

From transocean routes to global networks: a framework for liner companies to build service networks

Xiaoning Shi and Stefan Voß

Abstract—During the previous two decades liner carriers within maritime shipping have broken the barriers from being pure transportation providers towards being logistics service providers. Most of the top 20 liner carriers worldwide have set up spin-offs providing services from local booking up to 3rd party logistics services, combining the business advantages of tight linkages with liners together with the negotiation freedom with demanding customers by providing an extension of service coverage. Economical evaluations of transocean routes and global networks are of interest for decision makers responsible for business strategies as well as for operations. It is crucial to achieve appropriate judgements about which liner routes are profitable and how to build better service networks so that the companies' brand could be attractive to, e.g., shippers, including exporters, importers and forwarding agents. In this paper we discuss the corresponding trade-offs as well as related decision support systems of relevant service providers and companies.

Keywords— *liner, port, logistics, networks, decision support system.*

1. Introduction

Stemming from the inherent characteristics of world trade, the international shipping industry faces general issues of globalization, volatility, capital-intensity and periodicity. These issues, among others, provide the maritime shipping and logistics industry with a wealth of opportunities, however, with considerable uncertainties. The fact that liner carriers have already broken the barriers from being transportation providers towards being logistics service providers during the last two decades lets researchers consider related improvements and optimization after those extensions of business processes. Most of the top 20 liner carriers set up spin-offs providing different services, from local booking services up to 3rd party logistics services, combining the business advantages of tight linkages with the liners together with the negotiation freedom with demanding customers. A trade-off results from the relatively ambitious goals of the liner carriers and the marketing pressure of their spin-offs focusing on 3rd party logistics services, namely, the economical comparison between transocean routes and global networks. On one hand, as top liners deploy mega ships, economies of scale and single voyage efficiency are needed in order to accomplish the aim of unit cost saving. Thus, there is a need to focus on (long haul) transocean routes. On the other hand, for a 3rd party logistics provider (3PL), a global network with reliability

and agility is crucial, too. Decision makers handling business strategies as well as operations, who are willing to resolve this trade-off, must be aware of which routes are productive and how to build up better service networks so that the brand and the reputation of affiliated companies is attractive to shippers, including exporters, importers and forwarding agents.

In this paper, besides presenting a literature review on a variety of papers relevant to the topic, we also attempt to discuss the evaluation and analysis of route choice and the optimization of networks. We start with the ingredients of related networks – ports and routes – and later extend by addressing different functions of the liners and the 3PL, as well as illustrating several criteria suitable for the selection of a transshipment hub as well as inland feeders. Regarding the dynamic competition and cooperation within the liner market, we finally sketch a theoretical framework, which may be of use regarding the development of decision support systems (DSS) of the liner companies, on how to build efficient service networks.

2. Ingredients of the networks – routes and ports

Logistics services could be identified as appropriate extensions of existing networks. Therefore, cf. [3], we interpret the connections among routes and ports of call as sub-networks. As the definition of logistics can be quite broad we need to focus. That is, in this paper we are mainly concerned with door-door service derived from long-distance shipping services. Short-distance inland distribution logistics without any shipping is not covered in this paper. In order to gain better understanding about the networks of shipping and logistics, the routes and the ports could be defined as the links and the nodes, respectively, as basic ingredients forming the networks.

2.1. Routes – links/ports – nodes

There are three main transocean lanes, namely transatlantic, transpacific and far-east to Europe [5], playing significant roles as the cheapest transportation mode serving commodity flows. Besides these main lanes, each liner carrier would arrange its services based on given freight requirements, thus, the required routings from the shippers

motivate the liner carriers to construct complete world-wide networks. The lanes and routes connecting the ports can be viewed as the links in a graph with the seaborne transportation demands of the links denoted as weights.

Various researchers have addressed the definition of a “port”. For instance, Carbone and De Martino [4] define: “Ports have been natural sites for transshipment in order to transfer goods from one mode of transport to another. They have historically provided the link between maritime and inland transport, and the interface between the sea, rivers, roads and railways”. This definition is not fully comprehensive, as ports often also function as nodes without any mode diversity, e.g., from ship to ship. At least this statement indicates that ports are nodes with cargo in-flow and out-flow. (See, e.g., [31, 32] for a container terminal oriented survey.)

Considering the ports as nodes, we note that the liner carriers and their logistics spin-offs discussed in this paper are also of other characteristics – direct service networks together with indirect physical networks. For instance, a shipper as customer may book a door-to-door service in terms of local booking service¹ provided by a 3PL spin-off of the liner carriers. That is, the shipper and the service provider have direct service connections. However, it does not mean that this cargo freight is transported by the 3PL related liner carrier² only, not even within multi-modal transportation including inland-haul and short-sea distribution, if any, according to the service contract between the shipper and the 3PL. Therefore, indirect physical networks exist, which urges smooth and seamless connection.

2.2. Similarities among networks

Not only maritime shipping (transportation) networks have the features discussed in Subsection 2.1. Also some other (service) industries share the features which can be investigated by applying similar methods. It deserves to be noted that shipping and the logistics industry, as well as the telecommunications industry, share common characteristics of networks such as facility indivisibilities, technology interconnectedness and utility externalities, etc. A simplified comparison between the telecommunications and the port operations as well as freight shipping can be shown as follows. Similarities mainly exist regarding four aspects: generation and infrastructure development, distribution, mode choice and assignment. A brief comparison is that telecommunication service carries packages which contain data and messages; port operation moves containers either vertically up/off to/from ship or horizontally connected with trucks or trains; and also freight transport carries commodities from origins to destinations. Moreover, we can state that in all

¹For reason of domestic maritime regulation and territory security, most countries do not authorise the foreign liners full authority of direct-booking. This is one of the reasons that foreign liners set up 3PL spin-offs as interfaces providing local-booking services to the shippers.

²It refers to a liner carrier who sets up a 3PL spin-off. Later, those two companies might become sister companies belonging to the same group.

these “systems” we are concerned with consolidation and transshipment points.

Regarding the basic features of those industries and their similarities, theoretically, the literatures and research outcomes from each area could be applied to each other if done in an appropriate manner. For a review on the service network design for freight transportation see, e.g., Wieberneit [36] who specifically investigates tactical planning problems in freight transportation. Regarding the classification of the planning of a transport system, we refer to, e.g., [6]. In Section 3, we focus on the freight shipping industry.

3. Selection and preference of ports and networks

From a historical point of view, the main routes that contain lots of cargo desires are those routes firstly developed by ancient traders, and those nowadays need to be deployed with mega ships. However, taking basic logistics requirements into account, a superficial contradiction seems to arise from the liner companies and their 3PL spin-offs.

3.1. A superficial contradiction

On one hand, the target market niche of liner services is to provide transportation by visiting fixed ports according to pre-announced fixed schedules, meanwhile at a relatively stable freight of all kinds (FAK) price. More specifically, even the names of liners’ vessels are settled and announced in advance once the liners are willing to provide liner services, and those container vessels are supposed to visit selected ports one by one in a timely fashion, also based on pre-announced fixed schedules. Cargo fitting into containers are shipped at settled prices (in this paper we ignore the issue of setting booking prices and the strategic contractual wholesale prices) disregarding what the cargoes really are. As a result, we refer to any TEU (twenty-foot equivalent unit; measurement of containers) as a profitable “unit”. A fundamentally common aim of the liner companies is to achieve economies of scale together with significant cost savings per unit, achieved by deploying bigger ships along profitable routes consisting of productive ports with deep drafts.

On the other hand, attractive service offerings provided by the logistics companies could be increased frequency, less quantity per shipment and higher agility based on customers’ specialized requirements. Logistics companies providing 3rd party services with local booking authorities, especially those spin-offs of the liner companies considered here, are actually blooming since the last decline of the liner industry under the hope of attracting more customers from competitors providing similar liner services. Those 3PL spin-offs are endowed with the advantages of getting allocated capacities at lower contractual prices with their head companies or sister companies. Nevertheless,

they are trying every effort to accomplish and fulfil door-to-door and even value-added services as well as to expand networks by means of visiting feeder ports and setting up inland distribution centres.

Then a superficial contradiction occurs between the selection of transshipment hubs and the expansion of networks under the capital constraint and management constraint of the head-corporation of the liner company and the involved 3PL. In this paper, we consider the network design problem as a strategic issue.

Note that we regard a spin-off of the liner carriers providing logistics service as 3PL. However, other researchers might rate liner carriers themselves as 3PL considering buyer and seller of the respective trade contract ([28], p. 252). Here we somewhat ignore the debate of who can actually be regarded as 3PL or even "4PL". Instead, we focus on the performance and value of the service networks. For a framework for evaluating 3PL see, e.g., [33].

3.2. Possible solutions to solve the contradiction

In this section, we investigate liner carriers and their 3PL spin-offs from a network theory perspective, which might shed some light on resolving the above mentioned contradiction. Applying network theory allows the liner carriers to optimize their current networks as well as aggregate potential partners' network [3]. Consequently, a multi-criteria optimization system should be set so that a rational selection on transshipment hubs and feeder ports could be accomplished. For a comprehensive literature review up to 2000 on freight transportation structuring from the viewpoint of choice processes we refer to [18]. Here we further discuss some other criteria in terms of networks, information as well as the 3PL spin-offs.

In practice, the selection of ports of call, including transshipment hubs and feeder ports, could be viewed as selection processes for business partners, no matter whether it relates to vertical or horizontal partnerships. However, before they become business partners, port operators, to great extent, might be competitors within the same industry. That is, players belonging to the same region, neighbouring each other and sharing overlapping hinterland, form a competitive relationship (e.g., the so-called North-Range in Europe). As some literatures address, financial health, adequate physical facilities, intangible assets [1, 10] are crucial as contributing factors during preliminarily screening the potential ports of call. Further references regarding port selection can be found in, e.g., [17, 24].

3.2.1. Criteria of hubs/transshipment hubs

Distribution network. One difference between hubs and transshipment hubs is whether there exists an advanced distribution network to connect to the hinterland. If there is an advanced distribution network, the hub may not only act as a media to move cargoes from one ship to another (cf. the term crossdocking in slightly different context),

but also between different transport modes, e.g., from ships either to trains or to trucks. However, for many transshipment hubs, like Hong Kong or Singapore, a high percentage of the whole throughput refers to ship-to-ship movements. Thus, in such a case the hinterland distribution network is not of utmost importance (compared to, e.g., Hamburg). Most important are the free-port regulation and a sophisticated handling system that make the B/L transaction and water-water transshipment convenient.

Information system. Congestion, either on the seaside or on the landside could enlarge the total time of a vessel in the port, which would actually imply increased operational costs for the liner carriers. However, congestion free access to a port or congestion within the port is usually not one of the (main) criteria for choosing the hubs. As a matter of fact, several hubs suffer congestion quite often. It seems most important whether there is an efficient and effective information system to support the daily operations within the port so that even if congestion happens, a constructive solution would be suggested by the information system quickly. Recent discussion in this respect refers to so-called port community systems (see, e.g., www.dakosy.de for some example).

The 3PL spin-offs. In the hubs that the liner carrier or its corporation chooses, usually a related 3PL spin-off is set up, too, to ensure the convenience of the service that they could provide to the customers as a package. Comparing the local forwarder agent located in other feeder ports, the 3PL spin-off has stronger linkage with the liner carrier and, in return, might get more allocated capacities as support.

3.2.2. Criteria of feeder ports

Local forwarder agent. In practice, the selection of feeder ports is usually combined with the selection of the local forwarder agents. In most cases, if one forwarder agent distinguishes himself by his performance in one port, then other ports covered by this forwarder agent's business are probably also selected by the liner carrier as feeder ports. One superficial reason could be that the forwarder agent has a long cooperation with the liner carrier and gets used to follow all the managerial habits of the liner carrier which satisfies the liner carrier's requirements and further brings the liner carrier more freight. Another reason is that this forwarder agent could to great extent support the freight and fill capacities of the liner carrier by utilising his own network and attract shippers located in the hinterland. Considering the transocean routes initially constructed by the liner company, we define the extended inland or short-sea network of the local forwarder agent as the sub-network.

This phenomenon indicates that potential feeder ports would be selected due to their contribution to the original networks in fashion of better sub-network connection and accessibility. It should also be noted that such expected contribution might not happen as soon as the alternative feeder ports are added into the network, they might play

their roles step by step. Unfortunately, as time goes by, the freight flow may amplify itself and then the profit-driven liner carriers may set up their own spin-off or stock-holding companies there instead of cooperating with the former forwarder agents. Consequently, this feeder port may even have the chance to be upgraded as hub within the ports of call of this liner.

Besides the practical criteria mentioned above, Lirn *et al.* [15] apply the analytic hierarchy process (AHP) as a method for evaluation and selection of transshipment ports from a global perspective. In addition, other researchers propose multi-criteria optimization for partner selection issues, which could be regarded as the amendment and development of an AHP application, see [9, 10].

4. Network optimization for a dynamic liner market

In this section we discuss aspects of optimizing service networks regarding the dynamic liner shipping market by taking into account the capacity of other sub-networks with a whole networks perspective. General concerns of cost efficiency in container shipping can be found, e.g., in [30].

4.1. Dynamics as a characteristic of the liner shipping industry

In spite of the cooperation among the liner carriers and other players involved in the liner shipping industry, many observations disclose the fact that the liner shipping industry is full of dynamics, including membership diversity, partnership reshuffling, network restructuring, etc. Rimmer [27] provides a historical description on the membership diversity among the liner shipping alliances up to the mid nineties. A more recent exposition of cooperation, mergers and acquisitions within the liner shipping industry is given by Notteboom [25]. Furthermore, for an up-to-date review on the dynamics existing in this industry see [29].

In short, the membership of the shipping alliances can switch from partnership towards being competitors and vice versa. This not only results in fleet capacity changes but also leads to diversity between the services that the alliances can provide. In this case, the related liner carriers' behavior of changing membership can be interpreted as attempting to combine new sub-networks with other players, no matter whether the other players are carriers or local in-land haul service providers.

4.2. Flexibility as response

Due to the dynamic environments of the transportation industry, flexibility plays a vital role if relevant companies are willing to survive. Reasons for the importance of flexibility include network externalities, as pointed out by David [7]; benefits of users/producers of the services

are depending on the presence of other users/producers. Robinson ([28], p. 248) states that “*shipping lines are in the business of delivering value to buyers and sellers – and of capturing value to ensure they remain in business*”. Considering the dynamics of the liner market, we address the flexibility of the network as one of the competitive advantages to ensure that shipping lines remain competitive and survive in business.

Once liner carriers have to compete in context of flexibility, the selection and integration of sub-networks becomes vital. Min and Guo [22] investigate the location of hub-seaports in the global supply chain network from the point of view of cooperative game theory. They develop a cooperative strategy in order to support the liner carriers and the shippers to determine optimal locations for the hub-seaports. However, our approach is slightly different as we do not assume the liner carriers and the local sub-network providers having binding agreements among each other. To some extent, we deepen our research based on the non-cooperative assumption, which is more realistic in the real business. As discussed in Subsection 2.1, routes and ports would be regarded as the basic features of the service networks of the liner carriers. The following four aspects need to be taken into account: generation of seaborne transportation, distribution of the shipping requirements, modal split and assignment of the shipping volume.

4.2.1. Zoning

While discussing ports serving the container flows, related regions are actually divided within the overall transportation networks by means of zoning. Zoning is a process that combines similar nodes into different zones and separates them from each other. Such zoning process depends a lot on the objectives of the networks, the available data, budget and time constraints as well as the zones homogeneity. Furthermore, due to the limited knowledge of all the details of every node almost all information (or expectation) of the nodes could be integrated into the “zone” and later on each zone is reduced to a point. Then, spatial dimensions of a zone diminish. For instance, once ports *A* and *B* are integrated into one zone, the spatial distance between *A* and *B* is not important any more. In contrast, whether *A* or *B* would act as the hub of this zone would be an important decision. Once *A* acts as the hub and *B* acts as the feeder port, the assignment of the inbound and outbound links to and from this zone is related to the network design, while the volume between *A* and *B* within this zone is related to the sub-network design. In other words, one of the ports, say *A*, is selected as the central port because of advantageous transportation conditions while utilizing other ports, say *B*, as subsidiary within the zone. We note in passing, that a comprehensive survey of operations research approaches for the design of hub and spoke systems is provided in [34]. A simple adoption of hub and spoke systems to ship assignment is provided by Mourao and Pato [23].

4.2.2. Coding

The whole network is simplified by means of zoning and coding. Coding is a process that captures network links and centroids to represent the characteristics of the zone, respectively, instead of the former random links and nodes. That is, the network links and centroid are more relevant for the networks rather than the sub-network.

Now we are prepared to explain the behavior of the liner carriers: sometimes they set up 3PL spin-offs located in different areas and sometimes they simply select some local agents to act as the forwarder service and logistics service provider. However, the in-depth ideas are similar. The liner carriers set up their own 3PL spin-offs after zoning their current and potential traffic network and let the 3PL spin-off represent (the features of) this zone so that it could serve in the best possible way. As a different option, they select the local agents acting as a representative of a sub-network, whoever could contribute best to the whole network. Thus, the competition of the liner carriers, to some extent, is a competition of network integration. Furthermore, the turbulence of the liner market requires the flexibility of the network to ensure the just-in-time change. Once the circumstances or factors change as, e.g., observed with respect to the Panama Canal expansion, the sub-network and the whole network of the liner carriers should change accordingly to match customer demands and the circumstances.

In general, all the cargoes currently are served by the networks and the containerized shipments are transported from door to door, and during this procedure, at least two hubs are chosen (maybe more than two if the transshipment is included regarding the long distance). One hub locates in the zone of the origin, and the other hub locates in the zone of destination. Thus, the whole logistics procedure could be decomposed into the liner carrier's network and its 3PL spin-off/local service's sub-network. Furthermore, the sub-network selection and their connectivity are of great importance. We note that this is closely related to intermodal transportation problems, airline transportation networks as well as problems in telecommunications network design. For the latter see, e.g., the formal modeling approaches in [13, 20]. Route design in a specific liner shipping problem is considered in, e.g., [12].

In the following, we describe the problem from two aspects: sub-network selection and shipment distribution. Let $G = (N, A)$ be a graph consisting of a set of nodes N and a set of arcs A . G represents a physical network provided by the liner carriers and the logistics providers. Let K define a set of cargo shipments. A specific sea cargo shipment $k \in K$ is defined by an origin-destination or O-D pair, with $o(k)$ as origin and $d(k)$ as destination. The set of all paths from $o(k)$ to $d(k)$ for k is defined as P^k and the set of all O-D-pairs throughout the network is defined as P . The demand of a network or sub-network related to shipment k is denoted as d^k , which has to be transported from $o(k)$ to $d(k)$. In this paper important constraints such as time window constraints are not considered as key

constraints as we ignore operational details. The main constraints refer to arc-capacity so that they could fulfil the demands d^k . Considering the integration of some networks, the total capacity of the involved links should be enough to cover the total demands. One might include binary decision variables indicating whether a sub-network is to be added to the whole network, or not. Another variable x_p^k is a nonnegative shipment flow variable, which indicates the flow of shipment $k \in K$ transported via the path $p \in P$, i.e., the amount of cargo to be shipped. F_p^k denotes the freight rate of the shipment $k \in K$ via the path $p \in P$. F_p^s denotes the freight rate of the additional shipment $s \in S$, which is attracted by the newly-added sub-network defined as S .

By adding appropriate arc inclusion indicator variables as well as flow variables we can model a multicommodity flow problem similar to those in telecommunications network design, see, e.g., [13, 20]. Here we concentrate on the objective function.

Let C_p^k be the shipment flow cost or variable cost of handling the goods per unit flow of k along path $p \in P^k$. The fixed costs of the network are not considered, because they are sunk costs in this problem. When the liner carrier decides to integrate with some potential sub-networks, the fixed cost of the carriers' network had already been invested before, and the amount of it would not be taken into account for the next stage. In contrast, the fixed costs of the potential sub-networks should be considered because they are among the main factors of the decision making process.

The objective function can then be formulated as follows:

$$\max \sum_{k \in K} \sum_{p \in P^k} F_p^k x_p^k + \sum_{s \in S} \sum_{p \in P^k} F_p^s x_p^s - \sum_{k \in K} \sum_{p \in P^k} C_p^k x_p^k,$$

where:

$$x_p^k \geq 0, \quad \forall k \in K, \quad p \in P^k.$$

The objective is to maximize the total profit of the integrated network by taking into account not only the original shipping demand but also the additional shipping demand attracted by the improved network.

The nodes can be denoted as n_i and the zones can be denoted as z_i after zoning. Suppose that the liner carrier attempts to construct the global network or just to improve some part of the whole network. Figure 1 demonstrates the nodes, zones and the links of the sub-network and the whole network, respectively. We could not clearly separate the procedures of selection (set up 3PL spin-offs or select local agents) and zoning because they actually happen almost at the same time. However, slight differences still exist. As for setting up a 3PL spin-off of the liner carrier, it might happen after zoning because at the moment of location selection the liner carrier has already build up a global service network and most probably the headquarter of the 3PL spin-off will be located just in the centroid of the zone. In contrast, the selection of the local agents may influence the zoning of the liner carrier because some of the local agents are so strong that the shipping volume of the related zone changes too much. However, the common

idea of the setting up and selection is whether such decision would contribute to the payoff of the whole network as well as the sub-network itself. Suppose that one liner carrier attempts to cover the two main lands. The zoning process follows the criteria of covering as many freight nodes and simplifying the whole area as much as possible. The coding process lets the z_i represent instead of n_i , which tremendously decrease the links and the voyage time of the vessels. However, once comparing the potential options of the local agents of z_6 and z_7 , an overlap of these two zones is found. This infers that if the first local agent of z_6 is not strong, the initial zoning result can be obtained, but if another alternative local agent is to be integrated, then the zoning of z_6 and z_7 shall be reorganized.

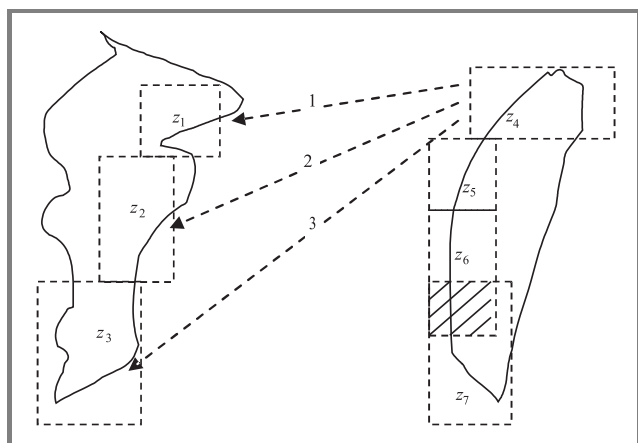


Fig. 1. The zoning of the origin and the destination of long distance transportation.

In Fig. 1, without loss of generality, we take z_4 as the origin area and the left side as the options of destination, including z_1 , z_2 and z_3 . The optimal route from the right hand side to the left hand side of this figure depends on the sub-networks inside the zones z_1 , z_2 and z_3 and their connectivity.

Regarding the integration of any sub-network into the whole network, both the payoff of the sub-network provider, in this case, a 3PL or local agent, and the payoff of the whole network must be positive and bigger than the former stages. Otherwise, such integration usually makes no sense to the liner carriers.

For possible heuristics to solve and validate some concept proposed in this paper, we refer to [35]. Regarding a mathematical proof of a similar port-of-call scheduling problem we refer to [19]. In addition, an interesting case study including six European ports in the context of port selection in the hinterland of Europe is [8].

5. Decision support systems in transportation companies

As indicated in Section 3, competition among the liner carriers currently relies on the implementation of the service networks by means of selecting sub-network providers

and cooperating with them. Furthermore, in order to have a smooth coordination and integration of different sub-networks some sophisticated information systems are necessary.

5.1. Liner carriers and port operators integration for efficient supply chain management

Stepping back in history and the development of trade, transportation and logistics, liner carriers or shipping carriers in general were pure traders centuries ago. However, nowadays they tend to have the ambition of being more comprehensive players. The shipping carriers attempt to touch inland-haul service, short-sea connections and certainly logistics service mainly related to door-door transportation (here we do not refer to the so-called value-added activities inside manufacturing factories which are always included as logistics, too).

Shippers and consignees are exporting and importing the cargoes and pay the freight rates, accordingly. However, as they only have direct service contracts with the liner carriers or the 3PL rather than with the port operators [29], the detailed operations between logistics providers and port operators are of less interest for them. Consequently, the efficient and effective integrated services including transportation services and port operations would be most welcomed by the customers, i.e., the shippers and the consignees.

In order to obtain better performance of service integration, DSS are of great importance for the liner carriers. Regarding the difference between DSS and decision making systems we distinguish whether the systems recommend several potential actions or automatically implement actions [16]. For the current solution methodologies, optimization-based solutions of information systems focus more on the average demands and requirements under static conditions, and simulation-based solutions accommodate the system dynamics which could be more suitable for the real-world business [16]. Furthermore, heuristic-based models contain the capability taking into account almost all network configurations providing optimized solutions accordingly.

5.2. Decision support system applications in liner and logistics companies

Since the last decade internet-based business (or e-business) activities have become a new technological challenge for the shipping industry. However, beyond the introduction of electronic data interchange (EDI) little systematic and theoretical research on e-business has been undertaken within this area so far. Therefore, we attempt to investigate the application of information systems in the shipping industry (the container shipping industry is focused in this paper) and their impacts of e-business on the container shipping industry in order to provide the liner carriers with the managerial recommendations accordingly. For a literature review on general business dynamics and the technology

strategies of six different e-business models in the container shipping industry see [2]. Moreover, we should note that various areas lack the practical application of DSS, largely due to the lack of unified generally applicable systems, cf. [11].

While business activities could be divided into operational, tactical and strategic activities, the respective sub-information systems perform various functions. End users of a container shipping company could be basically distinguished regarding activities along those time horizons from strategy promoters up to in-putters of daily operational data. These include vessel positions, container status, service requirements, payment transactions and so on.

As an example we consider Maersk Sealand which is regarded as a benchmark from almost every aspect in the shipping industry. We focus on a “handwaving” description of its information systems applications as well as implementations. The whole information system could be called MGM, consisting of three subsystems, namely MARS, GCSS and FACT, aiming at handling contracts, booking accomplishment and finance accounting, respectively.

Once we start our observation from the most basic activities – slot booking and bill of lading (B/L) issuing – of a container shipping company, it would shed light on the whole applied information system. As shown in Fig. 2, the exporter books capacity based on his planned cargo transportation³, which is going to be transported to the importer. To simplify the process, we regard the exporter as the shipper and the importer as the consignee regardless the pure medium trader who actually does not produce or own cargo. The pure medium trader gains profits by buying and selling cargo at different price, or maybe only transacting the B/L rather than cargo itself.

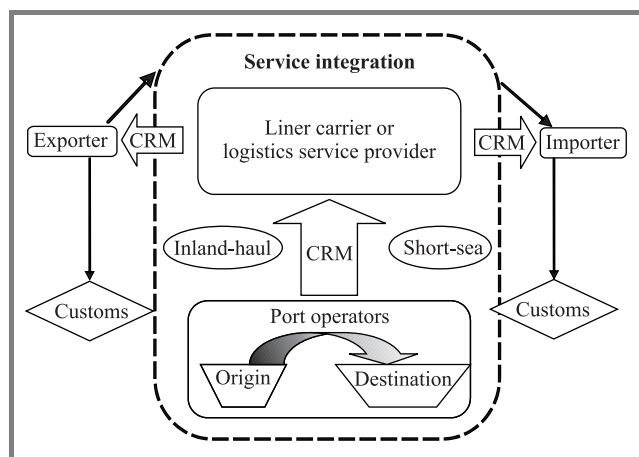


Fig. 2. The service integration and its cash/cargo/information flows (CRM – customer relationship management).

There are older and mature information systems applied within Maersk Sealand, namely MARS and RKDS, which help sales representatives and customer service staff to ad-

³Here we assume trade contracts in terms of CIF (cost, insurance and freight). In applying other INCOTERMS, the analysis is similar. For basic knowledge on INCOTERMS, we refer to, e.g., [14].

vide transportation services, arrange routes, input and output data. The interfaces of those systems were long-time criticized as not being user-friendly enough. They are still simultaneously applied together with a new system called global customer service system (GCSS) designed and developed by IBM. The GCSS is currently used mainly by the customer service group globally providing functions like routing, tracking, on-line publishing, etc. A “rater” – providing customer service – is supposed to use GCSS to figure out the service contract of a shipper and fix the service price according to this shipper’s booking. Beyond expectation, more “raters” are now hired in Maersk Sealand than during the period of applying the old systems, as it turns out to be even harder to exchange data using the new information system. Moreover, the interface of GCSS with other subsystems is not as smooth as expected. Manual work is arranged to supplement system problems.

Regarding tactic and strategic level business management, profit judgement and risk evaluation would be two main aspects for which information systems perform decision support functionality.

Process standardization. From a customers’ perspective, requirements would be well satisfied if they are met timely and specifically. In the past, once the requests of VIP customers change, the workflow of the carriers may change as well. However, implementing a new information system results in a situation where most customers are regarded exactly the same no matter what amount of cargo they transport, while those customized requirements would be noted in the specific entries inside the systems. Due to standardized workflows within the system even exception handling is assumed to be more streamlined especially when faced by employees who are new to specific situations.

Profit pre-analysis. Continuous deficits push decision makers to consider whether persisting transportation operations along the involved routes and ports are profitable or not. Various aspects are vital since any change of the liner routes and logistics networks would lead amounts of investment not only in marketing surveys but also in acquisition of infrastructures including vessels and cranes, etc. That is, it is a capital-condensed and cost-sensitive industry.

Similar to the operational systems of other liner carriers and logistics companies, MARS in Maersk Sealand provides distinctive options for cost per unit and expected benefit calculation for various types of containers regarding, e.g., volumes they occupy on deck and in haul (such as 20DC/40DC, i.e., a single 20- or 40-foot container containing dry cargo; HC, i.e. a 45-foot high cube container; etc.). Currently, an SAP R/3 package is implemented, namely financial accounting for container transport (FACT), and it is planned to be released by the end of 2008.

Risk evaluation. Risk evaluation based on historical data, service simulation, and expert judgement is of importance to demonstrate whether to accept specific transportation requirements. For risk management considerations regarding other types of cargo, such as crude and product oil see, e.g., [21].

Different types of containers as well as cargo need to be handled differently, especially reefer and hazmat containers. On December 18, 2006, the REACH (registration, evaluation, authorisation and restriction of chemicals) regulation was formally adopted by the European Union and is enforced since June 1, 2007. In order to save the testing cost on chemicals and to get an overview about which studies are available, a system which could serve as data sharing platform is currently under construction. A supplementary but vital requirement of this system is to ensure that not only manufacturers and importers but also their customers and distributors have the information they need to use and transport chemicals safely. Information relating to health, safety and environment properties, and risk measurement is required to be shared along the supply chain. Commercially sensitive information is not required to be exchanged [26]. Although REACH has just been put into force recently, its effect on information flow management within supply chains is regarded as huge.

However, it should be noted that, due to fast EDI processes, the information centre of the liner carrier need not be the centroid of any zone defined in Section 4. Actually, some of the information centres of the liner carriers are even located far from hubs, following various criteria such as human resources availability and cost. The geographic location of an information centre is not a key issue in this paper and it may be viewed as a fictitious node that contributes to the whole service network.

6. Conclusions and further research

In this paper, we have discussed the network structure of the maritime liner shipping companies and their spin-offs providing 3rd party logistics services. Commonalities with intermodal transportation in general as well as with telecommunications network design may serve as a means for advancing the subject. Moreover, game theoretical approaches may help to support strategic as well as tactical decision making in liner shipping. This may involve the assumption of cooperative as well as non-cooperative behaviors of involved players on different levels.

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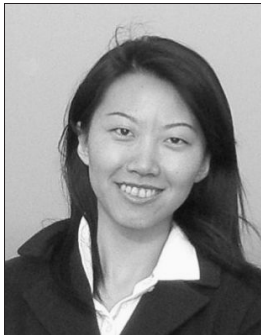
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Xiaoning Shi is a Ph.D. candidate jointly affiliated with the Institute of Information Systems at the University of Hamburg, Germany, and the Department of Management at the Shanghai Jiao Tong University, P. R. China. Her position in Hamburg is supported by the DAAD (Deutscher Akademischer Austauschdienst) and CSC (China Scholarship Council). Formerly, she was working as a teaching assistant and later as a lecturer at the Institute of International Shipping, Department of Naval Architecture Ocean and Civil Engineering, Shanghai Jiao Tong University. In 2005, she was a visiting research assistant at the University of Hong Kong and in 2002 she was working at Maersk-Sealand Shipping Corporation, Shanghai. She holds Bachelor and Master degrees in engineering from Dalian Maritime University (China). Her current research interests are in econometrical and game theo-

retical applications in the shipping/port industry and optimization of logistics networks.
 e-mail: shi@econ.uni-hamburg.de
 Institute of Information Systems
 University of Hamburg
 Von-Melle-Park 5
 D-20146 Hamburg, Germany
 Shanghai Jiao Tong University
 1954 Hua Shan Road
 Shanghai 200030, P. R. China



Stefan Voß is Professor and Director of the Institute of Information Systems at the University of Hamburg, Germany. Previous positions include full Professor and Head of the Department of Business Administration, Information Systems and Information Management at the University of Technology Braunschweig, Germany, from 1995 up to 2002. He holds degrees in mathematics (diploma) and economics from the University of Hamburg and a Ph.D. and the habilitation from the University of Technology Darmstadt. His current research interests are in quantitative/information systems approaches to supply chain management and logistics including public mass transit and telecommunications. He is author and co-author of several books and numerous papers in various journals. Professor Voß serves on the editorial board of some journals including being Editor of "Netnomics", Editor of "Annals of Information Systems", Associate Editor of "INFORMS Journal on Computing" and Area Editor of "Journal of Heuristics". He is frequently organizing workshops and conferences. Furthermore, he is consulting with several companies.
 e-mail: stefan.voss@uni-hamburg.de
 Institute of Information Systems
 University of Hamburg
 Von-Melle-Park 5
 D-20146 Hamburg, Germany