	11.3%	0.0%	15.0%	0.0%	0.0%
inter-regional	total travel distance (km)	12.460	11.180	30.835	31.175	12.660	12.670	21.395	21.395	0
	avg. interport distance (km)	6.240	5.575	5.139	5.198	3.165	3.219	5.334	5.334	0
	% of travel distance	57.7%	80.2%	68.8%	76.7%	82.6%	83.2%	78.6%	63.7%	0.0%
	length of loop (km)	21.619	19.869	44.765	38.625	15.330	13.810	26.790	22.775	2.338

¹WCNA: West Coast North America, ²WCSA: West Coast South America

³The classification of loop ports as "stopover port" is made by authors.

Tab. 2: Characteristic of loops under investigation¹

¹ AE10short: Gdansk, Aarhus, Gothenburg, Bremerhaven, Rotterdam, Port Tangier, Suez Canal, Tanjung Pelepas, Yantian, Tanjung Pelepas, Suez Canal, Port Tangier, Bremerhaven, Gdansk.

LEVANTshort: Hamburg, Alexandria, Port Said East, Salerno, Felixstowe, Antwerp, Hamburg.

SAMBAshort: Tilbury, Rotterdam, Bremerhaven, Antwerp, Algeciras, Santos, Algeciras, Tilbury.

If the Maersk Line service network does not provide an appropriate loop, the required string of ports is synthetically generated by adaptation of an existing one (ordinarily by shortening). It should be noted that the loops "SAMBAshort" and "LEVANTshort" include only one South American or Near East port respectively and as a consequence, it possesses no local travel distance in the region of destination.

2.2 Characteristics of liner services

Loops considered as sequence of ports and sea sections form the basis for establishing liner services. Due to liner shipping's nature, the vessels call the loop ports according to a given timetable associated with a certain inter-arrival time for ports (e.g. weekly or biweekly) and port call frequency. For guaranteeing a specific call frequency or aligning the throughput capacity of a liner service to regional demand, frequently several vessels operate in a loop at the same time. Furthermore, a change in vessel size is a typical measure for systematically adjusting the throughput capacity of a service to the demand. Table 3 shows main characteristics of liner services considered for analysis.

It shall be pointed out that the smaller loop of each route is operated by vessels of capacity lower than those of the larger loop. This is due to the lower interregional transport demand or number of loop ports, respectively.

Maersk service	TA2	TA4	AE10	AE10 _{short}	Levant	Levant _{short}	Samba	Samba _{short}	EGF-N17
loop nature	real world	real world	real world	synthetic	real world	synthetic	real world	synthetic	real world
no. of vessels	3	4	12	10	5	4	7	5	1
avg. vessel capacity	4.530 TEU	2.825 TEU	17.560 TEU	11.600 TEU	4.270 TEU	3000 TEU	7.780 TEU	2.300 TEU	820 TEU
avg. vessel length	290m	220m	400m	350m	260	220m	300m	220	140m
port call frequency	weekly	weekly	weekly	weekly	weekly	weekly	weekly	weekly	weekly

Tab. 3: Characteristics of liner services under investigation

Considering real world conditions, shipping companies usually use vessels of different sizes while offering liner services. For instance, the Maersk AE10 service is based on three 15.500 TEU and nine 18.270 TEU vessels.

3. Analysis of vessel acceleration measures

3.1 Liner services - status quo and assumptions made

The round-trip time of a liner vessel, i.e., the time between leaving the origin and reaching the destination port, is primarily determined by the number of ports, the travel distance between the ports, the handling performance of involved container terminals (i.e. boxes per hour and vessel), the number of containers to be handled at the ports and the travel speed of the vessel. Basically, the round-trip time is composed of three different time components: 1.) travel times (between ports), 2.) (un-)mooring times (at ports) associated with necessary times for pre-/post-processing of handling operations and 3.) the actual handling times. Regarding the travel times of liner services detailed information is presented on the Maersk Line's homepage (ML, 2014). The other two components of vessel round-trip time are not available without further ado and so some assumptions have to be made. Table 4 shows the assumptions for (un-)mooring & pre-/post-processing times of different vessel sizes being part of the analysis. They are based on both scientific findings (e.g. Chen and Huang, 1999) and practical experiences of the authors. Moreover, the actual vessel handling time is primarily determined by the terminal performance capability at quayside as well as the amount of containers to be discharged and loaded at the container terminal. Assumptions concerning the former are deduced from many years of experience authors collected in practice.

vessel capacity	820 TEU	2.300 TEU	2.825 TEU	3.000 TEU	4.270 TEU	4.530 TEU	7.780 TEU	11.000 TEU	17.580 TEU
handling performance (cont./h/vessel)	50	75	75	75	85	95	115	120	150
(un-)mooring & pre-/ post-processing (h/vessel)	0,25	0,50	0,50	0,50	0,75	0,75	1,00	1,25	1,50

Tab. 4: Time and productivity assumptions for processes at quay wall

With regard to the handling volume, it is assumed that the vessel capacity is always fully used and that the vessels are completely discharged and loaded in the region of origin and in the region of destination.

port type	ports of origin region	stopover ports	ports of destination region
TEU factor	15	15	15
container split between ports	uniformly distributed	x % of vessel capacity at all ports	uniformly distributed
vessel handling volume / port	vessel capacity * 2 / # origin region ports	x % of vessel capacity * 2	vessel capacity * 2 / # destination region ports

Tab. 5: Assumptions about the port handling volume

For reasons of simplification, the containers are to be uniformly distributed among the ports in both regions and all ports are characterized by the same TEU factor (see Table 5). Analogously, a uniform distribution of handling volume between the stopover ports is assumed. However, a certain percentage of vessel slots shall only be occupied by transshipment containers (varying between services) and reused at stopover ports.

For the Intra-European service, the assumptions made are that the vessel capacity is fully used and between 20% and 60% of loaded containers are replaced by new boxes at each port. Figure 1 shows the vessel round-trip time with its inherent time components (status quo). It can be seen that the component "travel time" represents the dominant time share for all analyzed services.

Additionally, the figure shows that the services on the same route with appreciably fewer ports are not characterized by a correspondingly lower share of handling time. Regarding the throughput capacity of a vessel's round-trip (sum of container loaded at all loop ports), the above mentioned assumptions lead to three determinants: the vessel size, the number of stopover ports and the transshipment volume being handled at these ports.

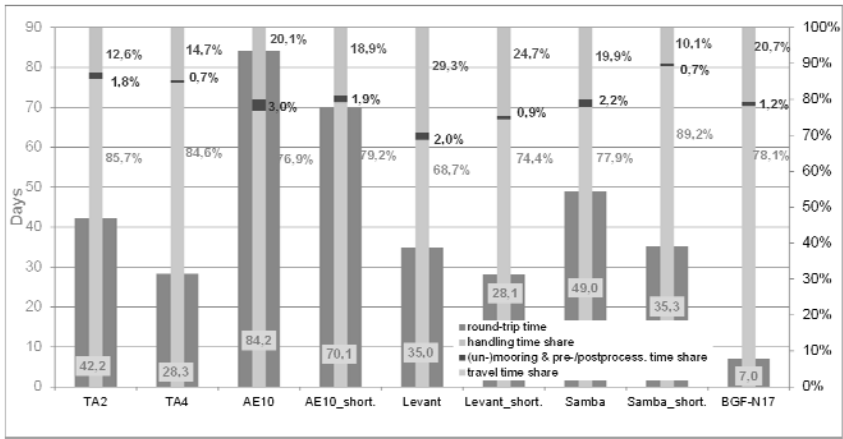


Fig. 1: Round-trip time of liner service vessels and its time shares

3.2 Cost-efficient measures for acceleration of liner services

Due to the high competition pressure in maritime container transport, both the involved liner shipping companies and the container terminals have spent a lot of effort in the recent years to improve the economic viability of their operations processes. Following, solution approaches are highlighted that are effective in achieving objectives but induce no or comparatively low extra (unit) costs. That is, the same or a similar factor input enables a noticeably higher output. Usually, organizational innovation or improvements in combination with sophisticated IT systems fulfill this requirement.

With regard to acceleration of terminal processes at quay wall, a distinction is made between approaches being associated with changes in the organizational concept and algorithm-based approaches for resource control as well as innovations measures concerning the IT systems in use. The former deals with determining the operations modes of production factors in short- and medium-term view by appropriate organizational rules or strategies, respectively. The algorithm-based approaches, in particular, are related to the use of quantitative

methods from the field of Operations Research (OR) for order-driven resource allocation and routing. Finally, the latter improves quality and quantity of the available operational data forming the basis for effective planning and control of terminal processes.

Practical experiences show that the implementation of new organizational concepts and/or basic changes in the IT landscape can lead to performance improvements in the double digit percentage range. Considering the handling processes of container vessels, the following concept-, algorithm- and IT-based Port Operations Measures for Realizing Time Savings (POM.RTS) needs to be highlighted exemplarily:

- Dual cycle operations of quay cranes: container discharging and container loading together forms single crane move (e.g. Goodchild and Daganzo, 2007; Preuß, 2012; Zhang and Kim, 2009).
- Twin-lift operations of quay cranes during discharging AND loading of vessels: a twin-lift crane move consists of two 20' containers. Highly motivated staff and a sophisticated decision support system enable twin-lift operations even during the loading process.
- Flexible pooling and dispatching of horizontal transport vehicles at quayside with the assistance of a positioning system enabling automatic localization of transport vehicles in use and orders being processed (e.g. anonymous, 2000; Ho and Liu, 2009; Kellberger and Münsterberg, 2014).
- Using transport vehicles of all the terminal areas in times of low system load for container pre-stowage close to dedicated berthing places. Thus, the travel distance of vehicles can be reduced during the actual handling process.
- Extensive cross-company integration of IT systems (between shipping companies and terminals as well as the shippers and consigners in the hinterland) increases the availability of operational data for all involved parties and thus, for example, appreciable improvements in

short-term resource planning become possible (e.g. Ilmer, 2005; Jürgens et al., 2011).

- Usually, algorithm-based resource control is preceded by changes in the organizational concept or would cause these changes. Practical experiences and scientific studies show that the application of OR methods can lead to appreciable improvements in terminal operations (but mostly in a lower range, as such, by concept change). Further information about the methods in use and their economic impact is to be found in numerous publications (e.g. Meisel, 2009; Murty et al., 2005; Park et al., 2011; Ursavas, 2014). An overview in this regard is provided by the literature surveys from for example Bierwirth and Meisel (2010), Carlo et al. (2014-a and 2014-b), Islam and Olsen (2013), Le-Anh and De Koster, (2006), Stahlbock and Voß (2008) or Steenken et al. (2004).
- Against the background, one main bottleneck in quayside operations is the horizontal transport (Saanen, 2004), it can even make sense to increase the number of vehicles, if additional units are available at the terminal and the variable vehicle costs are comparatively low. This is the case, for instance, with automated vehicles or with terminal facilities located in low-wage countries. Practical experiences show that, up to a certain extent, the arising extra costs are in a range of not being relevant for competitiveness.

With regard to time and fuel savings on the sea voyage, the topic "Weather Routing" (WR) is discussed more intensively in science and practice in the recent past (e.g. Chen, 2013; Hinnenthal, 2007; Lin et al., 2013; O'Brien, 2012; Padhy et al., 2008; Szałpczynska and Smierzchalski, 2009; Walther et al., 2014). Today, WR, in general, is understood as a particular type of vessel navigation which does not primarily align decision-making to the shortest path. WR-based navigation decisions additionally consider present and forecasted weather as well as sea conditions in conjunction with the vessel characteristics and the objectives specific to the shipping company. Considered separately,

weather and sea conditions are defined in the terms of wind speed and direction, wave height, ocean current, visibility due to fog, threatened safety due to ice-bergs and deck ice, etc. (Bowditch, 2002). Typical objectives of shipping companies being associated with Weather Routing Measures (WRM) can be multifarious, e.g. reduction of fuel consumption, realizing the estimated times of arrival at ports, realization of travel time savings or ensuring vessel safety. Against the backdrop of the paper's focus, the main interest in WRM is the reduction of travel times (more or less cost-neutral) by application of WR-driven navigation decisions. Consequently, the question arises which time saving potential can be exploited by WR. Basically, WRM for Realizing Time Savings (WRM.RTS) are very effective and provide large benefits in sea regions characterized by navigationally unrestricted water and adverse weather conditions occurring many times a year. Such conditions lead to a number of alternative route choices and make weather an essential route determining factor. Practical experiences show that the expectation of time savings in the double digit percentage range is reasonable under such premises (e.g., Gershanik, 2011; Weber, 2007). Thus, a potential for savings from the WR's point of view is particularly possible in case of longer travel distances in open seas, as is the case with intercontinental sea voyages, for instance.

3.3 Cumulated effects on vessel round-trip time - a mean valued based analysis

The explanations about the impact of POM.RTS and WRM.RTS in section 3.2 form the basis for determining the range of handling and travel time reduction being assumed for investigation. Regarding round-trip time savings induced by WRM, an average decrease of travel time between 0% and -5% is considered for all loop sections. Additionally time savings by POM are supposed to range between -5% and -25% at each of the associated ports.

Supposing that highly sophisticated POM.RTS and WRM.RTS are not yet a part of terminal and vessel operations, the changes in handling and travel time, mentioned before, are applied to all liner services being part of the analysis

(see section 2.1). In the cases in which the amount of time reduction is questionable due to the reasons discussed in section 3.2, the respective part of the diagram curve is highlighted by a dotted line. Figure 2 shows the resulting savings in round-trip time for all liner services.

For each route under investigation, the figures attest that with increasing travel distance and vessel size, the impact in savings grows as well. With respect to the number of vessels in use, the time savings become significant if they exceed the vessel inter-arrival time for the ports of a liner service. In case of time reduction in a lower range, benefits for shipping companies are there as well but in other dimensions (see below).

Due to the assumptions made in section 3.1, the (pure) number of ports in the origin and destination region has no influence on the effectiveness of POM.RTS. However, the curve profile of the service "TA2" and "LEVANT" reveals that the existence of stopover ports can gain considerable importance for success of POM.RTS. Having in mind the container throughput which is additionally induced by stopover ports on a round-trip (see section 3.1), in case of the LEVANT service, the interregional throughput volume is appreciably

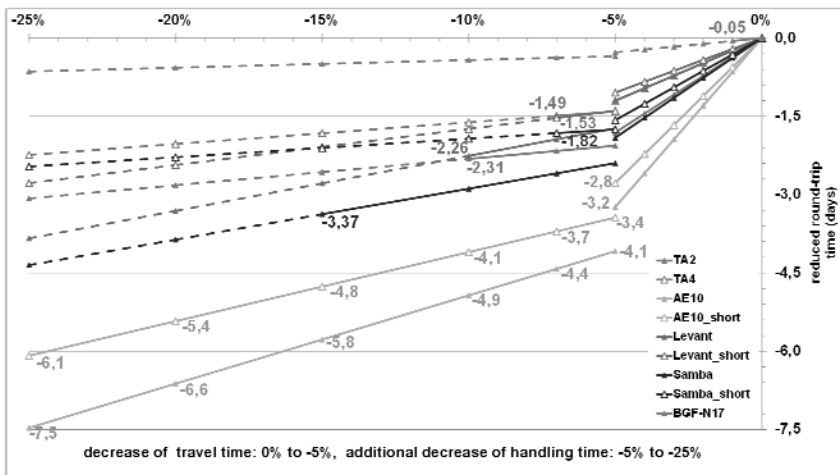


Fig. 2: Effects on round-trip time by WRM and POM

enlarged by the means of transshipment containers at the 5 stopover ports. For each stopover, a re-allocation of about 30% of vessel slots is supposed. In contrast to the LEVANT service, the TA2 service possesses no stopover ports. Basically, it should be noted that the effectiveness of POM.RTS rises with the vessel size increase and the increase in number of stopover ports or the amount of transshipment cargo to be handled at related "pit stops", respectively. Furthermore, the effectiveness of WRM.RTS is mainly determined by the length of loops and the share of open sea travel distances.

Following, the economic and operational benefit of decrease in vessel round-trip time is exemplarily explained. For this purpose, two impact cases are differentiated and possible reactions of shipping companies are highlighted: CASE a) the amount of time savings is higher than the vessel inter-arrival time for loop ports and CASE b) the amount of time savings is lower than the vessel inter-arrival time for loop ports.

- Reaction a1): For shipping companies it opens up the possibility to save a service vessel completely and keeping the same service capacity and quality as before. The resulting economic impact is tremendous. Gudehus and Kotzap (2012) estimate the charter rate of a 5.000 TEU container vessel (without fuel costs) at 23.000 US\$/day. Considering the liner services under investigation, the AE10 service allows a fleet size reduction by one vessel if POM.RTS and WRM.RTS are maximally effective.
- Reaction a2): The shipping company keeps the number and kind of vessels as they are and analogues to a1) the port call frequency rises. Associated with fleet acceleration, the annual throughput capacity of each service vessel increases and thus the annual throughput capacity of the liner service as well. Regarding the service "AE10", the port call frequency grows from 52 calls per year (vessel inter-arrival time of 7 days) to yearly 57 calls (vessel inter-arrival time of 6,4 days). Additionally, the annual vessel and liner service throughput capacity increases by 9,6%, i.e., by 12.697 containers per vessel and by

12*12.697 containers for the liner service (assuming re-allocation of 15% of vessel slots at each stopover port).

- Reaction a3): Another alternative (not discussed here any further) is to deploy the number of vessels as before and reduce the size of vessels while keeping the annual throughput capacity. As a result the port call frequency of the liner service increases, the annual vessel and liner service throughput capacity do not change and the service costs go down due to smaller size of vessels in use.
- Reaction b1): The shipping company does not change the kind and number of vessels and make use of the time savings for integration of one or more (additional) ports in the related string. Depending on the location of added port(s) the measure improves the liner service accessibility in the respective region.
- Reaction b2): Again, there are no changes in vessel use. Gains in round-trip time savings are considered as time buffer and this enlarges the scope of (re-)action for the operations management and with that improves the service punctuality.
- Reaction b3): Analogues to b1) and b2) the fleet structure is kept. The resulting time savings are used for reduction of vessel speed on sea while retaining the timetable of liner service. So slow steaming measures become possible or can be even furthered. Considering the liner service "A10short", the average vessel speed is about 16 knots (i.e. slow steaming is already applied). Using the time gained by acceleration measures for the purpose of further slow steaming, the average vessel speed can be reduced to approx. 14,5 knots without any adaptation of the liner service's timetable. According to Notteboom and Vernimmen (2009), slowing down a 10.000 TEU container vessel in this speed range leads to savings in fuel consumption of about 20 tons per day. The service "AE10short" comprises of ten 11.000 TEU vessels each with about 288 sea days (see section 3.1). Hence, liner service operations can yearly save between 57.000 tons and 58.000

tons of fuel by applying the acceleration measures suggested in this paper.

- Reaction b4) Finally, it should be noted that reaction a2) and a3) can also be applied in CASE b). To what extent the related approaches make sense or are beneficial has to be evaluated on a case by case basis.

4. MSVN - a cooperation of container terminals together with at least one ship routing company and one meteorological service provider

Considering the promising results presented in section 3, the systematic acceleration of liner vessels appears highly attractive from economic and operational point of view of liner shipping companies. A basic prerequisite for applying POM.RTS and WRM.RTS in a coordinated manner is a close cooperation among all associated parties, i.e., the container terminals located at the loop ports together with at least one ship routing company and one globally active meteorological service provider as well as eventually the liner shipping company as vessel operator and customer. Only the mutual understanding as (network) partners and the strong integration of customer enables an effective time-related integration of accelerated operations processes being necessary for achieving the maximum possible composite effect of time savings.

In this regard, it should be mentioned that the cooperation partners possess a comparatively diversified character. Nevertheless their range of services is complementary from the perspective of container liner shipping. Usually, there are no production- and competition-related interdependencies between them - if at all, container terminals located in the same region might be competitors for the handling volume arising in their hinterland.

With respect to the joint value added to customer, the tremendous complexity of logistics service as well as its generation in a modular fashion by

purposefully combining complementary core competencies of autonomously acting service providers is to be emphasized. Such characteristics are typical for service value networks already practiced by IT and Web service providers as business model (Basole and Rouse, 2008; Hamilton, 2004; Momm and Schulz, 2010) as well as existing in scientific work which includes recent publications and conference tracks in the field of information systems and technology (Chan and Hsu, 2012; Gordijn et al., 2012; Schulz et al., 2012).

Against this background, the authors consider the form of cooperation among container terminals, ship routing company and meteorological service provider as logistic MSVN in the maritime sector. Noting that there are differences existing between the related MSVN and the known (IT-based) SVN in the field of e-services, e.g., the missing "network's ability to orchestrate a complex service ad-hoc" or the necessity that MSVN "must be run on and by ubiquitously accessible information technology" (Blau et al., 2009-a).

Due to the potentially achievable collaboration benefit (illustrated in section 3), the basic advantages of SVN (Blau et al., 2009-b) and the successful SVN operations examples especially in the e-service industry (Blau et al., 2009-a), the idea of the maritime SVN is considered by the authors as a promising approach for improving the competitiveness of container terminals operating intercontinental liner services in a highly competitive market environment. In concrete terms, the constitutive MSVN partners (see Figure 3) perform the following care tasks:

CONTAINER TERMINAL: The terminals involved provide for the MSVN customers (i.e. shipping companies with contractual MSVN agreements) a premium handling service at dedicated berths which is based on highly sophisticated POM.RTS (see section 3.2). To stay competitive, it is of great importance that additional costs of premium vessel handling are compensated (more or less) by adequate productivity increase so as to keep the costs per container on the same level.

SHIP ROUTING COMPANY: A promising approach for cost-efficient reduction of travel time on sea is an advanced navigational concept which systematically

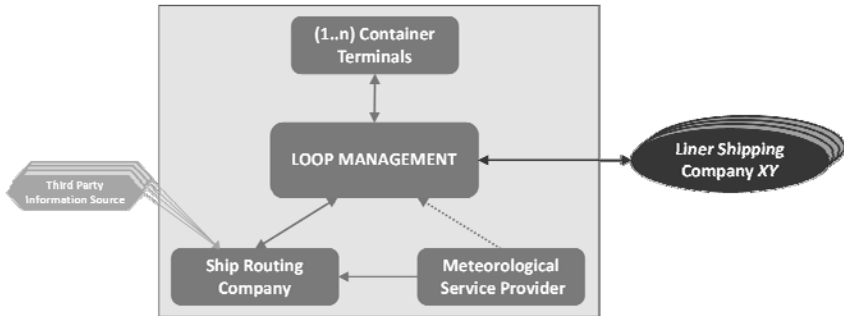


Fig. 3: MSVN partners and main information flows between them

considers weather and sea conditions for decision-making (see section 3.2). Nowadays, there are several companies worldwide which are specialized in providing WR-based navigational services to an outstandingly effective degree. To ensure best possible navigation decisions for vessel control with high travel time savings, it makes sense to consider a ship routing company as a further constitutive partner of the MSVN.

METEOROLOGICAL SERVICE PROVIDER: An absolute prerequisite for achieving high navigation quality is the availability of comprehensive weather data for all relevant sea areas and the ability to aggregate this data to build valid weather forecasts. For this reason, a globally active meteorological service provider is to be incorporated in the network as well. Such companies have at their disposal many years of experience in collecting, processing and providing forward projection of weather data. Therefore, they are equipped with the necessary competence to provide weather data as well as forecast information in the quality and quantity needed for highly effective vessel navigation.

LOOP MANGEMENT: For ensuring quality of MSVN service, a loop management is to be established as central instance. Prior to and during a vessel round-trip, the loop management is supplied with a wide range of information: comprehensive planning and operations information about the production processes are made available by the container terminals and the

shipping company in-charge, WR-based navigation recommendations are given by the ship routing company and present or forecasted weather information, respectively, is provided by the meteorological service provider. The loop management collects and aggregates this information and makes it available for the process owners to support decision-making. Moreover, the loop management triggers acceleration measures at ports and on sea, in case of time-related deviations from the timetable based on the expected operational impact of POM.RTS and WRM.RTS. Basically, the loop management has the function of a rather moderating network instance with limited decision-making and instruction authority. For the latter, the responsibility ultimately lies with the process owners, i.e., with the container terminals and the liner shipping companies as MSVN customers. Against this background, the loop management aims to reach a consensus on the control measures required for keeping the accelerated timetable. The management activities are primarily based on the internal agreements between the MSVN partners as well as the agreements between the MSVN and the liner shipping companies. In case of doubt, i.e., if related agreements do not cover the arising problem and hence define no organizational framework for deducing appropriate solution approaches, the loop management does not decide autonomously but initiate countermeasure(s) in accordance with the parties involved who would bear the probable additional expenditure incurred by these activities.

5. Summary and outlook on future research

The case-related analysis of POM and WRM for cost-efficient process acceleration in container liner shipping shows that their composite effect on round-trip times can be appreciable if particular pre-conditions are met. Furthermore, the examples of economic and operational impact resulting from these time savings reveal the large benefit of applied acceleration measures for liner shipping companies. In other words, the improvements in liner service operations can provide the shipping companies with noteworthy advantages

against their competitors, simultaneously putting the involved container terminals - functioning as core service providers - in a strong market position.

The basis for implementing such (advanced) services forms a close cooperation among all the parties involved in the acceleration processes at ports and on sea. Because of the many advantages of SVN concept (e.g. flexibility regarding changing market requirements, enabler for innovative/outstanding service offers or multiple troubleshooting options), from the author's point of view, related networks represent an effective approach for resolving the collaboration task mentioned above.

The constitutive partners of the maritime SVN are container terminals in various regions of the world as well as at least one ship routing company and one globally active meteorological service provider, while liner shipping companies function as customers of the network. The MSVN is fitted with a central instance, the loop management, which coordinates the internal network activities as well as matches the elaborated control measures to the requirements of customers.

Due to generally non-existing relationships among the network partners (if at all, then container terminals of the same region might be competitors) and the extensive integration of the MSVN customers in the actual production process, the decision-making and instruction authority of the loop management is very limited. With regard to this challenging coordination task, only contractual agreements and the hope for willingness of involved parties to collaborate will not be enough in order to ensure sustainable savings in round-trip time and push the network to a highly competitive market position. The competitiveness of MSVN is mainly determined by the effectiveness of its network management and the resulting quality of service. Thus, the management holds a key function for the network's success.

Considering the peculiarities of container liner shipping business as well as the characteristics of MSVN, further research work is required to identify or (if necessary) develop appropriate mechanisms for purposeful coordination of network partners. Furthermore, the design and operations of MSVN also raise

other questions, for example, in terms of network service composition, like the interpretation of "modular service components" from the logistics point of view or the possibilities of useful "implementation" of related components in respect of real-world requirements.

In this context, it should be noted that relatively large amount of research work about SVN is already done in the field of e-services (e.g. Blau, 2009; Conte, 2010; van Dinther, 2010). Thus, a comparison of similarities and differences between the nature of SVN in e-service and (maritime) logistics can provide valuable insights about the alienability of already developed solution approaches. An essential prerequisite for making the vision of MSVN real is the availability of design and coordination instruments that are (also) highly effective under actual conditions of application. This forms the basis for successful achievement of MSVN objectives in practice.

References

- Anonymous, 2000. NETRALOG - Entwicklung und Einsatz bioanaloger Algo-rithmen in der Schiffsabfertigung. Schlußbericht (Förderkennzeichen 011B8030), Hamburger Hafen und Logistik AG - Technische Universität Braunschweig - Hamburg Port Consulting GmbH, Hamburg (Germany).
- Asteris, M., Collins, A. and Jones, D.F., 2012. Container port infrastructure in North-West Europe: Policy-level modeling. *Journal of Policy Modeling*, 34, pp. 312-324.
- Basole, R.C. and Rouse, W.B., 2008. Complexity of service value networks: Conceptualization and empirical investigation. *IBM Systems Journal*, 47 (1), pp. 53-70.
- Blau, B., 2009. Coordination in service value networks - A mechanism design approach. PhD dissertation, University of Karlsruhe (TH), Karlsruhe (Germany).
- Blau, B., Krämer, J. Conte, T. and van Dinther, C., 2009-a. Service value networks. Proceedings of 11th IEEE Conference on Commerce and Enterprise Computing - CEC 2009, Vienna (Austria) pp. 194-201.
- Blau, B., van Dinther, C., Conte, T., Xu, Y. and Weinhardt, C., 2009-b. Koordination in Service Value Networks - Ein Mechanism-Design-Ansatz. *Wirtschaftsinformatik*, 51 (5), pp. 398-413.
- Bierwirth, C. and Meisel, F., 2010. A survey of berth allocation and quay crane scheduling problems in container terminals. *European Journal of Operational Research*, 202, pp. 615-627.
- Bowditch, N., 2002. The American practical navigator - An epitome of navigation. National Imagery and Mapping Agency - U.S. Government (ed.), Bicentennial edition, Bethesda (United States of America).
- Carlo, H.J., Vis, I.F.A. and Roodbergen, K.J., 2014-a. Storage yard operations in container terminals: Literature overview, trends, and research directions. *European Journal of Operational Research*, 235, pp. 412-430.
- Carlo, H.J., Vis, I.F.A. and Roodbergen, K.J., 2014-b. Transport operations in container terminals: Literature overview, trends, research directions and classification scheme. *European Journal of Operational Research*, 236, pp. 1-13.
- Conte, D., 2010. Value creation through co-opetition in service networks. PhD dissertation, Karlsruhe Institute of Technology (KIT), Karlsruhe (Germany).
- Chan, W.K.V. and Hsu, C., 2012. Service value networks: Humans hypernetwork to cocreate value. *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*, 42 (4), pp. 802-813.
- CC, 2014. CMA CGM. www.cma-cgm.com, accessed June 1, 2014.
- Chen, H., 2013. Weather routing vs. voyage optimisation. *Digital Ship*, January / February, pp. 26-27.

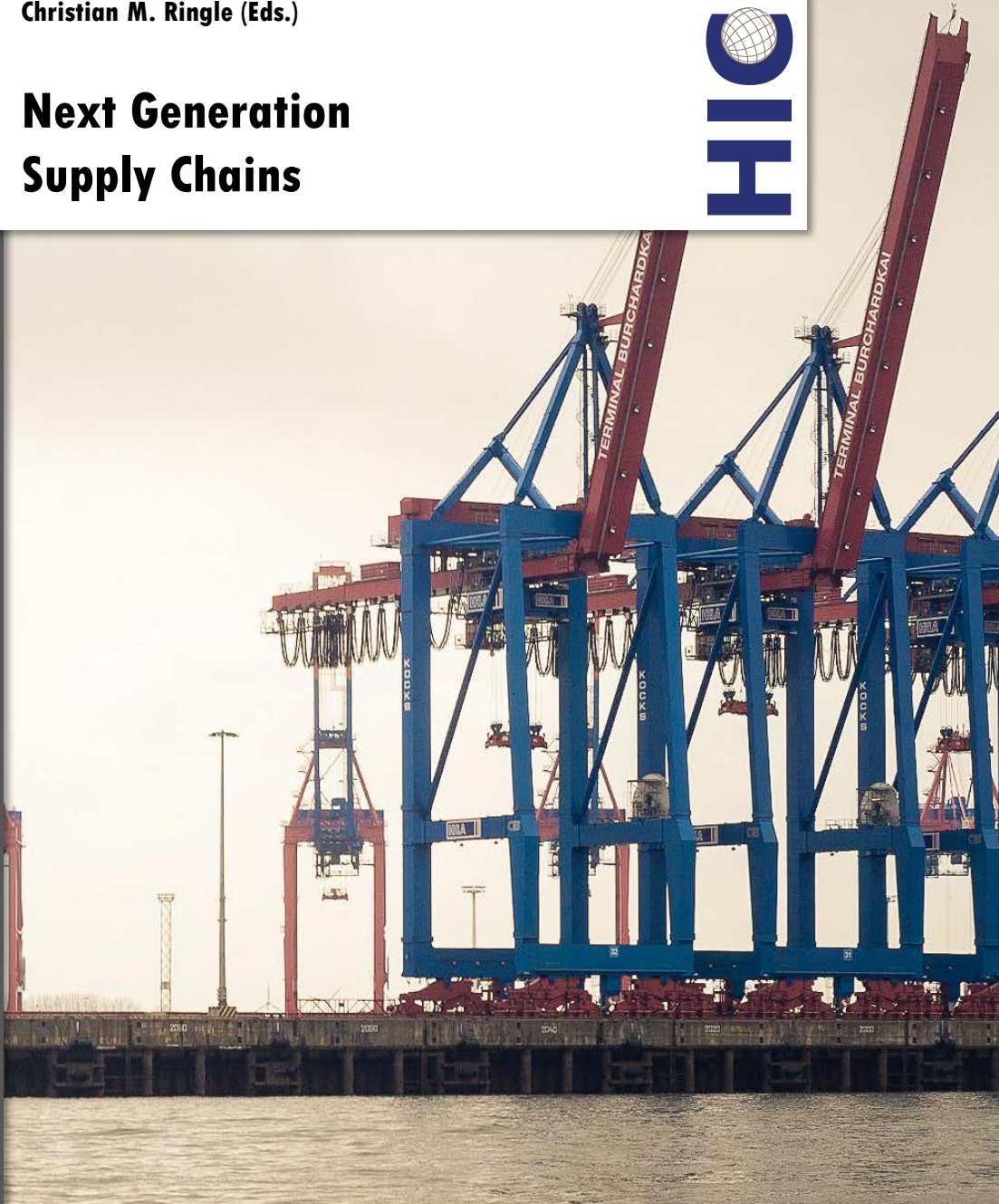
- Chen, K.-K. and Huang, C.-T., 1999. The determinants of the length of container ships mooring time of ports Keelung and Taichung. *Journal of the Eastern Asia Society for Transportation Studies*, 3 (2), pp. 167-182.
- Gailus, S. and Jahn, C., 2013. Ocean container carrier selection in North Western Europe - qualitative empirical research towards a discrete choice model. In: T. Blecker, W. Kersten and C.M. Ringle (eds.), *Pioneering solutions in supply chain performance management*. EUL, Lohmar, pp. 69-88.
- Gershanik, V.I., 2011. Weather routing optimisation - challenges and rewards. *Journal of Marine Engineering and Technology*, 10 (3), pp. 29-40.
- Goodchild, A.V. and Daganzo, C.F., 2007. Crane double cycling in container ports: Planning methods and evaluation. *Transportation Research Part B*, 41, pp. 875-891.
- Gordijn, J., Razo-Zapata, I., De Leenheer, P. and Wieringa, R., 2012. Challenges in service value network composition. In: K. Sandkuhl, U. Seigerroth and J. Stirna (eds.), *The Practice of Enterprise Modeling*. Springer, Berlin, pp. 91-100.
- Gudehus, T. and Kotzab, H., 2012. *Comprehensive logistics*. 2nd edition, Springer, Berlin (Germany).
- Hinnenthal, J., 2007. Robust pareto - optimum routing of ships utilizing deterministic and ensemble weather forecasts. PhD dissertation, Technische Universität Berlin, Berlin (Germany).
- Hamilton, J., 2004. Service value networks: Value, performance and strategy for the services industry. *Journal of Systems Science and Systems Engineering*, 13 (4), pp. 469-489.
- HL, 2014. Hapag-Lloyd. www.hapag-lloyd.com, accessed June 1, 2014.
- Ho, Y.C. and Liu, H.C., 2009. The performance of load-selection rules and pickup-dispatching rules for multiple-load AGVs. *Journal of Manufacturing Systems*, 28, pp. 1-10.
- Illmer, M., 2005. Enhancing container terminal productivity: A co-maker approach between carriers and operators. *Port Technology International*, (27), pp. 117-119.
- Islam, S. and Olsen, T.L., 2013. Operations Research (OR) at ports: An update. In: P. Gaertner, F. Bowden, L. Piantadosi and K. Mobbs (eds.), *Proceedings of 22nd National Conference of the Australian Society for Operations Research - ASOR 2013, Adelaide (Australia)*, pp. 91-97.
- Jürgens, S., Grig, R., Elbert, R. and Straube, F., 2011. Data flow across the maritime value chain. In: J.W. Böse (ed.), *Handbook of Terminal Planning*. Springer, Berlin, pp. 345-357.
- Kellberger, S. and Münsterberg, T., 2014. Terminal operating systems 2014 - An international market review of current software applications for terminal operators. In: C. Jahn (ed.), *Studies of Fraunhofer Center for Maritime Logistics and Services CML*. 2nd edition, Fraunhofer Verlag, Stuttgart (Germany).

- Le-Anh, T. and De Koster, M.B.M., 2006. A review of design and control of automated guided vehicle systems. *European Journal of Operational Research*, 171, pp. 1-23.
- Lin, Y.-H., Fang, M.-C. and Yeung, R.W., 2013. The optimization of ship weather-routing algorithm based on the composite influence of multi-dynamic elements. *Applied Ocean Research*, 17, pp. 184-194.
- Lu, J., Gong, X. and Wang, L., 2011. An empirical study of container terminal's service attributes. *Journal of Service Science and Management*, 4, pp. 97-109.
- Meisel, F., 2009. *Seaside operations planning in container terminals*. Physica, Heidelberg (Germany).
- Momm, C. and Schulz, F., 2010. Towards a service level management framework for service value networks. *Proceedings of 40. Jahrestagung der Gesellschaft für Informatik - Informatik 2010, Leipzig (Germany)*, pp. 521-526.
- Murty, K.G., Liu, J., Wan, Y.-w. and Linn, R., 2005. A decision support system for operations in a container terminal. *Decision Support Systems*, 39, pp. 309-332.
- ML, 2014. Maersk Line. www.maerskline.com, accessed June 1, 2014.
- Notteboom, T. and Rodrigue, J.-P., 2012. The corporate geography of global container terminal operators. *Maritime Policy & Management*, 39 (3), pp. 249-279.
- Notteboom, T.E. and Vernimmen, B., 2009. The effect of high fuel costs on liner service configuration in container shipping. *Journal of Transport Geography*, 17, pp. 325-337.
- O'Brien, M., 2012. Weather routing and voyage optimization. *Presentation on Fleet Optimization Conference, Connecticut (United States of America)*.
- Padhy, C.P., Sen, D. and Bhaskaran, P.K., 2008. Application of wave model for weather routing of ships in the North Indian Ocean. *Natural Hazards*, 44 (3), pp. 373-385.
- Park, T., Choe, R., Kim, Y.H. and Ryu, K.R., 2011. Dynamic adjustment of container stacking policy in an automated container terminal. *International Journal of Production Economics*, 133, pp. 385-392.
- Preuß, O., 2012. HHLA drückt in Altenwerder aufs Tempo. *Hamburger Abendblatt*, Nr. 162 (13.07.12), p. 21.
- Saanen, Y.A., 2004. *An approach for designing robotized marine container terminals*. PhD dissertation, Delft University of Technology, Delft (The Netherlands).
- Schulz, F., Michalk, W., Hedwig, M., McCallister, M., Momm, C., Caton, S., Haas, C., Rolli, D. and Tavas, M., 2012. Service level management for service value networks. *Proceedings of 36th Annual IEEE Computer Software and Applications Conference Workshops - COMPSAC 2012, Izmir (Turkey)*, pp. 51-56.
- Stahlbock, R. and Voß, S., 2008. Operations research at container terminals: a literature update. *OR Spectrum*, 30, pp. 1-52.

- Steenken, D., Voß, S. and Stahlbock, R., 2004. Container terminal operation and operations research - a classification and literature review. *OR Spectrum* 26, pp. 3-49.
- Szłapczyńska, J. and Smierzchalski, R., 2009. Multicriteria optimisation in weather routing. *International Journal on Marine Navigation and Safety of Sea Transportation*, 3 (4), pp. 393-400.
- Ursavas, E., 2014. A decision support system for quayside operations in a container terminal. *Decision Support Systems*, 59, pp. 312-324.
- Walther, L., Burmeister, H.-C. and Bruhn, W., 2014. Safe and efficient autonomous navigation with regards to weather. *Proceedings of 13th International Conference on Computer Applications and Information Technology in the Maritime Industries*, Redworth (United Kingdom), pp. 303-317.
- van Dintther, C., 2010. Designing service value networks - Coordination, competition and cooperation. Habilitation dissertation, Karlsruhe Institute of Technology (KIT), Karlsruhe (Germany).
- Weber, T., 2007. Ship routing services. Presentation on 1th International Conference on Ship Efficiency, Hamburg (Germany).
- Zhang, H. and Kim, K.H., 2009. Maximizing the number of dual-cycle operations of quay cranes in container terminals. *Computers & Industrial Engineering*, 56, pp. 979-992.

**Wolfgang Kersten, Thorsten Blecker and
Christian M. Ringle (Eds.)**

Next Generation Supply Chains



Prof. Dr. Dr. h. c. Wolfgang Kersten
Prof. Dr. Thorsten Blecker
Prof. Dr. Christian M. Ringle
(Editors)

Next Generation Supply Chains

Trends and Opportunities

Edition 1st pdf edition, August 2014
Publisher epubli GmbH, Berlin, www.epubli.de
Editors Wolfgang Kersten, Thorsten Blecker and Christian M. Ringle

Coverdesign Frederik Duchâteau, Moritz Petersen
Coverphoto Viktor Rosenfeld / [flic.kr/p/e7ujk3](https://www.flickr.com/photos/7ujk3/) (CC BY-SA 2.0)

ISBN 978-3-7375-0339-6

Copyright:

This book are licensed under the Creative Common Attribution-ShareAlike 4.0 International License.

This book can be downloaded at HICL (hicl.org) or at the TUBdok – Publication Server of the Hamburg University of Technology (doku.b.tu-harburg.de) –

ISBN: 978-3-7375-0339-6

A printed version of this is available in your library or book store –

ISBN 978-3-8442-9879-6

An alternate version for your ebook reader is available through online ebook stores – ISBN: 978-3-7375-0340-2

Preface

Today's business environment is undergoing significant changes. Demand patterns constantly claim for greener products from more sustainable supply chains. Handling these customer needs, embedded in a sophisticated and complex supply chain environment, are putting the players under a constant pressure: Ecological and social issues arise additionally to challenges like technology management and efficiency enhancement. Concurrently each of these holds incredible opportunities to separate from competitors, yet also increases chain complexity and risks.

This book addresses the hot spots of discussion for future supply chain solutions. It contains manuscripts by international authors providing comprehensive insights into topics like sustainability, supply chain risk management and provides future outlooks to the field of supply chain management. All manuscripts contribute to theory development and verification in their respective area of research.

We would like to thank the authors for their excellent contributions, which advance the logistics research progress. Without their support and hard work, the creation of this volume would not have been possible. We would also like to thank Sara Kheiravar, Tabea Tressin, Matthias Ehni and Niels Hackius for their efforts to prepare, structure and finalize this book.

Hamburg, August 2014

Prof. Dr. Dr. h. c. Wolfgang Kersten
Prof. Dr. Thorsten Blecker
Prof. Dr. Christian Ringle

Table of Contents

I. A Look Into the Future - Opportunities and Threats

Identification of Megatrends Affecting Complexity in Logistics Systems.....3

Wolfgang Kersten, Birgit von See and Henning Skirde

Planning Approach for Robust Manufacturing Footprint Decisions29

Philipp Sprenger, Matthias Parlings and Tobias Hegmanns

Future Problems in Logistics Due to Demographic Change51

Matthias Klumpp, Sascha Bioly and Christian Witte

Logistics Trends 2020: A National Delphi Study Concerning the German
Logistics Sector69

Stephan Zelewski, Alessa Münchow-Küster and René Föhring

Vision of a Service Value Network in Maritime Container Logistics.....87

Jürgen W. Böse, Carlos Jahn and Raman Sarin

II. Sustainability Efforts Within the Supply Chain

Logistics Performance Measurement for Sustainability in the Fast Fashion
Industry.....113

*Anna Corinna Cagliano, Muhammad Salman Mustafa, Carlo Rafele and
Giovanni Zenezini*

Design of Sustainable Transportation Networks.....137

Wendelin Gross and Christian Butz

Exploring Sustainability in Construction Supply Chains.....161

Margherita Pero, Eleonora Bottani and Barbara Bigliardi

Table of Contents

Is Money Really Green? - An Investigation Into Environmental Supply Chain Practices, with a Cost Focus183

John Bancroft

Relevant Purchase Criteria or Basic Requirement: Customer Perspectives on Green Logistics 195

Matthias Klumpp, Julia Naskrent and Nikolaus A. D. Hohl

Information Systems and Reverse Logistics: Examining Drivers of Implementation on Multiple Case Study Scenario211

Josip Maric, Florence Rodhain and Yves Barlette

Analysing the Role of Rail in Urban Freight Distribution223

Katrien De Langhe

Truck Loading Dock Process – Investigating Integration of Sustainability245

Niels Hackius and Wolfgang Kersten

How to Attract Air Freight Business: Defining Critical Success Factors for Regional Airports273

David M. Herold, Simon Wilde and Natalie Wojtarowicz

Early Supplier Integration in Cast Product Development Partnerships – A Multiple Case Study of Environmental and Cost Effects in the German Foundry Value Chain289

Robert Christian Fandl, Tobias Held and Wolfgang Kersten

Sustainable Logistic Scenarios in the NSR Region311

Jacob Kronbak, Angela Münch, Liping Jiang and Lisbeth Brøde Jepsen

III. Handling Risk - Concepts Towards Robust SCM

A Service Production Planning Model Integrating Human Risk Factors345

Nguyen Vi Cao and Emmanuel Fragniere

How to Cope with Uncertainty in Supply Chains? - Conceptual Framework for Agility, Robustness, Resilience, Continuity and Anti-Fragility in Supply Chains361
Immanuel Zitzmann

Flexible Supply Chain Design under Stochastic Catastrophic Risks379
Yingjie Fan, Frank Schwartz and Stefan Voß

A Risk Management Approach for the Pre-Series Logistics in Production Ramp-Up407
Patrick Filla and Katja Klingebiel

The Imbalance of Supply Risk and Risk Management Activities in Supply Chains: Developing Metrics to Enable Network Analysis in the Context of Supply Chain Risk Management423
Christian Zuber, Hans-Christian Pfohl and Ulrich Berbner

Risk Assessment in Managing the Blood Supply Chain447
Phongchai Jittamai and Wijai Boonyanusith

Supply Chain Risk Management in International Trade Operations Between Germany and Brazil469
Meike Schroeder and Renato Barata Gomes

The Forest Supply Chain Management: An Entropic Perspective487
Tarik Saikouk, Ismail Badraoui and Alain Spalanzani

A Multi-Agent Based Approach for Risk Management in a Port Container Terminal515
Lorena Bearzotti and Rosa Gonzalez

Authors XI

About HICL

Since 2006 the annual conference Hamburg International Conference of Logistics (HICL) at Hamburg University of Technology (TUHH) is dedicated to facilitate the exchange of ideas and contribute to the improved understanding and practice of Logistics and SCM. HICL creates a creative environment which attracts researchers, practitioners, and industry thinkers from all around the world.



Innovation is increasingly considered as an enabler of business competitive advantage. More and more organizations focus on satisfying their consumer's demand of innovative and qualitative products and services by applying both technology-supported and non technology-supported innovative methods in their supply chain practices. Due to its very characteristic i.e. novelty, innovation is double-edged sword; capturing value from innovative methods in supply chain practices has been one of the important topics among practitioners as well as researchers of the field.

This volume, edited by Thorsten Blecker, Wolfgang Kersten and Christian Ringle, provides valuable insights into:

- Innovative and technology-based solutions
- Supply chain security management
- Cooperation and performance practices in supply chain management

ISBN: 978-3-7375-0339-6