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A swift turnaround? Abating shipping greenhouse gas emissions via port call optimization

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Abstract

Waiting times for trucks, trains, airplanes and ships in service represent apparent transport system inefficiencies, and measures to reduce these may have the potential to abate transport GHG emissions. In international shipping, transportation researchers have pointed out that reduced waiting time in association with port calls holds such promise. We explore the potential for GHG abatement through port call optimization, focusing on crews and their employers - the shipping companies. Adding new empirical evidence to the transportation literature, we confirm the existence of idle time during port calls, and go beyond this in describing the causes for it. We show how several port stakeholders, including government officials, limit the crews' and shipping companies' room for maneuver in relation to port calls. We also show why the process of reducing waiting time in shipping is more complex than that for onshore transport modes, where real-time traffic information guides drivers' route choices, and reduces congestion and waiting time. Our findings have implications for both policy makers and transportation research.

Keywords: Greenhouse gas abatement; Waiting time; Port call optimization; Speed reduction; Energy efficiency; Real-time traffic information.

Highlights

- We explore the potential for GHG abatement via reduced turn-around-time in port
- We document why waiting time occurs for ships in association with port calls
- We show how port stakeholders limit crews' and shipping companies' room for maneuver
- We provide evidence that port officials often cause crew stress and delay
- We recommend IMO to facilitate port stakeholders' sharing of real-time traffic data

1. Introduction

For all major transport modes, measures to reduce waiting time can potentially abate greenhouse gas emissions (GHG). In theory, such measures can improve the flows of trucks, trains, airplanes and ships and lower fuel consumption and emissions without adverse effects on productivity, transport capacity or cargo transit time. In trucking, real-time traffic information helps drivers to plan routes efficiently, avoid congested roads and reduce waiting time (Yang and Koutsopoulos 1996; Jou et al. 2005; Vlassenroot et al. 2010; Lee et al. 2010). In rail, real-time traffic information enables dynamic route choices and reduces congestion, fuel consumption and emissions (Mazzarello and Ottaviani, 2007; Corman et al. 2009; Quaglietta et al. 2016). Aviation has also adopted advanced traffic management systems for traffic flow optimization and eco-efficient route execution (van Manen and Grewe 2019). In international shipping, however, measures to reduce waiting time have only recently started to attract attention (Lind et al. 2016).

International shipping accounts for approximately 2.2 per cent of global, anthropogenic CO2 emissions (in 2012) (Smith et al. 2014), and faces considerable challenges in its abatement efforts (Bows-Larkin 2015; Halim et al. 2018; Psaraftis 2018; Balcombe et al. 2019) as also acknowledged by industry (BIMCO 2019c) and policy makers (IMO 2018). In 2018, the United Nations' International Maritime Organization (IMO) set goals for international shipping to reduce CO2 emissions per transport work by at least 40% by 2030 (relative to 2008) and the total annual GHG emissions by at least 50% by 2050 (relative to 2008) (IMO 2018). These are challenging goals and the pathways to achievement remain unclear. Measures will likely need to be multifaceted, and reduced waiting time presents one such approach (Faber et al., 2011; Rehmatulla 2014; Rehmatulla and Smith 2015; Johnson and Styhre 2015; Jia et al. 2017; UNCTAD 2019). A ship's fuel consumption is proportional to the third or fourth power of the speed (Faber et al. 2011; Psaraftis and Konvotas 2013; IMO 2016; Ng 2019), and reducing the speed of vessels whilst underway is already recognized as effective in reducing emissions (e.g., Corbett et al. 2009; Lindstad et al. 2011; Psaraftis 2019; BIMCO 2019b; Lloyd's List 2019; Transport and Environment 2019). However, this adds to overall transport time. In contrast, reduced waiting time in port would not have adverse effects on cargo transit times or vessel productivity, but would lower both costs and emissions.[1] Eide et al. (2011) point out that faster turn-around in port is amongst the most cost-effective energy efficiency measures available, estimating potential cost savings in the range of 75 USD per ton of CO2 emissions averted. If this could be fully implemented, international shipping could avert approximately 60 million tons of CO2 emissions annually. An additional benefit of quicker vessel turnaround would be a reduction in local air pollution in ports, many of which are located close to heavily populated areas. Air pollution from ships in port has significant negative health effects on port-city residents (Tzannatos 2010; Zhao et al. 2013; Zhang et al. 2017; Dragović et al. 2018).

Echoing transportation research, BIMCO, the world's largest shipping association, has recently directed attention towards waiting time in connection with port calls (BIMCO 2018; 2019a; 2019b). It points out how a replacement of idle time with time transiting at a slower speed would reduce fuel consumption and emissions, benefitting both business and environment. The International Taskforce Port Call Optimization, whose main members are major ports and liner companies, are working towards the same goal (ITPCO 2019a). To facilitate information sharing among port stakeholders, it has developed a manual with standardized terms for the specific activities associated port calls (ITPCO 2019b). With inspiration from aviation, the Sea Traffic Management (STM) validation project, whose members are policy makers, shipping companies and researchers, aims to develop information sharing to "… allow personnel on-board and on shore to make decisions based on real-time information. These services enable more just-in-time arrivals, right steaming…" (STM 2019). Within the period 2015-30, STM anticipates fuel-savings and GHG abatement from such measures in the range of 7 per cent.

Pointing out the crew's role in the execution of port calls, Johnson and Styhre (2015) indicated that "what has been labelled "waiting time in port" … may not always be unproductive from the viewpoint of

[1] Speed reduction as such is not a new phenomenon in international shipping. For a decade, ships have "slow-steamed", which is a commercial decision by the ship-owner to reduce engine loads and speeds in response to high fuel prices and excess ship capacity (Mander 2017; Psaraftis 2019). "Slow-steaming" reduces the productivity of ships and extends transit times for cargoes.

the ship crew, who may use the waiting time for other types of work, such as maintenance and rest" (Johnson and Styhre 2015, 175). Crew roles resemble those of truck and train drivers: Their decisions affect operations, and therefore they are important for the understanding of GHG abatement potential through port call optimization. Johnson and Styhre (2015) considered that there was more that researchers could learn about such processes, calling for ethnographic studies of port calls. We follow this call. To the best of our knowledge, no one has explored the causes for waiting time associated with port calls, from the perspective of vessel crews and their employers, the shipping companies. There has similarly been a lack of direct shipboard observation of vessels engaged in port calls, which has the potential to offer a detailed insight into the reasons for many delays. Aiming to fill this gap in the transportation literature, we explore the potential for GHG abatement thorough reduced turn-around-time in port. We investigate the following two related research questions in the context of tanker shipping: *Why do tankers wait in ports?* and *Can crews and shipping companies reduce turn-around-time in port?* We select tankers, because most of these are trampers, calling at many different ports. As we will show in our literature review below, tankers have received less research attention than container ships. Tankers represented 34.6 per cent of the world fleet in terms of deadweight in 2019 (UNCTAD 2019), and accounted for 28.3 per cent of its GHG emissions in 2012 (Smith et al. 2014).

Our paper structure is as follows: First, we review the transportation literature on speed optimization, port efficiency and turnaround time in port to elaborate on knowledge gaps. Then we present our two methods. We structure our subsequent analysis section around the different phases of a port call, before we discuss factors affecting port call duration. We then discuss our findings in the light of previous studies, and explain why the reduction of waiting time represents a more complex challenge in shipping than in onshore transportation. In the conclusion, we summarize our results, and discuss their implications for policy and research.

2. Literature review

In the transportation literature, the determinants of port efficiency have gained considerable attention (e.g., Tongzon 1994; Sánchez et al. 2003; Cullinane et al. 2004; Wu & Go 2010; Ducruet et al. 2014, Talley and Ng 2016; UNCTAD 2019) and researchers have predominantly directed their focus towards container shipping and ports. This is not surprising, considering how containerization has enabled liner vessels to reduce turn-around time in port considerably since the 1960s (Sampson and Wu 2003; Levinson 2006; Poulsen 2007). In short, containerization has enabled the reaping of time economies in port (Slack et al. 2018). Several recent studies have investigated the relationship between container terminal efficiency, berth allocation, vessel size and port time (Du et al. 2011; Ducruet et al. 2014; Slack et al. 2018). Yahalom and Guan (2018) amongst others have pointed out the existence of diseconomies of scale for ultra-large containerships at berth. The loading and discharging per TEU (as measured by bay-time) is more time consuming for such vessels than smaller ones. A Norwegian study by Rødseth et al. (2018), on the other hand, found that container terminals operate under increasing returns to density. Small vessels, which only unload a few containers per port call, fail to gain economies of density, and port authorities should consider this when designing their port fees. Rødseth et al. also found that the type of container (loading/unloading; empty/laden) influences port call duration. In a global study, Slack et al. (2018) showed considerable geographical variation in container ships' times in port, indicating that local and regional factors may be important determinants for turnaround time in container shipping.

In container shipping, speed optimization has also gained considerable research attention (e.g., Lindstad et al. 2011; Psaraftis and Kontovas 2013; Psaraftis 2019d). In particular, research has focused on the so-called scheduling problem, developing appropriate models to optimize global liner networks and guide speed choice under different commercial constraints (e.g., Fagerholt 2001; Wang and Meng 2012; Wang and Meng 2017; Dulebenets 2018; Ng. 2019). Several studies on scheduling problems and speed choice have also explicitly taken into consideration environmental externalities associated with shipping air emissions (Fagerholt et al. 2010; Tai and Lin 2013; Psaraftis and Kontovas 2014; Lindstad et al. 2016; Psaraftis 2019d).

Findings from container shipping, which offers scheduled liner services between two or more predefined ports at regular intervals, are not transferrable to the main dry bulk and tanker segments with more unpredictable trading patterns (Norstad et al. 2011). Predominantly such vessels sail to and from wherever it is that cargoes can be ‘fixed’. In line with this observation, Styhre et al. (2017) noted that ports can more easily direct emission abatement efforts towards liner vessels, which call regularly at the same ports, than ships in world-wide tramping, which rarely return to the same ports. A recent study by UNCTAD (2019) of ship AIS data indicated that the duration of port calls for tankers differs significantly across the world. In Japanese, German and Dutch ports, for instance, tankers have relatively short port calls despite the fact that such ports accommodate large ships. In contrast, Nigerian and Iraqi ports, which also accommodate large tankers, have significantly longer port times. The neglected tanker sector therefore deserves further research in relation to port call optimization.

From the literatures on tanker chartering (Mokia and Dinwoodie 2002; Panayides 2018) and maritime contract law (Baatz 2018), we know that tanker ship-owners and their counterparts, the charterers, have economic incentives to optimize port calls. If a charterer causes delays in port beyond the lay-time for cargo-operations specified in the charter party (e.g., due to delayed arrival of cargoes), ship-owners are entitled to demurrage payments from the charterer for the longer than expected use of the ship. If a breakdown on the ship (e.g., a crane or cargo pump breakdown) causes delayed loading or discharging (longer time in port than that specified in the charter party lay time), the charterer will meet the ship-owner with a claim. Such incentives should *ceteris paribus* do a great deal to minimize port time, and yet delays in port persist raising questions about potential reasons for such intractability.

It is important to acknowledge that port calls consist of different phases, and idle time occurs at three different locations: At anchorage (outside the port), in the approach to/departure from port (when maneuvering), and alongside in port (tied-up to load/discharge).

Jia et al. (2017) and Andersson and Ivehammar (2017) have pointed out that tankers often spend considerable time waiting at anchorage, and recommended the implementation of virtual arrival system. This would enable ships to slow down in cases of port congestion and arrive to port just-in-time, when berths are available. They argued that such a system holds considerable potential for speed reduction and GHG abatement. In a study of tanker shipping, however, Poulsen and Sampson (2019) showed how cargo-owners' commercial priorities outweigh the fuel-saving benefits of virtual arrival. Cargo-owners often prefer fully loaded tankers to wait at anchorage, using them as floating storage in anticipation of rising cargo values. Poulsen and Sampson also pointed out how low trust levels between shipping companies and ports contribute to waiting time. In many ports, "a ship would run the risk of "losing its ticket in the waiting line for a berth", if they only arrived virtually" (Poulsen and Sampson 2019, 237). Finally, they observed that virtual arrival systems could have unintended negative consequences for seafarers in the form of fatigue.

The causes for waiting time in the other two locations – when ships are maneuvering to/from berth or alongside – have not attracted the same attention from researchers. The case study of two dry bulkers by Johnson and Styhre (2015) represents an exception to this. They found that the two case vessels spent 50 per cent of their time in port unproductively (on average 17 and 30.5 hours, respectively), and attributed this to port opening hours, stevedores' working hours, crews' tendencies to arrive early to port before stevedores are ready to commence cargo operations, administrative procedures and pilots' late arrival of vessels. Poulsen et al. (2018) recently found that major 'frontrunner' ports in terms of environmental protection had generally shied away from emission abatement measures aimed at vessel waiting time. Such measures require complex collaborations between several stakeholders and their benefits for GHG abatement from ships at sea are not immediately visible to the port's key stakeholders, port-city residents.

Overall, the transportation literature has a strong quantitative focus, often informed by positivist epistemologies. In a literature review of transportation research on climate change mitigation, Schwanen et al. (2011) called for more studies with qualitative research methods, including ethnographic observation. They argued that empirically rich, qualitative studies of prevalent practices in transportation hold promises to supplement positivist informed transportation research. As previously noted, Johnson and Styhre (2015) echoed the call for ethnographic studies of port calls. We follow up on these calls, employing a combination of such methods to shed light on the myriad reasons for delays in port and how open these are to change. We contribute with a detailed exploration of port call delays using a combination of interviews and ethnographic observations, and as a result we are able to go beyond the existing literature in describing the causes for waiting time. On a broader level, we contribute to the ongoing GHG abatement discussions in international shipping with our assessment of port turn-around-time as a GHG abatement measure. Our study has implications for policy makers as well as shipping companies and ports.

3. Methods

We focus our data collection on the execution and duration of port calls (in the maneuvering phase and alongside). Our aim is to explore and understand why delays occur, how crews and their employers can shorten port calls, and the potential intended and unintended consequences of such efforts. Our research design is qualitative and inductive in nature, based on a bottom-up, open, approach to data collection and analysis. We employ two qualitative research methods for data collection: Non-participant, ethnographic observation (Kristiansen and Krogstrup 1999) and semi-structured interviews

(Kvale and Brinkmann 2009). As indicated by Kvale and Brinkmann (2009), this research design is appropriate for an in-depth exploration of a ‘why?’ question.

We did non-participant, ethnographic observations onboard two tankers for a total of 37 days in 2013 and 2018, respectively, and we experienced six port calls (Table 1). NN specifically selected the *Northern Hemisphere* (a pseudonym), a handy size product tanker engaged in Northern European short sea trades, to experience a trading pattern with frequent port calls. Reduced port turnaround time holds the highest potential for GHG emission abatement in the short sea trades, where ships spend proportionally more time alongside than vessels in long haul trades. During NN’s time onboard, he mapped the different phases in the port call. He identified the stakeholders, who are involved in the individual activities of a port call, and mapped the different crewmembers’ tasks in this connection. During his time onboard, he made extensive field-notes in his cabin, out of sight from the crew, in order to minimize the effects of his presence onboard. NN sailed on the *Pollyanna*, a panamax product tanker, and experienced port calls both in South and North America. Her study focused specifically on ship-shore communication. As well as interviewing seafarers on board about their interactions with port personnel of all descriptions (including pilots, bunker barge masters, terminal staff, loading masters, surveyors and so forth) NN also conducted observations of interactions between port personnel and seafarers from the bridge of the vessel, from the cargo control room, from the manifold (when taking bunkers) and from the deck office. Specific points of interest related to tensions arising between seafarers and port personnel from issues of scheduling and timing. Like NN she kept extensive confidential field-notes. We quote extensively from our field-notes in the analysis, in order to provide transparency regarding our evidence.

Table 1. Port calls experienced during our onboard studies

Port	Cargo operation	Notes	Time	Researcher
Panama City	Discharging		September/October 2013	NN
Single Bouy Morring, off Colombia	Loading	Compulsory pre-departure underwater survey	September/October 2013	NN
New Orleans, USA	Discharging	Change of class scheduled	October 2013	
Gdánsk, Poland	Discharging		April 2018	NN
Ventspils, Latvia	Loading	Propeller polishing by divers; Bunkering alongside	April 2018	NN
Bremen, Germany	Discharging	Inspection by class society	April 2018	NN

Following on from the two voyages, 12 semi-structured interviews were conducted with 12 managers in nine Nordic tanker shipping companies during the spring and summer of 2018 (Table 2, please see our interview guide in Appendix 1). Interviewees came from the chartering, operations and technical departments and included one executive. The chartering managers find cargoes for ships and appreciate the value of efficient port call execution for their customers. The operations managers oversee vessel performance in accordance with contractual specifications and make demurrage calculations in cases where port call duration differs from that agreed in charter parties. Two technical managers, who had responsibility for vessel maintenance and smooth technical operations, also had seafaring experience and therefore important first-hand experience with port calls. In the analysis section, we provide extensive references to the interviews, in order to enhance the transparency of our interpretations. We have translated some of the quotes from a Scandinavian language to English. We continued to do interviews until we reached a point of methodological saturation, where interviewees provided very little new information.

In March 2020, we validated our findings at a major green shipping technology conference, where we presented our results for an audience of approximately 30 ship-owners, ship managers and port industry practitioners, and participated in a panel discussion on port call optimization.

Table 2. Interviewees

Interviewee no.	Interview no.	Position	Shipping segment(s)	Date	Duration of interview
1	1	Vice president, Technical department	Product	March 24, 2018	E-mail correspondance
2	2	Senior manager, Operations department	Product	April 17, 2018	Telephone interview, notes only
3	3	Vice president, chartering department	Chemicals	June 26, 2018	01:18:59
4	3	Vice president, technical department	Chemicals	June 26, 2018	01:18:59
5	4	Head of Projects, technical department	LPG	July 4, 2018	01:23:14
6	5	Head of chartering	Product	July 10, 2018	01:02:49
7	5	Vice president, technical department	Product	July 10, 2018	01:02:49
8	6	Technical superintendent	Chemicals and product	July 18, 2018	00:55:24
9	7	CEO	Gas	July 24, 2018	00:53:41
10	8	Chief Operating Manager	Chemicals	August 20, 2018	01:09:40
11	9	Vice President, Operations department	Gas, chemicals and product	August 21, 2018	00:52:56
12	10	Manager, Chartering and operations department	Chemicals and product	August 29, 2018	00:53:09

4. Findings

In order to answer the question of why tankers wait in port, port calls should be disaggregated into different phases: 1. Approach to port; 2. Mooring; 3. Tank inspection; 4. Cargo-operations; 5. Post-cargo operations, and 6. Departure. Waiting time in the different phases occurs for different reasons and depends on different stakeholders, and we discuss these causes in the second part of the analysis.

Table 3. Examples of delays in association with tanker port calls and measures to reduce such delays

Phases	Examples of delays	Crew and shipping company measures to reduce delays	Other measure
Approach to port	Waiting for pilot; Waiting for tugs; Waiting for other ships to pass by in narrow fairways		Sharing of real- ships, pilots, tu stakeholders
Mooring	Waiting for port mooring staff to arrive to berth	Shipping company can make investments in high quality ropes and mooring lines to reduce mooring time	
Alongside, before cargo-operations	Waiting for terminal cargo surveyor to do cargo sampling		Sharing of real- ship, terminals, other port stak
During cargo-operations	Waiting for cargoes from refineries; Waiting for discharging due to insufficient terminal tank storage; Waiting due to low pressure/capacity in refinery/terminal cargo pumps		Terminals/refir investments in and tank storag
Pre-Departure	Waiting for customs; Waiting for immigration; Waiting for agent and signing of bills-of-lading; Waiting for cargo surveyors; Waiting for pilots; Waiting for tugs; waiting for underwater drug survey completion	Shipping company can employ the most efficient local agents	Sharing of real- ships, pilots, tu stakeholders
Getting underway	Waiting for other ships to pass by in narrow fairway		Sharing of real- ships, pilots, tu stakeholders

4.1. Approach to port

A port call starts, when the master receives orders to dock from the operations department. As the vessel enters the port authority's geographical jurisdiction, the vessel approaches port. Most tankers require tug assistance maneuvering in the approach to port and for berthing, because they have conventional rudders and propellers and lack adequate bow and stern thrusters. This sets them apart from ferries, cruise ships and other specialized vessels with higher maneuvering capabilities that often enable them to call port without tug assistance.

The approach to port requires collaboration between ship-based and shore-based personnel. If going directly to a berth, liaison between the terminal and the agent appointed by the vessel operator establishes a berthing time which is conveyed to the vessel master and may be subject to multiple alterations which generally relate to the loading/discharging of preceding vessels and/or terminal capacity and functionality. Once berthing time is confirmed, a pilot and tugs are booked which may be partially determined by availability. The same applies when a vessel is proceeding to anchor. The master establishes safe conditions for the pilot boat to approach and for the pilot to board. Once a passage plan and course of action is agreed between the master and the pilot, the pilot communicates with both the local tug crews and the vessel bridge team to secure the tugs and begin the final approach to the berth/anchorage. The master remains legally responsible for the vessel and closely monitors the instructions from the pilot who technically acts as an 'advisor' but in practice temporarily dominates the communication of instructions between the relevant parties. Speed choice, and therefore the duration of the process, depend on the decisions of the pilot (subject to the master's tacit approval) which should be based upon local physical and navigational factors such as vessel capabilities, underwater keel clearance, air draught restrictions, other shipping traffic, currents and wind. The master communicates directly with the pilot or pilots and generally repeats their guidance as instructions to the helmsman. He or she also communicates with the deck crew over a walkie-talkie and the chief engineer in the engine control room. The pilot generally communicates with the tug masters, terminal or vessel traffic station via VHF radio and may also hail other pilots on board proximate vessels to enquire about status, course, etc. The entire process requires deep concentration from all stakeholders, who are ready to take immediate action in the case of any unintended event. Periodically vessel crew feel hurried by pilots who are keen to keep to their schedules in terms of getting to the next ship (Anonymous et al 2016: 27-30). This was observed as the *Pollyanna* approached a river anchorage *en-route* to a terminal. A field-note records how:

> When anchoring in the river the pilot seemed to be putting pressure on the anchoring team and the captain. There was a problem in that the brake slipped twice on the starboard anchor. The captain later told the chief mate that this was because 'the speed we came in at was too great' (*Pollyanna* field-notes).

Thus, it seems that there are already incentives for pilots and crew to hurry in maneuvering *en-route* to a port or berth. Pilots have schedules to meet and vessel crews feel under pressure from pilots to act with all haste. They are also aware of the commercial imperatives of their own companies. In this context we were not surprised to discover that shore-based personnel regard the potential for timesaving in the approach to port phase as highly limited. The vice president of commercial operations in a tanker shipping company explained:

> …it's very limited what you can do actually, because it's so much depending on the tugboats, the pilot, the shore … and everything (Int-11).

This statement encapsulates the complexity of the operation, which involves simultaneous collaboration between many stakeholders, and it is consistent with our own shipboard observations.

4.2. Mooring

A vessel will not be permitted to go alongside or attach to a Single Buoy Mooring (SBM, which is used to load/discharge at sea) without the permission of a terminal. On one of our voyages, an allocated SBM was vacant but the vessel was made to wait. Once the go-ahead was received, the vessel was very much under instruction from the terminal. NN noted that:

> There are two ships on the SBMs but ours is free. The general verdict is that there is insufficient cargo in the tanks which is why we are being kept waiting. [...] The pilot is due at 19.00 but at 19.10 I still see no sign. In the end it is not too delayed and two large guys come aboard and make it to the bridge. They are followed shortly afterwards by the agent who sits to one side of the bridge occupying himself with his laptop. [...] The pilot then takes the captain to one side to explain how he wants the winches and lines prepared. He needs the crane to be ready on standby to haul up a large crate. He needs a tug to be hitched to the starboard bow and he needs lines preparing aft for the tug to attach to, once the ship is tied up to the SBM. He explains that a boat will take the line from the SBM to the ship which will need to haul it on board using a winch. He is very clear that once there are four lines on deck the chain is to be secured. In relation to the aft, he wants a line secured to each side of the vessel to be passed through a central mooring eye (must check proper name) to the tug. The tug will keep 120-130 metres of mooring line between it and the vessel. To minimise the possibilities of misunderstandings the pilot draws his plan.
>
> After some time, a second launch arrives with the loading master. He meets with the chief officer to make a 'safety check'. This looks as if it involves a tank inspection as well as an inspection of the mooring lines, winches, etc. Once the loading master pronounces all [is] well the pilot gets the all clear to proceed. With the loading master come a variety of other personnel. Twelve in total (though in the paperwork just nine are mentioned). Some are hose connectors (4 according to the paperwork). The remainder are the loading master, a marine pollution surveyor, two cargo surveyors, the agent, and possibly a 'loss control' though I do not know who this is or whether he is indeed on board. (*Pollyanna* field-notes)

This field-note encapsulates the safety critical nature of mooring procedures and, in relation to attaching to an SBM, it indicates the collaboration required between ship and shore personnel and the lack of autonomy experienced by the vessel crew in this process. It suggests that crew have limited capacity to save time in the course of this process.

When coming alongside, once the ship is at the jetty or pier, the deck crew secures the ropes and the gangway to shore. Here there may be some potential for small time saving measures, but these are very limited. For example, a head of tanker shipping operations explained how high-quality ropes had enabled his company to reduce the average duration of vessels' mooring time from 40 to 25 minutes. He emphasized that:

> …there are also some safety concerns. You don't want to stress the crew to put the gangway down, for example, or more. It should take the time it should (Int-11).

The head of commercial operations in a different company also suggested that the mooring process depends on the crew. She described the timesaving potential as “peanuts” for the individual vessel, but worthwhile for an entire fleet (Int-2).

4.3. Alongside, before cargo-operations

Once the ship is secured alongside, or to an SBM, the deck crew connects to the terminal cargo pipelines. Firefighting and oil spill prevention equipment is placed on the main deck as a precautionary measure, and cargo-surveyors come onboard to check the cargo-quality before discharging can commence or loading can proceed. This requires the crew to open the manholes to some of the cargo-tanks for the cargo sampling to occur, and the surveyor can lower a lead line with a cargo sampler into the tanks (Int-12 and field-notes *Northern Hempishere*). For insurance and liability reasons, it is highly important for the shipping company and/or terminal to document that the cargoes carried are not contaminated or “off spec” in any way.

This period is one in which delays can occur or conversely time may be saved. Aboard *Pollyanna*, the cargo surveyors joined the vessel whilst she was transiting the Panama Canal in the hope of saving time. Field-notes in the course of a long day recorded both the testing process in advance of arrival and how delays in receiving the analysis could potentially delay the discharge of the cargo as follows:

> 09.20 am
>
> There were lots and lots of shore side people on board. Some boarded with me, pilots (two I think), the ex-army agency man, and some men with sample bottles who had come to sample the cargo.
>
> The cargo samplers worked with two of the crew to sample from the tanks as the ship negotiated the first lock.
>
> 21.15
>
> Up until a few hours ago the Captain did not have the firm results of the cargo testing (the samples that were taken at Cristobal) so he wasn’t sure if the vessel would go to anchor [...] or go directly to unload. (*Pollyanna* field-notes)

In this instance the results did arrive in time for the ship to go directly to berth at the terminal. By way of contrast, the chief officer recounted a previous experience when cargo sampling had deliberately been used by terminal representatives as a means to delay a vessel because the terminal was not ready to begin operations but did not want to admit this as financial penalties would be incurred. He described how:

> The loading procedure involves putting a foot of cargo in one tank and then sampling to check for contamination from unclean tanks. The sample was taken and the answer came back that the tanks were no good and the procedure was repeated. Again the ship was told there was a problem with the sample and again it had to remove the cargo from the tank and transfer it to a

> slop tank. By this time any number of personnel from various shore side interests were involved and samples were being taken left right and centre. Another foot was loaded and again rejected until finally all was pronounced well and the ship loaded and departed. En passage they received a message from the BP refinery to say that in fact the cargo in the slop tank was fine and should be evenly distributed across all of the cargo tanks. The P&I inspector later told the chief that the refinery had run out of cargo and they were attempting to place the blame for the delay on the vessel when in fact the vessel as not at fault. (*Pollyanna* field-notes)

These notes indicate that, as with the mooring phase of a port call, vessel crews have very limited control over time and time savings. Indeed, it is evident that time may be manipulated by shore-based personnel in order to meet their own needs and to minimize costs accrued by terminals.

4.4. During cargo-operations

Cargo operations account for the majority of the time spent by a vessel in port. For a handy-size product tanker, for instance, cargo operations typically take approximately 36-48 hours (Int-2). They depend on the cargo parcel size, cargo pump capacities and terminal storage capacity, which are beyond the control of the crew and the shipping company (Interviewees 4 and 6). For loading operations, terminal pumps are used, while vessel cargo pumps perform discharging operations (Int-8). However even when vessel pumps are used discharge rates may be limited by the terminal. A vice president of chartering explained:

> Typically restrictions from shore determine the speed of cargo operations. In fact, I don't know if we use our pump capacity to the maximum (Int-6).

The head of the technical department, who also participated in the interview, added that he did not know about this either, indicating that cargo terminal capacity rather than ship cargo pumps is the main bottleneck in the cargo-operations (Int-7).

In an interview in another shipping company, we also discussed the shipping company's efforts to reduce time in port. This is a verbatim transcription from the interview:

> Interviewee: We use a global agent, whom we use in all ports. And this global agent has set some goals to reduce port time. Again, it depends on the terminal. The ships are designed with a certain pump capacity, which they never use to the maximum….
>
> Interviewer: Why do you say that cargo pumps are not running at full speed…?
>
> Interviewee: Yes, that is due to the fact that terminals cannot receive cargoes at such speeds. Fundamentally, when you design a tanker, you design it in such a way that it can discharge, typically in 12-16 hours, but it is very seldom that you find facilities which can handle such high volumes. So typically, it takes longer time [to discharge].
>
> Interviewer: Yes. And that concerns your discharge? But when you load, do you then use cargo pumps from shore?

> Interviewee: Yes, but again they decide the speed. And this is determined by many factors. It can be determined by pressure in the tanks. Or if they have sufficient cargo in the tanks. So again, there really isn't much we can do about it. (Int-4).

To save time, further investments in port terminals and terminal cargo pumps would be required, which is obviously entirely beyond the shipping company's influence.

When asked about the potential for shorter port calls, a shipping company technical director with seafaring experience of his own argued: "There is not much we can do here. We are dependent on terminal working hours, tug and pilot services. It's beyond our control" (Int-1). He elaborated: "Oil terminals are already efficiency machines and cannot afford to waste any time with idle ships alongside."

In the tanker trades, cargo operations are largely independent of normal weather conditions, and take place 24-7 according to our interviewees and our own observations. Only severely adverse weather might force cargo operations to a halt, requiring the vessel to leave port/disconnect from an SBM temporarily for safety reasons (Int-3). A field-note reinforces the point:

> Once all the activity is over the pilot tells the captain that he is not expecting any bad weather or high winds but they will have to keep an eye on things. He then tells the captain about a VLCC which recently broke away from the SBM in high winds causing the pipelines to part. He said that they managed to stop pumping and recover the pipelines so fast that there was no serious calamity. (*Pollyanna* field-notes)

The duration of cargo operations also depends on the cargo types involved, and increases with complexity. Crude oil and most product tankers may carry only one cargo at a time, but chemical tankers routinely carry multiple cargoes simultaneously. A bosun and a technical superintendent (Int-8) explained that chemical tanker loading/discharging is time consuming when several cargo types are carried simultaneously. Some cargoes cannot be loaded or discharged at the same time due to the risks of explosion/contamination. Safety is paramount, and particular care is required towards the end of the loading process, in order to avoid tank overfilling. NN observed the last stages of a loading process from the ship's cargo control room, where two bridge officers communicated intensively with the deck crew to avoid overfilling the cargo tanks and causing an oil spill (*Northern Hemisphere* field-notes).

When vessels switch between cargoes, tank cleaning is necessary. Tank cleaning is generally carried out *en route*, and does not usually affect port time. However, some tank-cleaning operations on sophisticated chemical tankers have to take place in port which extends port time (Int-8). To clean the residue from some chemical cargoes it is necessary to heat up tanks to very high temperatures. This is easier and consumes less energy, when done alongside, because the ballast tanks, which run adjacent to the cargo-tanks, are not full of cold water whilst the ship is in port.

During cargo operations, several other activities take place. When a ship goes alongside in a port customs clearance takes place and immigration officers come onboard to check crew lists, passports, visas, and seaman's books. So-called SIRE inspections take place every four to six months onboard tankers, and Port State Control takes place on all ship types. Such inspections, which are focused on vessel maintenance, safety procedures, crew training etc., require the attention of the captain and some of the officers. Inspection measures have been instrumental in reducing oil spills in recent decades, but are also a stress factor for the crew during the port call (Sampson et al 2016). The duration of the inspections can vary, but 6 hours is seen as typical, and they do not interrupt cargo operations.

4.5. Pre-Departure

While cargo operations are ongoing, officers prepare for the next port call, planning the precise voyage of the ship, communicating with port authorities, the shipping company operations department etc. IMO regulation requires detailed route planning for the entire, next voyage before departure. Meanwhile the ship's slops and garbage are discharged in port, and new provisions and spare parts are brought onboard. These activities cannot always take place when cargo operations are in process and may require a vessel to shift berth and/or proceed to anchor prior to departure. Finally, crew changes or crew visits to dentists or doctors take place with the guidance of the local agent. Sometimes bunkering operations take place while alongside, but in other instances local port safety regulations require this at anchorage. Overall, it is fair to say that time is ports is generally very pressured with a lot of different activities scheduled to take place in the minimum possible amount of time. A field-note is illustrative:

> The chief officer tells me that he realises I have to go but that I will be missing some prime ship shore interaction when I leave because so many surveyors will be coming to the ship as well as stores, bunkers and so forth. He says that on the VLCCs a big port for services, crew changes, and so on, is Fujairah. He says that sometimes there you have a bunker barge alongside, a lube oil barge on the aft, stores, crew change overs and all kinds of service engineers etc coming all together and you don't know which direction to run in. (*Pollyanna* field-notes)

On tankers, the completion of cargo operations requires processing of cargo samples with some sent to a laboratory ashore and some retained onboard. Shipping company's local agents come onboard again and the captain signs the bill-of-lading to document that the cargo is now onboard. In some cases, the local agent is authorized to sign the bill-of-lading on behalf of the captain to save time in port (Field-notes *Northern Hemisphere*).

Two technical managers with seafaring experience argued that a delay could occur in this phase, if the ship has to wait for documents from shore (Int-2 and 8). They depend on agents, and terminals to bring on cargo documents for master signature. Arguing along similar lines, a CEO of a gas tanker shipping company explained that in some cases, 3-4 hours of waiting time could occur after cargo-operations. He explained:

> …..That's the area, where we could save some time. But again, there are many factors at play here. It's very dependent on authorities. And authorities decide…. Customs and immigration need to come onboard and say good-bye… We have a bonus scheme for our agents. … So we collaborate with the agents to save time. We do not wait for the agent (Int-9).

In the course of the voyage on the *Pollyanna*, NN was able to witness just how delays may frequently come about. In this instance, there was a disagreement between the terminal and the vessel with regard to the amount of oil, which had been loaded. The field-notes recorded that:

> The cargo operations all went very smoothly until about four o'clock. Sometime after that things went a bit pear-shaped. The issue was that when the cargo was fully loaded the vessel had less on board than the terminal said it had delivered (the discrepancy was 1,083 barrels). The chief officer told the cargo surveyor that he could not sign one particular paper [...] the captain concurred and came down to explain that he had been instructed by his office not to sign and that he needed to get back in touch with them. The loading master and [...] the agent were particularly agitated over it all although the discussion never became overheated or rude. The captain had instructions from his office to leave the port without signing the papers and things would be done electronically (known as EDP) but when he came to tell the shore-side personnel this he was told that it wasn't possible as the port didn't have this procedure (other ports do). The loading master repeated several times that the charges for being on the SBM were $10,000 per hour and all the shore staff really tried to push the captain to cast off whereupon they all would have left meaning the ship would have to hang around for them to come back and do the paperwork once the shore-side offices had settled the disagreement. The LM told the captain that the terminal never agree to change the figures to match the ship figures so that it was pointless of the charterer to resist. In the end the office gave permission to cast off and then before the procedure was actually carried out they came back to the captain and told him to sign. An expensive delay was averted. At one point the captain pointed out to the loading master that 'we are just stuck in the middle actually'. (Field-notes *Pollyanna*)

In this situation, the researcher observed at firsthand how financial pressures strongly incentivize rapid operations and departure at the end of cargo loading/discharging. The observations suggest that there is limited scope for further time savings in these settings and that if they exist they relate to operations beyond the vessel – decisions and activities in shore-side offices and terminals.

4.6. Getting underway

Once the paper work is completed, the pilots come onboard and the ship can set sail. Some of our shipping company interviewees emphasized that it is the responsibility of one of the bridge officers to contact the local agent to order tug and pilot assistance. This is important to ensure timely departure (Int-5 and 8). However, the appropriate time to contact pilots and tug service providers varies between ports and depends on local traditions. The head of technical department in a chemical tanker company with seafaring experience explained the difficulties in this phase:

> When should I give the pilot a notice? Shall I gamble and say that all paper work will be completed within the next two hours? And then give him a notice now? … Or shall I wait until I have received all the papers? And then I will postpone it several times. So it's a bit of a gamble. Some pilots get very annoyed, if we tell them that we will be ready within two hours, and then, unfortunately, we are not ready, because we are still waiting for papers… (Int-4).

This example emphasizes how the crew lacks overall control in relation to the timing of departure.

4.7. Intimidation in port

The duration of port calls varies between regions according to seafarers and interviewees (Int-5, 6, 8, 9 and 12). Generally, port calls tend to be at their fastest in Europe and North America. When asked about such geographical differences in port call duration, an operations and chartering manager with nautical experience (Int-12) explained:

> Interviewee: Oh, yes. Customs takes a long time. It can really take a long time in Black Sea ports. In the Ukraine and in the other countries. It takes a long time. You do not just enter port, connect [the hoses] and start loading immediately. It takes hours, depending on how many fines they want to give you. They are very tough. If they find something, you will get a fine… And they will always find something. Then there is something, you haven't done. And then you get a fine. This takes time. And they come onboard, eight, six, ten, twelve men, perhaps, and check everything.
>
> Interviewer: Is this equal to the crew number?
>
> Interviewee: Yes. And they all want something. Some cigarettes. Some drinks… And that takes time.
>
> Interviewer: Yes. Then the conditions are better, when you call in a European port…?
>
> Interviewee: Oh yes, that's the case. ... Northern Europe is more civilized. For instance, our voyages in Denmark. We call port, and the surveyor come onboard immediately after. A few minutes later, the vessel can commence loading. In less than an hour, they have started loading. That's very fast.

Seafarers argued that they generally felt high stress levels due to pressures from officials, who expect facilitation payments to speed up customs clearance or other administrative procedures. They felt that officials used the threat of delays to pressure for facilitation payments, and argued that the power balance was strongly in their disfavor (Field-notes *Northern Hemisphere*).

The issues of facilitation payments appears to be largely absent in Europe and North America, and the absence of such pressure might contribute to swifter part calls (Sampson et al 2016). However, pressure on the crews still occurs in these areas. A marine engineer provided a lengthy explanation about port calls in the US. He said he had often felt strongly intimidated by US Coast Guard officers, who openly display their weapons during onboard inspections. He felt that they often behaved, as if they expected the crewmembers to be simple criminals (Field-notes *Northern Hemisphere*), thus illustrating the seafarers' vulnerable positions in port calls. This is an important factor to bear in mind, when assessing the potential for port call optimization. It limits the crew's control of the duration of the port call.

4.8. Terminal ownership and port time

Ownership of port terminals also seems to have an effect on port call duration. A CEO in a gas tanker shipping company (Int-9) explained that port call efficiency was higher, when a series of tankers on a long-term charter to an oil major regularly called at the terminals, owned by the charterer. This facilitated coordination in the port call. He said:

> Interviewee: …. when we load in the US, the terminal is not owned by [the charterer]. But in Europe, we discharge at terminals owned by [the charterer]. Then we [the shipping company's gas tankers] are instructed about service speed [from the charterer]…. so that they [the oil terminal] are ready to serve us [when we arrive].
>
> Interviewer: Does this mean less waiting time in the European terminal, due to better coordination than in North America, where the cargo and terminal owners are two different parties?
>
> Interviewee: Yes.

While the evidence from this interview suggests that terminal ownership is an important determinant of port turnaround time, further research could explore the relationship in greater depth. In this context, it is important to bear in mind that terminal ownership differs significantly between shipping segments. In tanker shipping, vertical integration between cargo-owners and terminals is common. In container shipping, vertical integration is also common, but here container lines, rather than cargo-owners own the terminals. In the dry bulk trades, charterers in large mining corporations and power plants own some dedicated terminals, but most dry bulk terminals are simple quays, owned by local port authorities (Talley 2009).

5. Discussion and Analysis

We are by no means the first to study issues of port efficiency, speed optimization and ship turn-around-time in port. However, we have employed novel, non-participant ethnographic observations onboard two tankers and combined them with semi-structured interviews, to explore causes for port waiting time. We focus on this issue seen from the crew's and the shipping company's side, which have been neglected by the predominantly quantitative transportation literature. Providing an empirically rich analysis of the causes for delays in port, we direct attention to the important, but often neglected tanker sector.

Our study confirms the occurrence of idle or unproductive time for tankers in association with all of the different phases of a port call, as also observed by Jia et al. (2017), Anderson and Ivehammar (2017) and UNCTAD (2019). Most of this, roughly in the range of several hours per port call, occurs before or after completion of cargo operations. Vessels may wait for a berth, a pilot, laboratory results on samples, for a terminal to be in a position to pump cargo, and for a range of related activities and clearances. Having loaded/discharged cargo they may be forced to wait again to avail themselves of a range of services, to be cleared by customs and immigration, and sometimes to organize and await underwater inspections relating to drug smuggling controls. Waiting for pilots and tugs is common, but due to variations in local practices and routines crews rarely know when the right time is to call for tug and pilot assistance. Thus timing is largely beyond the control of the crew who can only play a limited role in organization/coordination. Shipping companies on the other hand can, and do, provide incentives to ensure agents do not cause waiting time in port. They can also help crews save a small amount of time in the mooring phase, through investment in high quality ropes and lines. Nevertheless, whilst companies have sound financial reasons to reduce the time spent in port, as explained by Panayides (2018) and Baatz (2018), they also find their capacity to influence events to be severely constrained. The sharing of real-time traffic information among port stakeholders holds a promise to improve stakeholder coordination and reduce the risks of delays before and after completion of cargo-operations. However, for it to happen, policy interventions from the IMO will be required.

Waiting time in port appears to depend on cargo-type. In the dry bulk trades, Johnson and Styhre (2015) found evidence of more unproductive port time than we did for tankers (they found between 17 and 30.5 hours of waiting). This difference is partly due to the different nature of the cargo-operations in the two trades. As pointed out by Johnson and Styhre (2015), rain stops the loading or discharging of dry bulk cargoes (such as grain or fertilizer), while tanker cargo-operations can continue 24-7 in all but the most adverse weather conditions. Johnson and Styhre (2015) attributed waiting time to dry bulk ports' restricted opening hours and stevedores' working hours. Such issues are largely absent for tanker port calls, where cargo-operations can usually commence as soon as tanker hoses are connected to terminal pipelines. Our work, however, shows that port authorities and oil terminals have the potential to speed up loading/discharging through infrastructure investments in more powerful and faster cargo pumps.

Waiting time may also depend on geography. Some ports may have significantly lower turnaround time (for similar ships) than others, as recently documented by UNCTAD (2019). In container shipping, Slack et al. (2018) found considerable geographical variation in port time, and attributed this to local and regional factors. Our study aligns with Slack et al.'s findings. We nuance the causes for the observed variation, as we point out the role of port officials' behavior for the duration of port calls. In their case of dry bulk shipping, Johnson and Styhre (2015) investigated vessels employed in Northern European short sea trades, where port efficiency is generally high and the risk of intimidation from port officials is low. This is not the case in many other ports around the world, where officials may cause delays and exhibit intimidating behaviour.

Waiting time for ships in port mirrors the problems associated with traffic congestion for trucks and trains. For both onshore transport modes, the provision of real-time traffic information to drivers can reduce waiting time and emissions, guiding them to more optimal routes and helping them time departure and arrival (Corman et al. 2009; Lee et al. 2010; Quaglietta et al. 2016). International shipping, on the other hand, is only now starting to look in the same direction. As pointed out in Section 1, shipping companies, their associations, and port and maritime policy makers have recently pointed out the potential for similar improvements in shipping, in particular in association with the sharing of real-time ship data among ships, ports and other relevant stakeholders. While confirming unproductive time in association with port calls, our work underlines the complexity involved in speed optimization efforts in shipping. In contrast to trucks and trains, ships do not have a single driver. Crews, who often count up to 20 persons, are in fact highly dependent on numerous stakeholders onshore, many of whom have positions that are more powerful. As such, measures to reduce waiting time and optimize port calls represent a more complex challenge than efficiency enhancements with real-time traffic data for onshore transport modes. In their study of major ports' greening initiatives, Poulsen et al. (2018) found that that major ports failed to implement measures to reduce waiting time in port due to the high complexity associated with this. We extend this work, documenting the nature of this complexity.

In shipping history, technological innovations (such as containerization) have reduced cargo-handling time in port significantly (Levinson 2006; Poulsen 2007). It remains to be seen, to what extent new technologies can help reduce the unproductive port time, identified in this article. Areas where innovation may be of assistance include in relation to the cargo pumping capacity of shore-based terminals and in laboratories where sample testing occurs. Further research based on operations and time saving potential in these locations would be valuable in this regard. Currently it is required that ship documents, notably the bills-of-lading that document that a cargo has been loaded, are signed in an analogue manner, which can take time after cargo operations are completed. A future, electronic signature on bills-of-lading could enable some time saving (Wunderlich and Saive 2020), but ships would still need to wait for local authorities, i.e. customs and immigrations officers, to come onboard for inspections of the crews' passports and other documents.

6. Conclusion

Waiting time for trucks, trains, airplanes and ships in service represent apparent inefficiencies in transport systems, and measures to reduce these can help the transport sector abate GHG emissions. In international shipping, a major emitter of GHG, reduced waiting time in association with port calls holds such promise. Transportation researchers, shipping industry and policy makers alike see swifter turnaround in port as a promising measure in the range of actions with the potential to reduce GHG emissions. It would enable ships to replace some port time with time transiting at a slower speed – without adverse effects on productivity or cargo transit time. Due to the at least cubic relationship between a ship's speed and fuel consumption, this could, in principle, lead to significant GHG abatement. Reduced port time would also help reduce local air pollution in many port cities around the world.

In this article, we have studied the causes for tankers' waiting time in port with an inductive, qualitative research design. We have explored the roles of crews and their employers, the shipping companies for faster vessel turn-around in port, because they are important stakeholders for port call optimization. Adding new empirical evidence to the transportation literature, we confirm the existence of idle time in port. We detail the causes for it and point out some of the previously neglected factors, which limit the crews' and shipping companies' room for maneuver in relation to port call optimization. We also show why that the process of reducing waiting time is more complex in shipping than in onshore transport modes, where real-time traffic information guides drivers to choose optimal routes as well as departure and arrival time and allows them to avoid time-consuming congestion. In the case of shipping and ports, a much larger group of stakeholders – including government/port officials, oil terminals and refineries, cargo surveyors, ship agents, tug service providers, pilots and other ships – influence the duration of port calls. In contrast to trucks and trains, ships do not have one driver, and both crews and shipping companies find themselves strongly limited in their efforts to optimize port calls. Although efficiency measures have the potential to abate GHG emissions from shipping, the complexity of such measures should not be underestimated.

Further research could explore successful cases of swift turn-around in port. Our study suggests that best practices might be present when the same company owns terminals and cargoes and/or ships and ensures port stakeholder coordination. Such may be present both in container, tanker and certain dry bulk shipping segments, and best practices may be relevant for the entire shipping and port sector. It also indicates that investment in infrastructure can impact positively on cargo transfer times (pumping/discharging rates) and that even small measures such as ensuring the use of the best quality mooring ropes can make a contribution. Comparative studies of traffic management in different transport modes also represents an area fertile for further research.

Our work has implications for policy makers, as we point out how port officials often cause delays in port. The IMO could direct efforts to facilitate the real-time sharing of traffic information among port stakeholders to help minimize delays. At the same time, it should direct more attention towards the behavior of officials, who both often cause crew stress and extends port time unnecessarily in many ports around the world.

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APPENDIX 1

Interview-guide for chartering, operations and technical managers in tanker shipping companies

June-August 2018

In my **e-mail approach to the interviewees**, I explain my interest in the potential for reduction of GHG emissions from shipping. I explain that my research concerns the question of how shipping can achieve the GHG goals agreed at the IMO MEPC meeting in April. I reveal my two key questions below (but not more than that):

1. What is the potential for time savings in tanker operations (in port and at anchorage)? Could reduce turn-around time in port and reduced time at anchorage enable ships to slow-steam further and achieve emission abatement?
2. What is your view on the GHG data collection systems from the EU (MRV) and the IMO (DCS)?

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The interviews will be **semi-structured** (and ideally take at least one hour). Preferably I will target heads of operations and chartering departments in tanker companies (product, chemical, LPG, and LNG). The interviews will fall in two parts:

1. Time savings potential, because this question is focused on the shipping companies' own operations.
2. The MRV and DCS discussions, because they are both concerned with shipping companies' own operations and environmental regulation. I expect the latter aspect to be more controversial in the view of the interviewees than the discussion on time savings.

The overall structure of the interviews will be the following:

1. Start with open-ended questions: Please describe what you do. How you do it? How does regulation affect your company?
2. Gradually follow up with more testing questions: Did you consider the following aspects and factors? If you see an improvement potential, why has this potential not already been achieved? How can shipping achieve significant GHG emission reductions?
3. Ending with clarifying questions about the business model of the shipping company: What are your competitiveness factors? (In order to supplement the information which is available in company annual reports and on corporate website).

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PART 1 – POTENTIAL FOR TIME SAVINGS

Do you see a potential for **time savings** in the operation of tankers, which could allow for service speed reductions?

- If yes, where?
    - How large is the potential?
    - How to achieve it?
    - Why has it not been achieved already?
- If not, why not?

Port turn-around time

- What are the factors, which influence a ship's turn-around-time in port?
    - Do you see variation in the duration of port calls?
        - If yes, what in your experience is the shortest and what is the longest?
            - What causes such variation?
- What are the main activities during a tanker's port call?
    - Could you please describe the different activities and processes that take place during a tanker's port call?
        - How long time does each activity take?
            - Which of these activities is the crew or the shipping company in control of?
            - How do bunkering, provisioning, garbage and sludge handling, crew changes or other activities influence the time spent in port?
                - Would it be possible to save time on any of the activities?
                    - Which and how?
                    - How can achieve such time saving measures?
            - How do customs clearance, immigration, signing of bills of lading etc. influence the time spent in port?
- Port turn-around time saving measures
    - What can you, in the chartering (or operations) department of a tanker shipping company do to reduce port turn-around time?
        - Do you have experiences with this?
    - What can seafarers onboard the ships do to reduce time in port?
    - Who are the other key stakeholders, who can ensure short turn-around time in port?

Time spent at anchorage

- Do any of your ships spend time in laden condition at anchorages, while waiting for berth?
    - If yes:
        - Where?
            - Is there any difference in the waiting time between different geographies, terminals or ports?
                - If yes, what causes this variation?

            - For how long do the ships wait?
            - Is waiting time at anchorage affected by the ship's charter party? Or type of charter (voyage vs. time charter)?
            - Does waiting time at anchorage affect your earnings in any way?
                - Under voyage charters?
                    - When will you start earning demurrage?
                    - Does demurrage rate differ from the voyage charter rate?
                        - If yes, how and why?
                - Under time charters?
            - Can you minimize or avoid the waiting time?
                - Would you want to do that?
                - What would be required to minimize waiting time?
- **Virtual arrival schemes**
    - Do you use virtual arrival schemes in your company today?
        - If yes, where and when?
            - Do you propose to charterers to use virtual arrival clauses to your voyage charterers?
        - If not, why not?
            - Do you have experiences with virtual arrival schemes from the previous shipping companies that you worked in?
            - Would implementation of virtual arrival clauses not enable shipping to reduce its fuel consumption and achieve emission abatement?
    - Are you familiar with the BIMCO virtual arrival clause for voyage charters, which was developed in 2012?
        - What is your view on the clause?
        - Do you use it? Or offer your charterers to use?
            - If yes, who use it?
                - And how frequently is it used?
            - If not, why not?
    - Do you see a potential for implementation of virtual arrival schemes?
        - If yes, what would it require?
        - And who should be involved for it to succeed?

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PART 2 – DATA SETS ON GHG EMISSIONS

Shipping company **performance monitoring system**

- How do you **measure the fuel consumption of your ships**?
    - Which onboard energy consumers do you focus on?
    - Do you use noon reports?
    - Do you use auto-logging systems?

    - Do you have flow meters onboard?
    - How frequently do you collect data?
    - What do you use the data from the systems for?
    - Have you changed your systems in recent years?
    - What are the key factors, which influence a ship's fuel consumption?
        - Which of these factors do you have an influence on?

View on **EU MRV**

- How does the EU MRV affect the work you do and your shipping company?
- How do you **collect data for MRV**?
    - Which data do you collect?
    - Where do you collect the data from?
    - Who collects the data?
- **Resources for MRV** data collection
    - Who is responsible for MRV data collection in your company?
    - Did you allocate additional resources to the data collection process, in terms of:
        - Human resources,
        - New IT-infrastructure, or
        - Monitoring equipment onboard the ships in your fleet?
    - How much does the MRV data collection require of your company in terms of man-hours per year/human resources?
        - To comply with EU MRV did you need to make any changes in the collection of fuel consumption data from your fleet (i.e., amend or revise your vessel performance monitoring systems)?
            - If yes, which, how and why?
- Did you use consultants or other external experts for the design or implementation of your MRV data collection system?
    - How do you **quality control** your MRV data?
        - Who is verifying your MRV data?
        - How does verification take place?
            - How frequently does it take place?
            - Can you use the process of data verification to improve your data quality?
- How does company's fleet performance monitoring system compare with the data collection for the MRV and DCS systems?

View on **IMO DCS**

- How do you collect data for the IMO DCS?
    - Which data do you collect?
    - Where do you collect the data from?
    - Who collects the data?

    - How frequently do you collect data?
- Could you please compare the IMO DCS and the EU MRV?
    - What are the key differences between the two systems?
        - Do these differences affect your work or data collection in any way?
    - Do you see any differences between the systems in terms of data quality?
        - If yes, where and why?

Internal use of MRV and DCS data

- How do you use MRV and DCS data within your shipping company?
    - For what purposes? Why?
    - Can you use the MRV data to identify a potential for energy efficiency or other types of improvement potentials within your fleet?
    - Can you use the MRV or DCS data to identify fuel inefficient ships in your fleet?
        - Have you actually done so?
- To what extent can you and your colleagues in the shipping company affect the efficiency measurements in the MRV and DCS systems?
    - Can you make changes in the operations of your ships, which would improve the performance measurements of your ships in the MRV and DCS systems?
        - If yes, how?
        - If no, why not?
- Do the MRV or DCS data convey the same message with regard to the efficiency of individual ships?
    - If not, what are the causes for the observed differences?
        - Do the MRV and DCS systems reflect the true performance differences between individual ships?
        - Do the MRV and DCS data sets align with the performance metrics that you use in your internal fleet performance monitoring system?
            - If yes, what are the key performance metrics?
            - If not, why not?

External use of MRV and DCS data

- **Who** do you expect to use the MRV and DCS data, when data sets become publicly available?
    - Will charterers use them for chartering decisions?
        - Can they identify the most fuel efficient ships in the market?
    - Will you or your company use the data sets, when chartering ships?
        - Can you use the MRV or DCS data sets for guiding your own chartering decision?
    - Could other stakeholders have an interest in using the MRV data?
        - Who? Why?
        - For instance:
            - Port authorities (for green port fee reductions)?
            - Policy makers?

            - For implementation of Market-Based Measures in the future?
            - What is your view on MBMs?
        - Journalists?
        - NGOs?
        - Others?
- Does the MRV or DCS systems provide you with any **business opportunities**?
- Does the MRV or DCS force you to reveal **commercially sensitive information**?
    - If yes, which information?
    - And what effects do you foresee from MRV and DCS?

Link between **MRV, DCS and private eco-rating** schemes

- Are you familiar with private eco-ratings in shipping?
    - If not: CCWG, CSI, ESI, Rightship, BetterFleet, EVDI
    - If yes, which ones?
        - Do you use them?
            - If yes, what for?
        - Do you know of other using it?
    - How do the eco-ratings affect the work you do, your company and the business of tanker shipping more broadly?
- From you point of view, how do the MRV, DCS and the private eco-rating schemes (CCWG, ESI, CSI, Green Award, Rightship/EVDI and BetterFleet) compare?
    - Are they measuring the same factors?
    - Or are there important differences between any of the ratings?
        - If yes, which?
    - Are there any overlaps between the private eco-ratings and the MRV and DCS systems?
        - If yes, which?
        - In your opinion, which of the systems provide the best measurement of a ship's energy efficiency?
            - And of its overall environmental performance?
- Do cargo-owners ask you questions regarding your CO2 emissions or any other aspects of your environmental footprint?
    - If no, why not?
    - If yes, what do they ask?
        - And who asks?
        - What do they use the information for?

View on the **air emission regulation in shipping**

- What is your view on regulation of air emissions in shipping?
    - Regulation from the IMO? The EU? And others?
    - **How is regulation affecting your business** and your company?
        - What regulation is affecting you the most?

        - How is regulation on air pollutants and regulation on GHG affecting your company? And the shipping markets?
        - What are the costs associated with compliance for you?
    - In your opinion, **how can shipping achieve the GHG emissions reductions** agreed at the April 2018 MEPC by 2050 (i.e. a 50 per cent reduction in absolute GHG emission levels relative to 2008)?
        - To what extent can these ambitions be achieved through efficiency improvements in the shipping sector?
        - In your opinion, does shipping need a new type of fuel to achieve the goals?
- From you point of view, why did the MRV and DCS systems come into existence?

Shipping company strategy

- In addition to the information available on your web-page and in your annual report, so short follow up or clarifying questions about :
- Which **trades** are you active in?
    - In terms of geography?
    - In terms of vessel sizes?
    - In terms of contract types and contract durations?
        - Use of spot, time charter, bareboat charters and Contracts of Affreightments?
    - Do you engage in asset play?
    - Do you contract newbuildings or buy second-hand vessels?
- How are ships **managed**? In-house or outsourced set-up for:
    - Chartering
    - Operations
    - Technical management
    - Crewing
    - Why? What is the motivation behind this set-up?
- What are the key **sources of competitiveness** for your company?