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ORIGINAL ARTICLE

Communication between deep sea container terminals and hinterland stakeholders: information needs and the relevance of information exchange

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Abstract Hinterland container transport is increasingly identified as an important element in door-to-door transportation of goods in the context of global supply chains. Container terminal operators also continuously seek strategies to distinguish themselves from their competitors by providing dedicated information on containers, transport means and the terminal. This paper explores the information needs of container terminals and hinterland stakeholders and highlights the importance of different information types for different stakeholders. Information needs are studied through gate survey, interviews and questionnaires sent to different parties involved in seaport-hinterland transportation at the APM Terminal in Rotterdam. This information is divided in three main categories: information about containers, information about transport means and information about deep sea terminal. In each category, the specific information types and the importance of that information for each hinterland party are discussed. The findings of this research can be used by different hinterland parties to optimize the planning and control of container logistics processes. They can also support developing customized ICT solutions for hinterland transportation.

Keywords Information · Freight transport · Hinterland · Intermodal · Container

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Introduction

Traditionally, the majority of deep container terminals have focused their business on terminal handling and port operations in the best interest of their main customers (i.e. container carriers). However, nowadays, terminal operators are more and more involved in linking sea terminals with inland terminals, or even final destinations in the supply chain, such as distribution centres of shippers (Veenstra and Zuidwijk 2010). This involvement in hinterland transport may also help to release containers faster and reduce terminal congestion at seaports (Franc and van der Horst 2010). At the same time, to improve the productivity, security, sustainability and safety in container operations, many container terminals are increasingly investing in higher automation. Automated guided vehicles (AGVs), position detection systems (PDS) and radio frequency identification (RFID) are examples of technologies that have been increasingly applied to automate container handling processes in a container terminal (Brinkmann 2011; Carlo et al. 2014). With the growth in automation, more information about terminal processes has become available in recent years. This information can be used not only to improve operations in terminal operating systems (TOS), but also to speed-up and optimize hinterland transportation processes (Angeloudis and Bell 2011). This is even more important since—due to the relatively limited growth in container volumes—the competition is heating up in many deep sea container ports (Notteboom and Rodrigue 2008). As a result, the hinterlands of many seaports are expanding from captive to contestable regions where major container ports increasingly compete with each other (De Langen 2007). Therefore, terminals also increasingly seek to differentiate themselves from their competitors by dedicated information provision about containers, transport means and the terminal.

This paper aims to explore the information needs of hinterland parties and indicate its importance from different actors' perspectives. The ability to share information between these parties, and to track shipments in transit, is critical in improving the coordination of freight transportation in multimodal freight transport (Crainic et al. 2009). Multiple challenges can be distinguished in the process of information exchange between deep sea container terminals and hinterland parties. The challenges can be divided in three categories: (1) Lack of information about the container status: these regard unknown statuses of containers, incorrect customs documentation and arrival and departure times of containers; (2) Lack of information about the transportation means: these are issues related to the planning of trucks and barges, and also to the arrival and departure times of deep sea vessels; (3) Lack of information about the deep sea terminal: this category involves issues about barge planning and the lack of insight in waiting times and turnaround times.

Altogether, the above indicates insufficient information availability to hinterland parties, so as to efficiently organize hinterland transport. In many cases, hinterland parties make their decisions based on incomplete information. Filling this gap calls for an analysis of the information needs of different hinterland parties and of the importance of the different information types for different actors. Therefore, the following main research question is defined in this paper:

What are the information needs of hinterland parties and how important is this information to them?

In the next section, physical transport flows, actors and information flows are discussed. A literature review concerning information exchange in transport chains is presented next, followed by the information needs of hinterland parties and the discussion of the importance of different types of information for different parties. Finally, our conclusions are presented, together with recommendations for further research.

Container terminal hinterland transport: flows, actors and information

Physical flows in the transport chain

A transport chain consists of an export part between exporter and (deep) sea shipping and an import part between the (deep) sea shipping and the importer. In this paper, the focus is on the import part of the transport chain because the APM Terminal in Rotterdam receives more import containers than it exports. The transport chain for import containers starts when the (deep) sea vessel arrives at the terminal. The terminal operator unloads the container and loads it on a hinterland modality. Hinterland modalities transport the container, optionally via an inland terminal, to the consignee/importer (Fig. 1).

Hinterland transport is mostly arranged by freight forwarders. The role of the freight forwarder differs per region (Ducruet and Van der Horst 2009). In the hinterland of the Port of Rotterdam, freight forwarders are mostly hired by importers to coordinate the transport chain. This involves the bookings for the (deep) sea transport and the hinterland transport. Sometimes freight forwarders also have distribution and transport document tasks (Ducruet and Van der Horst 2009).

Information flows in the import transport chain

Information flows to organize the unimodal truck transport chain are depicted in Fig. 2. The unimodal truck flow in Fig. 2 is placed in a semi-circle, with the same orange lines for the physical flows. The blue lines are added to give an overview of the information flows. The importer receives information from the exporter, or freight forwarder, about the container and (deep) sea shipping (not visible in Fig. 2). When the importer receives the shipping details, he normally asks a freight forwarder to book the hinterland transport (1). The freight forwarder makes a booking at the truck operator (2), which sends a confirmation of booking back to the

Fig. 1 Transport chain import containers. *Source*: Menger (2016)

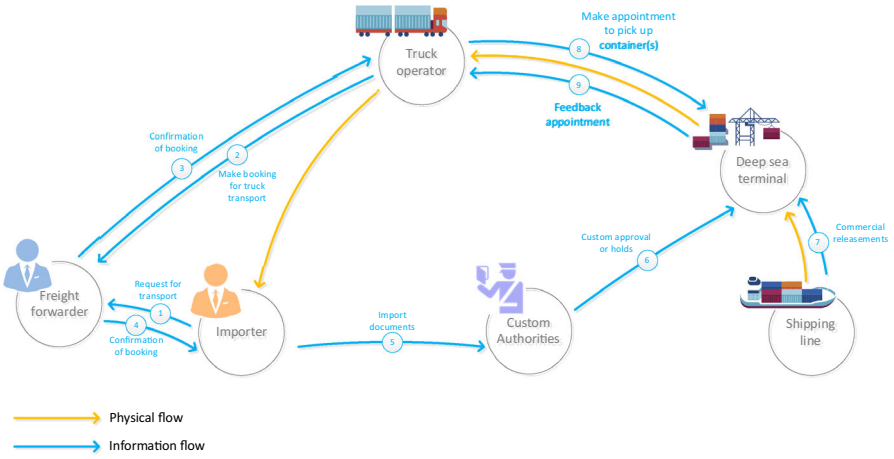

Fig. 2 Flows unimodal transport. *Source*: Menger (2016)

freight forwarder (3). The freight forwarder informs the importer that the hinterland booking is done (4). Now the importer sends the import documents to the customs authorities (5). Sometimes this is done by the freight forwarder. Customs authorities inform the terminal about the release or holding of goods (6). The shipping line also communicates with the terminal about the commercial release of the container (7). Number 6 and 7 may happen in a reversed order. When the container is released, the truck operator makes an appointment at the terminal to pick up the container (8). The deep sea terminal gives feedback on this appointment request (9). When this is done, all necessary information is exchanged and the container can be picked up by the truck operator.

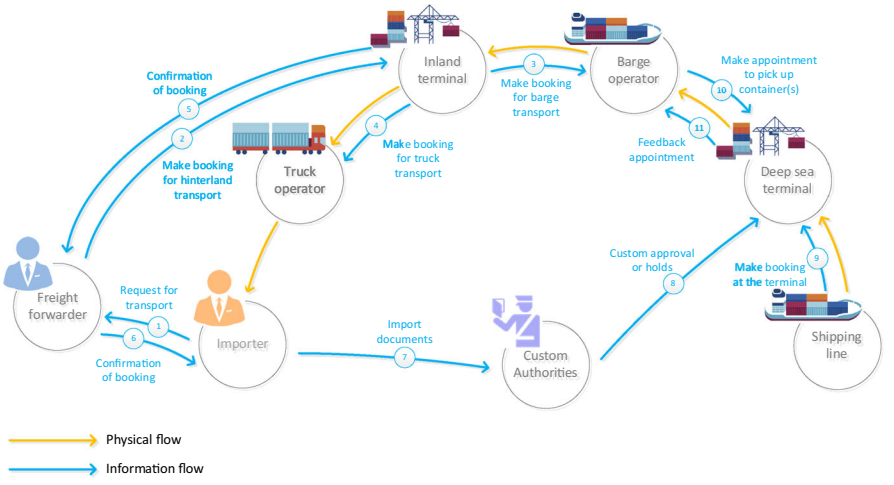

Fig. 3 Flows intermodal transport. *Source*: Menger (2016)

Information flows to organize the intermodal transport chain are depicted in Fig. 3. Again, the actors are placed in a semi-circle with an orange line between them to indicate the physical flows. The information flows necessary to organize intermodal transport are mostly the same as for unimodal transport. An important difference is that there are more actors in intermodal transport. Here, the hinterland transport is often booked at the inland terminal (2). The inland terminal makes the bookings for barge transport (3) and truck transport (4), and sends a confirmation back to the freight forwarder (5). It is possible that the freight forwarder makes individual bookings at the barge operator and the truck operator, but in the hinterland of the Port of Rotterdam, it is more common that the inland terminal books the inland transport. When the hinterland transport is arranged, the information flows (6–11) are the same as for unimodal transport (4–9), with the only difference that not the truck operator but the barge operator makes an appointment at the deep sea terminal.

Literature review about information in transport chains and research method

Information in transport chains

Information can be defined as 'facts provided or learned about something or someone' (Oxford Dictionaries 2015). In scientific literature, the terms 'information' and 'data' are often used interchangeably. 'Information Hierarchy' helps to differentiate among different types of facts and describes a structural relationship between them (Wallace 2007):

- *Data* Observation or signals about the current state of a system (raw facts)
- *Information* Data organized and presented by someone or for a specific purpose
- *Knowledge* Information that is processed or organized in some ways to be a basis for action taking
- *Wisdom* Distilled and integrated knowledge and understanding.

Based on this classification, information is data that are edited or processed to something presentable. Receiving and understanding information leads to more knowledge. This information (or the knowledge that is created based on that information) is the basis for decision making by an actor (Liew 2007). For example, in a transport chain, better decisions on transport services or modality can be made with more information on, e.g. the time of availability of transport means, or the circumstances of a shipment-in-transit. In a transportation system, there are different types of information, which can be classified in a number of ways. In this paper, we classify information types in two main ways. The first one is a categorization in chronological order. Here, we have four main sub-categories of information:

- *Fixed information* This is information that does not change over time and is fixed at any point in time along the transport chain. Examples are container type or container code.

- *History* This is information about events that happened in the past, for example, the time and modality at gate (in/out).
- *Status* Information about the current situation of an object. This could be, for example, the location of a container in the stacking area.
- *Predictions/future events* This information contains forecasts about future events or situations, for example, the expected truck turnaround times at a terminal.

The second way to categorize information is per level (or unit of analysis). In this classification, we may distinguish between three information levels:

- *Container level* This is information about individual containers. This information could be exchanged for multiple containers at the same time. Information about two different containers can be partly the same, but is never completely the same.
- *Transportation mean level* This level contains information about the (deep) sea vessels, barges and trucks.
- *Deep sea terminal level* The information in this level is about terminal information like the terminal planning or capacity.

In the end, the information characteristics and the information types resulted in the information types presented in Tables 2, 3, 4 and 5.

Information exchange in container transport chains

A reliable container transport chain contains as few uncertainties as possible. To reduce the uncertainties along a transportation chain, information exchange among parties is a necessity (Zhou and Benton 2007). Better communication may also lead to a faster response to sudden changes or disruptions (Olesen et al. 2013a). This finally results in a better match of capacity with demand, better logistics planning and more efficient use of resources. Several different types of information can be shared along the supply chain. Mirzabeiki et al. (2009) discuss nine value-adding supply chain information types: the available timeslots at the terminal, container status, terminal capacity, customs documents, prediction of the handling time, the location of the products/containers, the conditions of the products and shipment quantity.

According to Flynn et al. (2010), the goal of information exchange is to provide maximum value to the customer at low cost and high speed. When there is more information available about the arrivals of deep sea vessels, barges and trucks, better terminal planning could be made, with reduced waiting times. With real-time information available, schedules could be better adapted to changes in the planning (Olesen et al. 2013b). More exchange of information could also lead to improved transport chain integration (Vanpoucke et al. 2009). A better integration of the transport chain has several advantages, for example, increased reliability throughout the whole transport chain (Panayides and Song 2009). This is possible because customers receive more (real-time) information about order status, availability of products, tracking of orders and invoices (Mirzabeiki et al. 2009). This leads to

shorter waiting times (Olesen et al. 2013b) and cost savings (Heilig and Voß 2014). Flexibility also improves, which leads to a more competitive position of the port or deep sea terminal (Mirzabeiki et al. 2009).

To facilitate information exchange, many innovative technologies—like RFID, GPS-enabled devices and Web-enabled paperless information exchange systems—are present in the freight transportation domain. These technologies—which are sometimes termed 'freight Intelligent Transport Systems (ITS)' or 'freight Smart Transport Management (STM)' systems (Stefansson and Lumsden 2009)—help parties replace manual and repetitive work and allow more accurate information exchange in a chain. A freight ITS usually comprises three elements, namely intelligent infrastructure, intelligent vehicle and intelligent freight (Stefansson and Lumsden 2009). These elements work together to exchange information and transport cargo in an integrated way. According to Olesen et al. (2013b), the lack of information exchange in a transportation chain has three main causes: trust, availability and quality of data and the complexity of the system and/or technology. Companies are only willing to share information when they trust both the system and the companies. This means that there are different information needs and importance of information.

Information needs and the importance of information

Research methods used to analyse information

In order to determine the information needs and the importance of information for different parties, three research methods have been used in this paper: gate survey, interviews and a questionnaire. Using multiple methods supports the validity of results and elucidates complementary aspects of the same phenomenon (Patton 1999).

Gate survey

The gate survey is used to determine the gap in information exchange between hinterland parties and deep sea terminals. The questionnaire was administered over five days, from 07h00 to 23h00. The days were spread over six different weeks and different working shifts in order to cover all the working schedules. When hinterland parties have a problem due to lack of information, they usually call the terminal gate. The gate survey was a short questionnaire to register all these calls. Calls registered over a period of time provide a good overview of the problems caused by the lack of information in hinterland transportation. The questionnaire was kept as simple as possible to ease the filling-in effort of gate employees. It consisted of seven questions. The first four questions were container number, booking number, PIN code and TAR code. The other three questions concerned modality, subject of the phone call and whether the caller was able to find the answer online. Of course, the amount of information that can be obtained from the gate survey is limited. Also, other important information, obtained via other

channels, is not mentioned in the phone calls, which may lead to an incomplete overview of information needs. Furthermore, the gate survey is labour intensive. Despite these challenges, the gate survey is a useful and practical method to study the information needed by hinterland parties. The shortcomings of this method are covered with the next two research methods, as explained in the following sections.

Expert interviews

To determine the information needs of hinterland parties, we also carried out a number of expert interviews. Interviews can be structured interviews or open interviews (Baarda et al. 1995). Structured interviews are based on a pre-defined list of questions. This was less suitable for this research, because the questions could be different for each stakeholder group. There could even be differences between two companies from the same group. For instance, an importer who transports all containers by barge and one who transports all containers by truck have different information needs and thus different interview questions. In an open interview, the interviewer explores the topic and the viewpoint of the interviewee by asking questions (Baarda et al. 1995). Accordingly, answers could be accessed very quickly and follow-up questions could be asked directly. There are multiple types of open interviews. For this research, we used the semi-structured interview method. Interviews were used to (1) determine the information needs of hinterland parties, (2) determine why the different information types are important for different parties. In total, 21 interviews were conducted based on a selection made by APM Terminals out of their customer base. The first four interviews were pre-interviews, aiming to get a better overview of the problems and information needs of hinterland parties. After the pre-interviews, 17 interviews followed and only the results of the latter were taken into account in our analysis. For each stakeholder group, we interviewed three companies, except for the barge operators for which five companies were interviewed.

Questionnaires

Questionnaire is an appropriate research method to study self-supported beliefs (Patton 2005). Questionnaires were used in this research to determine the importance of different information types for different hinterland parties. The questionnaire starts with several general questions about the company profiles (e.g. company name, type, number of TEU per year handled and the job title of the person filling out the questionnaire). This is followed by a list of information types that are derived from the gate survey and the interviews. All information types were divided in three categories; one for each level (container, transportation means and deep sea terminal). The importance of information types was measured using a 7-point Likert rating scale (Allen and Seaman 2007). As a similar questionnaire was sent to all hinterland parties, there was also a ‘not applicable’ option included for each question. The questionnaire was sent to 15 companies in each stakeholder group (75 companies in total). The response rate is given in Table 1.

Table 1 Responses questionnaires

Company type	Questionnaires sent	Responses (n)	Response rate (%)
Truck operators	15	9	60
Barge operators	15	5	33
Freight forwarders	15	1	7
Importers	15	4	27
Exporters	15	1	7
All	75	20	27

Importance of information about containers

The first column of Table 2 contains the tested information types about containers resulting from the gate survey and the interviews. The next columns give the average scores (μ) on importance from 1 (not important) to 7 (very important). After the average scores, the number of responses (n) for the information type is given. When a respondent mentioned that a specific information type is not applicable for him/her, this was not considered in the calculation of the average score. Therefore, the number of responses (n) is less in those cases. The μ and n are given for every actor group with enough responses ($N \geq 4$).

"Container type" is an important piece of information for all parties. During the interviews, several experts noted that they would like to have this information from the terminal, because the information received from the shipping lines was not always reliable. For 'history' information types, confirmation that a container is discharged is regarded as the most important. Again, this information is communicated by the shipping line, but it is not always correct. Once a container is discharged from a vessel, it can be picked up for further hinterland transport; it is thus important that this information is correct. Information about the current status of a container contains several important information types: information about customs holds and documents, as well as the availability of the container. These information types were mentioned both in the interviews and the gate survey. From the interviews, we conclude that if hinterland parties have more information about the predictions and future events of containers, they could themselves make better estimates about when they could pick up their container. Overall, hinterland parties would like to know, in as much detail as possible, when a container can be picked up or delivered. If the provided information is of good quality, the planning of the transport companies can improve, leading to a more reliable service for their customers.

Importance of information about transportation means

The importance of information needs about transportation means is given in Table 3.

The most important information about the 'history' information types are the actual times of arrival and departure of (deep) sea vessels (ATA and ATD). With

Table 2 Importance of information types about containers

Information about containers	All actors		Truck operators		Barge operators		Importers	
	$N = 20$		$N = 9$		$N = 5$		$N = 4$	
	μ	n	μ	n	μ	n	μ	n
Fixed information								
Container type	6, 2	19	6, 6	8	6, 0	5	6, 0	4
History								
Total time of the container in the stack at the terminal	3, 5	18	2, 4	7	3, 0	5	5, 8	4
Confirmation export container loaded on vessel	3, 4	16	2, 9	7	3, 8	5	3, 0	2
Confirmation import container discharged from vessel	6, 7	17	7, 0	8	6, 2	5	6, 7	3
Times gate in/gate out at terminal	4, 6	19	4, 4	8	4, 0	5	5, 8	4
Times gate in/gate out container terminal overseas	3, 4	16	2, 7	6	3, 8	5	4, 3	3
Modality gate in/out at terminal	4, 7	18	4, 8	8	4, 2	5	5, 7	3
Current status								
Container status for customs holds	6, 6	19	7, 0	8	6, 2	5	6, 5	4
Type of customs holds	6, 4	19	6, 6	8	6, 2	5	6, 5	4
Documents OK	6, 7	19	7, 0	8	6, 8	5	6, 5	4
Pre-check container available	6, 8	19	7, 0	8	6, 6	5	7, 0	4
Presence container at terminal	6, 6	19	7, 0	8	6, 6	5	6, 3	4
Type stack import containers	3, 8	17	4, 1	7	2, 6	5	5, 0	4
Position container at vessel	4, 2	18	3, 3	7	4, 0	5	6, 5	4
Temperature settings reefer	4, 2	18	3, 3	8	4, 5	4	5, 3	4
Actual temperature reefer	4, 1	18	3, 0	8	4, 5	4	5, 0	4
Difference between actual and desired temperature reefer	4, 6	18	3, 3	8	6, 0	4	4, 5	4
Container registered as early arrival yes/no	5, 4	18	5, 9	7	4, 0	5	6, 0	4
Container registered as late arrival yes/no	5, 7	18	5, 9	7	5, 2	5	6, 0	4
Predictions and future events								
Expected time for customs scans	5, 6	19	5, 9	8	5, 4	5	6, 3	4
Expected time of discharge from vessel	6, 1	19	6, 8	8	5, 2	5	6, 5	4

N number of responses per actor group, μ average score, n number of responses per information type

this information, hinterland parties make a better estimation of when their containers are discharged, which enables them to make a better and more reliable planning. In contrast to information on containers, the importance of information on transportation means varies among stakeholder groups. Apparently, information on arrival and departure times of barges is important for barge operators, but not for truck operators and importers. Important information types of the current status of transportation means are mainly about the delays of (deep) sea vessels and the possible impact of these delays; e.g. changes in the cargo cut-off time (CCO) and delays in the yard opening time (YOT). Delays of sea vessels mainly have an impact on import containers, and they only have an impact on export containers when yard

Table 3 Importance of information types about transportation means

Information about transportation means	All actors		Truck operators		Barge operators		Importers	
	$n = 20$		$n = 9$		$n = 5$		$n = 4$	
	μ	n	μ	n	μ	n	μ	n
History								
Actual time of arrival (deep) sea vessel (ATA)	6, 4	20	6, 0	9	6, 6	5	7, 0	4
Actual time of arrival (deep) sea vessel (ATD)	5, 6	19	5, 2	9	6, 6	5	4, 3	3
History (deep) sea vessel (e.g. changes in ETA, CCO, YOT)	5, 1	19	4, 6	9	6, 4	5	4, 0	3
Actual time of arrival barges	3, 4	17	2, 6	8	6, 0	5	2, 0	2
Actual times of departure barges	3, 6	17	2, 4	8	6, 6	5	3, 0	2
History barge (e.g. changes in ETA, ETD, cancellations)	3, 6	17	2, 2	8	6, 4	5	3, 5	2
Current status								
Delays of (deep) sea vessels	6, 8	20	6, 9	9	6, 4	5	7, 0	4
Delays in yard opening time	5, 7	19	6, 9	9	4, 2	5	5, 0	3
Changes in cargo cut-off time	6, 1	19	6, 4	9	5, 6	5	5, 7	3
Progress of discharging/loading (deep) sea vessel	5, 7	20	6, 4	9	4, 6	5	6, 0	4
Progress discharging/loading barge	3, 9	17	2, 9	7	5, 8	5	4, 3	3
Changes in hinterland modality	3, 5	18	4, 0	8	3, 4	5	3, 3	3
Predictions and future events								
Estimated time of arrival (deep) sea vessel (ETA)	6, 4	20	6, 7	9	6, 4	5	6, 5	4
Estimated time of departure (deep) sea vessel (ETD)	5, 5	19	6, 3	9	5, 4	5	3, 0	3
Cargo cut-off time (CCO)	5, 4	19	5, 8	9	6, 0	5	3, 3	3
Yard opening time (YOT)	5, 2	19	6, 3	9	4, 2	5	3, 3	3
Estimated time of arrival barges	4, 0	16	3, 6	7	6, 0	5	2, 0	2
Estimated time of departure barges	4, 1	16	3, 4	7	6, 0	5	3, 0	2
Origins/destinations barges at terminal	2, 8	16	2, 7	7	3, 6	5	1, 5	2
Time of arrival/departure barges at inland terminal	2, 9	16	2, 0	7	3, 8	5	3, 0	2
Available capacity barges at terminal	2, 9	16	2, 0	7	3, 8	5	2, 5	2
Prices for barge transport from/to APMT MVII	3, 3	15	2, 6	6	3, 8	5	2, 0	2

N number of responses per actor group, μ average score, *n* number of responses per information type

opening and cargo cut-off times also change. Changes in the YOT and CCO are mainly important for truck operators, and less important to barge operators and importers. This is possibly because the capacity of a truck is lower than that of a barge; therefore, it would be more influential for truck operators when one container could not be delivered. To importers, this information is of lesser importance. The most important information type about predictions and future events is the estimated time of arrival of the (deep) sea vessels (ETA). This is because the ETA is a key information in the planning of hinterland processes. It is remarkable that the information about destinations and available capacity of barges is not important to

most stakeholders. The arrival/departure times of barges are only important for barge operators, while the expectation is that importers would also like to have access to this information because, they may know when a container arrives at the inland terminal. Overall, the most important information types for truck operators, importers and the average overall responses are almost the same. Most information types are about the arrival times of (deep) sea vessels.

Importance of information about deep sea terminals

The importance of information types about terminals is given in Table 4.

The most important fixed information at terminal level is the closure of the terminal and the explanation of the different types of customs holds and errors. There exist a large number of different errors and customs holds with different error codes and the meanings of these codes are not always known, leading to suboptimal decisions and thus inefficiency. The information types about the *history* were about the past truck turnaround times. This information did not get a high score in the analysis. This might be because information on truck turnaround times is provided after the truck is delayed; consequently, it is not very useful to hinterland stakeholders because truck schedules cannot be changed based on the provided information. In other words, the value of information is not only defined by its "availability" to the stakeholder, but is also influenced by information characteristics like "timeliness"—or the timing that the information becomes available for use. The information types about the current status of the terminal, in the questionnaire, concern malfunctions and IT outages at the terminal. Both information types have a high level of importance from the point of view of stakeholders. This can be explained by the fact that malfunctions or IT outages directly influence the operations of most hinterland parties. The most important information type in the category of 'predictions and future events' is the barometer for crowdedness at the truck gate. Hinterland parties—especially truck operators—would like to know how busy the truck gate of the terminal is and what the expected future pattern would be. The availability of this information enables hinterland actors to make better estimates of truck turnaround times, leading to higher efficiency and better asset utilization—especially for trucking companies.

Discussion and implication of findings

Overall, there are many similarities in the information needs of the different actor groups. For instance, the status of a container, ETA of (deep) sea vessel, and status of the terminal are important information types for most actors. The largest differences in information importance are between truck and barge operators. However, although they would like to have different information types, they need that information for the same purposes. For example, while truck operators want to have information about the crowdedness at the truck gate, barge operators want to know about the planning of the barge quay and free time slots. A lot of the information types at the container and transportation means level have as final aim

Table 4 Importance of the information types about the deep sea terminal

Information about the deep sea terminal	All actors		Truck operators		Barge operators		Importers	
	$n = 20$		$n = 9$		$n = 5$		$n = 4$	
	μ	n	μ	n	μ	n	μ	n
Fixed information								
Closures at terminal	6, 8	20	6, 9	9	6, 8	5	6, 5	4
Newsletter	5, 2	19	4, 7	9	6, 0	5	5, 3	3
Explanation of different types of customs holds	6, 2	20	6, 7	9	5, 4	5	6, 3	4
History								
Report for truck turnaround times last week	4, 6	18	4, 2	9	4, 0	4	5, 7	3
Causes high truck turnaround times	5, 1	18	5, 3	9	4, 0	4	5, 3	3
Truck turnaround time for individual trucks	4, 4	18	4, 6	9	3, 8	4	4, 0	3
Current status								
Malfunctions at terminal	6, 5	20	6, 7	9	6, 6	5	6, 0	4
IT outage at terminal	6, 3	20	6, 6	9	6, 4	5	5, 8	4
Predictions and future events								
Barometer for crowdedness at the truck gate terminal	5, 9	19	6, 6	9	4, 5	4	6, 0	4
Barometer for crowdedness at the barge quay terminal	4, 1	17	2, 7	7	6, 2	5	4, 3	3
Free time slots barge quay	4, 3	15	2, 4	5	6, 6	5	4, 0	3
Planning barge quay	4, 3	16	2, 7	6	6, 4	5	4, 3	3
Predictions truck turnaround time terminal	5, 1	18	4, 9	9	4, 8	4	6, 0	3
Weekly pattern number of trucks at terminal	4, 7	18	4, 2	9	4, 8	4	5, 0	3
Overview barge waiting times	4, 1	16	2, 3	6	6, 2	5	4, 3	3
Weekly pattern barge volumes at terminal	3, 4	14	2, 4	5	4, 4	5	3, 5	2
Future shipping services at APMT MVII	4, 7	16	3, 9	8	5, 8	5	5, 0	1

N number of responses per actor group, μ average score, *n* number of responses per information type

to make a better estimation of when a container is available to pick up or when a container can be delivered at the terminal.

An overview of important information types is presented in Table 5. In general, the four groups of important information types for the hinterland parties are container status, moment of container availability, terminal crowdedness at the truck gate and terminal status. Overall, information about transport means is regarded as less important. The *container status* contains information types about the release of the container and other data. Hinterland parties want to know if there are customs holds on the container and, if so, which types of customs holds. Information about the temperature of reefers and whether a container is registered as a late arrival or not is also within this information group. The *moment of container availability* is important. The pre-check of whether a container is available is one of the information types in this group. Also, the information about the estimated and actual times of arrival and departure of (deep) sea vessels, the progress of discharging/loading and delays were mentioned. The third group of important information types

Table 5 Most important information types

	All actors	Truck operators	Barge operators	Importers
Containers	Pre-check container available (6, 8) Confirmation import container discharged from vessel (6, 7) Documents OK (6, 7) Container status for customs holds (6, 6) Presence container at terminal (6, 6)	Confirmation import container discharged from vessel (7, 0) Container status for customs holds (7, 0) Documents OK (7, 0) Pre-check container available (7, 0) Presence container at terminal (7, 0)	Documents OK (6, 8) Pre-check container available (6, 6) Presence container at terminal (6, 6) Confirmation import container discharged from vessel (6, 2) Container status for customs holds (6, 2) Type of customs hold (6, 2)	Confirmation import container discharged from vessel (6, 7) Container status for customs holds (6, 5) Type of customs hold (6, 5) Documents OK (6, 5) Position container at vessel (6, 5) Expected time of discharge from vessel (6, 5)
Transportation means	Delays of vessels (6, 8) Estimated time of arrival vessel (ETA) (6, 5) Actual time of arrival vessel (ATA) (6, 0) Progress of discharging/loading vessel (6, 0) Changes in cargo cut-off time (5, 7)	Delays of vessels (6, 9) Delays in yard opening time (6, 9) Estimated time of arrival vessel (ETA) (6, 7) Changes in cargo cut-off time (6, 4) Progress of discharging/loading vessel (6, 4)	Actual time of arrival vessel (ATA) (6, 6) Actual time of departure vessel (ATD) (6, 6) Actual times of departure barges (6, 6) History vessel (e.g. changes in ETA, CCO, YOT) (6, 4) History barge (e.g. changes in ETA, ETD, cancellations) (6, 4) Delays of vessels (6, 4) Estimated time of arrival vessel (ETA) (6, 4)	Actual time of arrival vessel (ATA) (7, 0) Delays of vessels (7,0) Estimated time of arrival vessel (ETA) (6,5) Progress of discharging/loading vessel (6,0) Changes in cargo cut-off time (5,7)
Terminal	Closures at terminal (6, 8) Malfunctions at terminal (6, 5) IT outage at terminal (6, 3) Explanation of different types of customs holds (6, 2) Barometer for crowdedness at the truck gate terminal (5, 9)	Closures at terminal (6, 9) Explanation of different types of customs holds (6, 7) Malfunctions at terminal (6, 7) IT outage at terminal (6, 6) Barometer for crowdedness at the truck gate terminal (6, 6)	Closures at terminal (6, 8) Malfunctions at terminal (6, 6) Free time slots barge quay (6, 6) IT outage at terminal (6, 4) Planning barge quay (6, 6)	Closures at terminal (6, 5) Explanation of different types of customs holds (6, 3) Malfunctions at terminal (6, 0) Barometer for crowdedness at the truck gate terminal (6, 0) Predictions truck turnaround time terminal (6, 0)

is about *the crowdedness on the terminal*. The crowdedness can be subdivided in two types: crowdedness at the truck gate and crowdedness at the barge quay. For the truck gate, hinterland parties would like to have a barometer, indicating the crowdedness on the terminal. Similar to the truck barometer, hinterland parties would like to have a barometer for the crowdedness at the barge quay. They also want to have more detailed information about the planning of the barge quay and the waiting times for the barges. This is because barges have often long waiting times in the port. The last category is about the *status of the terminal*. This includes closures, malfunctions and IT outages. When the terminal is closed, this directly influences the operations of hinterland parties and therefore these information types are important to all hinterland parties.

Several overarching conclusions can be drawn, based on Table 5. First, since there is an overlap in the desired information types at the 'container' level, the terminal operator may give priority to investing in a platform to share this information with hinterland parties. A similar observation can be made about the information types regarding 'terminal', and there are quite some similarities between the different actor groups in terms of importance of these information types. If there is a larger demand for information by more actor groups, this is expected to encourage the terminal to provide this information. Secondly, information types regarding 'transport means' show quite some diversity between the different actor groups. This consideration is somewhat expected, given the different transport means used by the different actor groups. This diversity, however, reduces the likelihood of these information types being supplied by the terminal operator. Thirdly, it can be seen that truck operators have a quite high information demand, but they have limited resources to access that information. The willingness to pay for the information has not been tested in this research. It is doubtful if all information types will remain as important as stated here, when the terminal introduces a price for the information that it provides. Moreover, information gathering and sharing is not for free. The terminal must invest in information systems to gather the information, process it, communicate it and possibly also to answer questions about the information provided. Therefore, it would be interesting to see in further research how the importance of information types would react to the pricing of the information. Also, effective pricing strategies for information sharing by a terminal operator would be a relevant direction for future work.

Conclusions and further research

A transport system involves many actors, and requires a considerable amount of coordination and information exchange between them. Although a number of papers have studied the strategic value of information in supply chains, there is not much scientific literature about information exchange in container transport chains—and especially on the information exchange between terminals and hinterland parties. This paper aimed to fill this gap. The information needs of different actors have been studied through gate survey, interviews and questionnaires. The collected

Table 6 Most important information types—all actors and the importance on scale 1–7

Containers	Transportation means	Deep sea terminal
Pre-check container available (6, 8)	Delays of (deep) sea vessels (6, 8)	Closures at terminal (6, 8)
Confirmation import container discharged from (vessel (6, 7)	Estimated time of arrival (deep) sea vessel (ETA) (6, 5)	Malfunctions at terminal (6, 5)
Documents OK (6, 7)	Actual time of arrival (deep) sea vessel (ATA) (6, 4)	IT outage at terminal (6, 3)
Container status for customs holds (6, 6)	Progress of discharging/loading (deep) sea vessel (6, 0)	Explanation of different types of customs holds (6, 2)
Presence container at terminal (6, 6)	Changes in cargo cut-off time (5, 7)	Barometer for crowdedness at the truck gate terminal (5, 9)

information was divided in three groups: Information about containers, information about transport means and information about the terminal. The information needs at container level mainly concern the current container status like customs holds, or the presence of the container at the terminal. The information needs on transportation means level are mainly about (deep) sea vessels, for example, the estimated time of arrival (ETA), or cargo cut-off time (CCO). At terminal level, the information needs are mainly information about the terminal (e.g. closures) and information about predictions and future events.

The framework on information types—developed by literature search, the gate survey and the interviews—was later tested in the questionnaires to also study the importance of different information types for different hinterland parties. The most important information types are listed in Table 6, and this—combined with the identified information needs discussed above—answers the main research question of this paper.

This paper is a first step in the determination of the information needs of hinterland parties. Based on the results of this paper, we propose a number of directions for future research. A first possible direction includes extending the sample size of respondents. Given the limited size of the core customer base of APM Terminals, this was not possible within the current research. To get a more reliable overview of the information needs of hinterland parties, it is recommended to expand the research with more respondents from the respective actor groups. Furthermore, in this extension, one may also focus on willingness to pay for different information types by different actor groups. Secondly, future research may focus on the analysis of the impact of different information types on the performance of the transport chain. For this purpose, a simulation framework can be developed and the value of information sharing in different scenarios can be studied. Thirdly, this research has focused on the information needs of different hinterland parties. The mechanisms (and incentive design) to share information between parties is not discussed here, and this is another possible direction for further research.

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