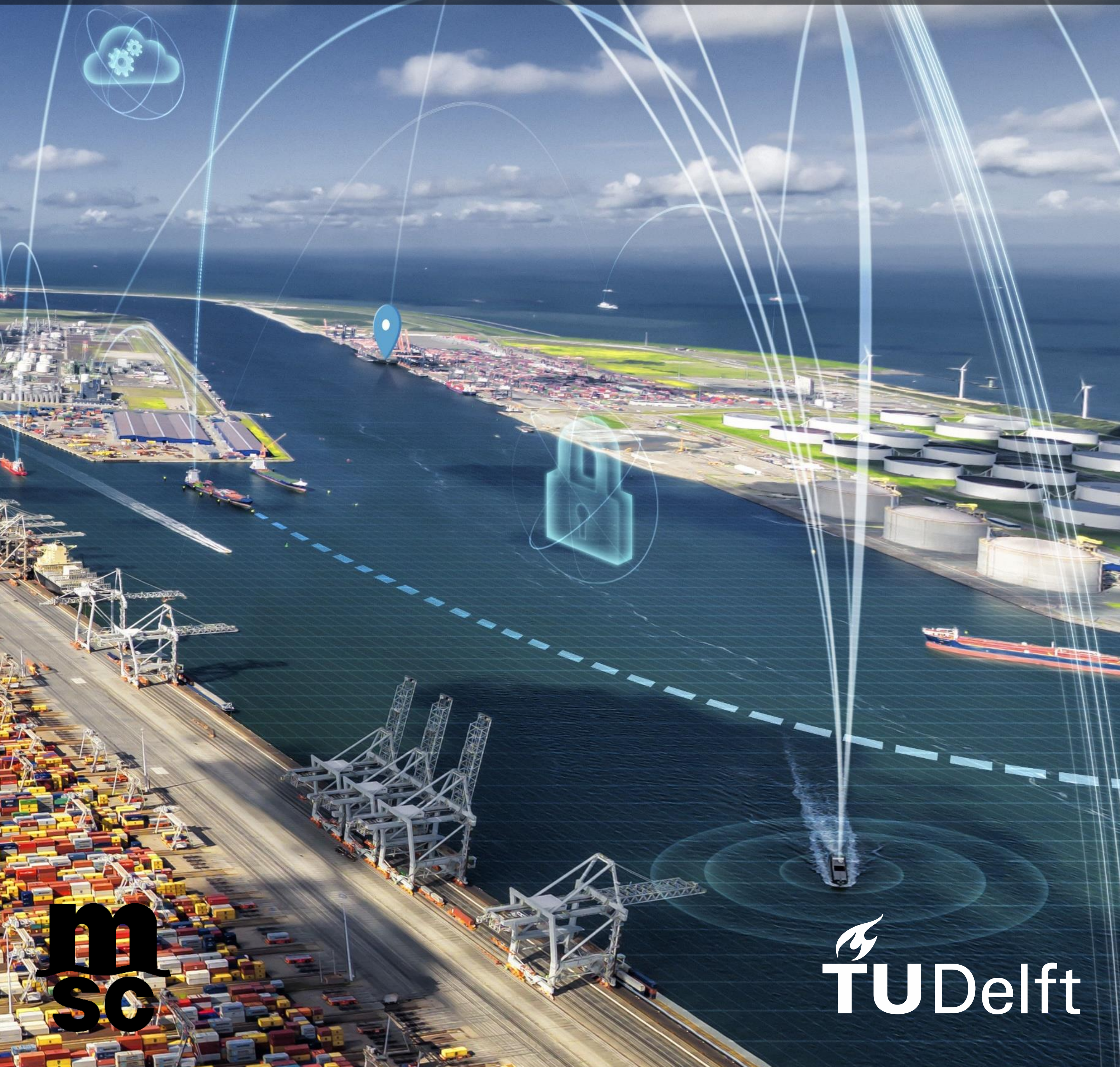
IDENTIFYING AND IMPROVING PORT CALL PROCESSES TO ENABLE JUST-IN-TIME ARRIVALS AND SERVICES

A case study on MSC container shipping in the Port of Rotterdam

MSc Thesis - CONFIDENTIAL

M.W. Vermeulen



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Identifying and improving port call processes to enable Just-In-Time arrivals and services

A case study on MSC container shipping in the Port of Rotterdam

By

Maurice William Vermeulen

in partial fulfilment of the requirements for the degree of

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Master Assessment Committee	
Chairman committee:	Dr. Ir. R.G. Hekkenberg
Staff member:	Ir. J.W. Frouws
Staff member:	Dr. Ir. E.B.H.J. van Hassel
Staff member:	Prof. Dr. Ir. L.A. Tavasszy
Staff member:	Dr. Ir. H.J. de Koning Gans
Company supervisor	
Mediterranean Shipping Company (MSC):	B. den Ouden
Author Details	
Student number:	4465555
Author contact email:	maurice-vermeulen@hotmail.com

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There are no secrets to success.
It is the result of preparation, hard work, and learning from failure.
~ Colin Powel

PREFACE

With great pride I present you this thesis. The report finalizes the graduation research as part of the Master of Science degree in Marine Technology with a specialisation in Shipping Management at the Delft University of Technology. This study is conducted in cooperation with MSC Nederland BV. The research is performed under the supervision of B. den Ouden from MSC, and Dr. Ir. E. van Hassel and Ir. K. Frouws from the Delft University of Technology.

It has been a great pleasure to research the complex port call processes of the world's second largest shipping company in the biggest port of Europe. Several persons have contributed to this graduation research. First of all, I would like to thank the supervisors who were closely involved in this study. Bob, you inspired me with your motivation to enable Just-In-Time arrivals and services in the maritime industry. I honestly hope my research can bring the industry a step closer to this concept. Koos and Edwin, I highly appreciated your time, support and valuable feedback in the past year. It has definitely contributed to the quality of my research.

Secondly, I would like to thank the interviewed persons for their valuable input. The knowledge and practical experiences of these experts were crucial to research the incentives and relations of actors in a port call and to identify and improve the current port call processes. I am convinced it is nearly impossible to conduct proper research in this field without a thorough understanding of the port call processes in practice. Many thanks to the following persons who were willing to share their knowledge during this research:

➢ E. de Jong	Regional Operations Manager	MSC
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➢ Capt. B. van Scherpenzeel	Chairman	PCO Taskforce
➢ Capt. A. M. van der Wurff	Port Optimization Manager	Maersk
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Last but not least, I would like to show my appreciation to my family and friends for their support during the past year. Special thanks to especially my father who gave me useful insights by means of his experiences as captain of both sea vessels and barges.

Maurice Vermeulen
Rotterdam, September 2020

ABSTRACT

The IMO has proposed Just-In-Time arrivals and services as one of the short-term solutions to reduce greenhouse gas emissions in maritime shipping. The Just-In-Time concept allows vessels to optimize their speed during their voyage. If a vessel earlier knows at which time it is requested to arrive at the pilot boarding place, the vessel can adapt its speed to arrive when the berth, nautical services and the fairway are available.

Besides environmental reasons, shipping companies as MSC consider the Just-In-Time initiative as a major port call process optimization. Since this concept aims to minimise unnecessary ad hoc waiting times and reduces fuel consumption per mile steamed, MSC assumes a significant amount of money can be saved by implementing Just-In-Time arrivals and services.

In the past, it has become clear it is extremely complicated to implement this initiative. Research is required in order to find out what needs to be improved to enable Just-In-Time arrivals and services. The current port call processes must be analysed. As start point, a case study is conducted about the port call processes of the world's second largest shipping company in the biggest port of Europe. In this study, the current port call processes of MSC container shipping in the Port of Rotterdam are identified and improved in order to enable Just-In-Time arrivals and services.

The following method is used in this research. First, the Just-In-Time arrivals and services initiative and the port call processes in general are understood. Thereafter, the current port call processes are researched by means of an actor-stakeholder analysis and a qualitative and quantitative process analysis.

The actor-stakeholder analysis is used to understand the incentives and relations between actors. Subsequently, this information is used in the process analysis. In the qualitative analysis, a distinction is made between the business processes and information systems in the different phases of a port call. The quantitative analysis elaborates on findings of the qualitive analysis. A data analysis tool is developed in order to gain valuable information from the data of the port call processes.

By comparing the desired and current state of the port call processes, it is identified what needs to be improved to enable Just-In-Time arrivals and services. Solutions are proposed to the involved actors which are recommended in order to enable the Just-In-Time concept in MSC container shipping in the Port of Rotterdam.

Several conclusions are drawn from this study. The research has emphasized the complexity of the port call business processes. This is primarily caused by the various actors, the many relations between actors, the different provided services and the high unpredictability of external disruptions. It can also be concluded that the involved actors primarily act on the basis of their own incentives. In order to enable Just-In-Time arrivals and services, collaboration is required among the involved actors. Most actors see the benefits of this concept. However, some actors are not willing to share data about their processes since this is considered as sensitive information. In case actors are willing to share data, it can be concluded that the information is not exchanged frequently enough or does often not meet any data standards. As last, this study shows that adaptations are required to the current business process of a port call in the Port of Rotterdam in order to enable Just-In-Time arrivals and services.

READING GUIDE

It is highly recommended to read the complete report including appendices to obtain a proper overview of the conducted graduation research. Since the research on the port call processes of MSC container shipping in the Port of Rotterdam has been relatively extensive and detailed, a reading guide is added to get a clear overview of the information in this report. In addition, those interested in a particular part of this research can use the reading guide to find the desired information in this report. Below, each chapter is shortly introduced.

Chapter 1 - Introduction – Plan of Approach. The introduction of this report elaborates on the background, problem definition and objective of this research.

Part I – Literature research (Chapter 2-6)

Chapter 2 - Introduction. The introduction of Part I clarifies the relations between the different topics discussed in the literature research.

Chapter 3 - Just-In-Time arrivals and services concept. This chapter gives a more detailed explanation about the background of this research. In this study, the port call processes are identified and improved to enable Just-In-Time arrivals and services.

Chapter 4 - Port call processes – general description. Information about the desired port call process – the pre-requisite to enable Just-In-Time arrivals and services – is given in this chapter. As complement to this chapter, it is recommended to read Appendix B.

Appendix B - Port call business process. This section gives a detailed description of the desired port call process. This process is based on research and knowledge of PCO Taskforce, a taskforce in which shipping industry and ports collaborate to achieve port call optimization.

Chapter 5 - Applied methods in this research. A general description of the methods, which are applied in this research, are covered in this chapter.

Chapter 6 - Conclusion. This chapter concludes the information obtained in Part I.

Part II – Case study description & Actor-stakeholder analysis (Chapter 7 – 10)

Chapter 7 - Introduction. The introduction of Part II clarifies the essence of the information in this research part.

Chapter 8 - Case study description. This chapter introduces the case study of this research; port calls related to MSC container shipping in the Port of Rotterdam are discussed.

Chapter 9 - Actor-stakeholder analysis. In this section, the involved actors in a port call process of MSC container shipping in the Port of Rotterdam are analysed. Due to the size of the report, the complete analysis is moved to Appendix C. It is recommended to read also this section. Many details are given which often effects the current port call processes.

Appendix C - Complete actor-stakeholder analysis. Each actor is extensively analysed to gain an understanding of their role and incentives in a port call.

Chapter 10 - Conclusion. This chapter concludes the analysis of each actor. Extra charts are made to clarify the position and incentives of the involved actors in a port call.

Part III – Process analysis of a port call – qualitative and quantitative (Chapter 11 – 15)

Chapter 11 - Introduction. This section describes the essence and relations of the conducted process analyses.

Chapter 12 - Qualitative analysis – contractual phase. The contractual relations in MSC container shipping are clarified in this section. Contractual relations can impact the operational phase of port calls.

Chapter 13 - Qualitative analysis – operational phase. This chapter shows an extensive analysis of the current port call processes of MSC container shipping in the Port of Rotterdam.

Chapter 14 - Quantitative analysis. Details of the quantitative research of port calls of MSC operated vessels in the Port of Rotterdam are clarified in this section. It also includes an explanation of the developed data analysis tool.

Chapter 15 - Conclusion. This section gives an overview about what needs to be improved to enable Just-In-Time arrivals and services.

Part IV – Proposal adaptation of business process, Conclusions and Recommendations (Chapter 16-18)

Chapter 16 - Proposal adaptation of port call business process. This chapter shows a proposal with recommendations to each involved actor. The aim of this section is to propose solutions for the current port call processes to enable Just-In-Time arrivals and services.

Chapter 17 - Research conclusion. This chapter concludes and reflects on the complete research.

Chapter 18 - Recommendations for further research. Suggestions for further research, which are related to this study, are given in this section.

Part V – Appendix

Appendices A - K. These sections complement the information of Part I – IV.

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LIST OF ABBREVIATIONS

ACM	Authority for Consumers & Markets
AGV	Automated Guided Vehicle
APMT-R	APM Terminals Rotterdam
APMT-MVII	APM Terminals Maasvlakte II
ATA	Actual Time of Arrival
ATC	Actual Time of Completion
ATD	Actual Time of Departure
ATS	Actual Time of Start
ASC	Automated Stacking Cranes
AVANTI	Access to Validated, Nautical Information
BIMCO	Baltic and International Maritime Council
BMPH	Berth Moves Per Hour
CO_2	Carbon dioxide
COLREGs	International Regulations for Preventing Collisions at Sea
DCSA	Digital Container Shipping Association
DDN	Delta Dedicated North
ECT	Europe Container Terminals
EEDI	Energy Efficiency Design Index
ETA	Estimated Time of Arrival
ETC	Estimated Time of Completion
ETD	Estimated Time of Departure
ETS	Estimated Time of Start
HCC	Harbour Coordination Centre
GHG	Greenhouse gas
GIA	Global Industry Alliance
GIDS	Gezamenlijk Interactief Dienstverleners Systeem
HaMIS	Harbour Master Information System
IAPH	International Association of Ports and Harbours
IHMA	International Harbour Masters' Association
IMO	International Maritime Organization
JIT	Just-In-Time
LAB	Loodsen Aantal Boten
MSC	Mediterranean Shipping Company
MLC	Maritime Labour Convention
NOR	Notice of Readiness
PBP	Pilot Boarding Place
PCS	Port Community System
PCO	Port Call Optimization
PRONTO	Port Rendezvous of Nautical and Terminal Operations
PTA	Planned Time of Arrival
PTC	Planned Time of Completion
PTD	Planned Time of Departure
PTS	Planned Time of Start
RTA	Requested Time of Arrival
RTC	Requested Time of Completion
RTD	Requested Time of Departure
RTS	Requested Time of Start
SCA	Slot Charter Agreement
SOLAS	Safety of Life at Sea
UKHO	United Kingdom Hydrographic Office
ULCV	Ultra Large Container Vessel
VSA	Vessel Sharing Agreement
VTS	Vessel Traffic Service

LIST OF DEFINITIONS

Anchorage – location at sea where vessels have the possibility to anchor.

Anchoring – mooring a vessel by using an anchor.

Avanti – application, proposed by the maritime industry, IHMA and UKHO, to improve the availability of master data in a port such as depths and admission requirements.

Actual time of arrival berth (ATA berth) – the actual time the incoming vessel arrives at the berth.

Actual time of arrival pilot boarding place (ATA PBP) – the actual time the incoming vessel arrives at the pilot boarding place.

Actual time of completion service (ATC service) – the actual time the service is completed.

Actual time of departure berth (ATD berth) – the actual time the vessel departs from the berth.

Actual time of start service (ATS service) – the actual time the service provider starts providing their service.

Bareboat charter – agreement in which a charterer gets full control over the ship.

Bill of Lading (B/L) – document which acts as evidence of a contract of carriage between shipper and shipping line to perform the cargo transport under agreed terms and conditions.

Berth – the quay used by a vessel to anchor or lay alongside.

Berth pocket – port section which can be used by vessels to make fast for mooring or anchoring.

Berth position – specific location along the berth (e.g. bollard number) at which the vessel can moor.

BIMCO – international shipping association with members such as shipowners, agents, brokers. Its aim is to create commercial contracts between parties on behalf of its members.

Boatmen – people that help vessels to fasten lines to posts and bollards.

Broker – intermediary between a ship owner and charterer which task is to find available and suitable vessels.

Charterer – cargo owner or representative of cargo owner.

Charter party – contract between ship owner and charterer, in which the cargo owner pays the charterer freight to transport their cargo.

Consignor – exporter of record for a shipment to be delivered, also called sender.

Consignee – importer of record for a shipment to be delivered, also called recipient.

Container terminal – terminals which are involved in activities such as handling, storage, discharging/loading containers to another transport modality.

Contract of affreightment – combination of voyage charters. In this contract, the ship owner agrees to transport a given quantity over a certain time period for a specified price per ton cargo.

Contracts of carriage – contract between a carrier of goods and passenger which basically mentions the rights, duties and liabilities of the involved parties. It also points out matters as acts of God or clauses as force majeure. This is in order to eliminate liability and obligation in case of natural hazards / unavoidable events.

Demurrage – costs paid by the charterer to the ship owner if the cargo operations (loading/discharging) time exceeds the agreed duration in the charter party.

Despatch – costs paid by the ship owner to the charterer if the cargo operations time is below the minimal threshold.

EEDI – the most important critical measure developed by the IMO in order to reduce emissions in shipping. It requires new ships to meet minimum energy efficiency regulations based on the year it is built in.

End-to-end supply chain visibility – transparency in the processes involved in the end-to-end supply chain, from start until the end.

Estimated time of arrival berth (ETA Berth) – the estimated time the incoming vessel arrives at the berth.

Estimated time of arrival pilot boarding place (ETA PBP) – the estimated time the incoming vessel arrives at the pilot boarding place.

Estimated time of completion service (ETC service) – the time the service provider estimates that the service is completed.

Estimated time of departure berth (ETD Berth) – the estimated time the outgoing vessel departs from the berth.

Estimated time of start service (ETS service) – the estimated time the service provider start providing their service.

Fairway – main navigable channel in a river or port that has enough depth for vessels.

Freight forwarder – company/person who takes the responsibility of the goods transport on behalf of the consignor.

GIA – partnership initiative of the IMO, launched in 2017, which brings maritime leaders such as oil and shipping companies, ports, classification societies, engineering companies and big data supplier together. It aims to address and tackle obstacles towards decarbonization in shipping.

GS1 – organisation that creates worldwide standards in business communication.

IAHP – an international association for seaports that promotes interest in ports globally.

IHMA – the organisation that brings harbour masters around the world together.

IMO – the organisation which primarily sets the rules for the international shipping industry.

Incoming vessel – the vessel that plans to visit the port.

International Ship and Port Facility Security Code (ISPS) – safety measure with the aim to maintain safety for the maritime transport sector (vessels, ports, cargo, crew).

Just-In-Time arrivals and services – a concept that is used by leading companies in the industry to optimize the maritime supply chain. It enables vessels to operate at the most efficient speed which is adapted in such a way it arrives at the pilot boarding place at the right time.

Liner shipping – shipping that provides services on fixed schedules. Liner ships sail pre-determined routes and load/discharge at fixed ports. It transports small amount of goods for several clients.

Mediterranean Shipping Company (MSC) – one of the largest shipping companies in the world. It is a global leader in container shipping. MSC is involved in transport over road, rail and sea.

Master – captain of vessel.

Notice of Readiness (NOR) – message sent by the vessel that confirms it is ready to start the charter service or to start loading/discharging cargo.

Outgoing vessel – the vessel that leaves the port.

PCO Taskforce – taskforce in which agents of shipping companies and port authorities actively work together with international associations. Its aim is to acquire standards of the nautical and logistic industries together. The companies collaborate to optimize the quality and availability of data.

Pilot – person that sails vessels through congested waters (harbours, river mouths).

Pilot boarding place – the place at which the pilot (dis)embarks.

Planned time of arrival berth (PTA Berth) – the time the incoming vessel is planned to arrive at the berth.

Planned time of arrival pilot boarding place (PTA PBP) – the time the incoming vessel is planned to arrive at the pilot boarding place.

Planned time of completion service (PTC service) – the time the service is planned to be completed.

Planned time of departure berth (PTD berth) – the time the vessel is planned to depart from the berth.

Planned time of start service (PTS service) – the time the service provider plans to start the service.

Pronto – project that must improve event data, such as starting and completion times, in the Port of Rotterdam.

Port – any place a ship can call. This means a place with possibilities to load, discharge, maintenance & repair, and anchor.

Port call – all involved activities of a vessel which are related to a port visit of a vessel.

PortXchange – an application launched to improve event data in a port. It consists of a common platform provided for shipping companies and their agents, service providers (terminals, bunkers, pilots etc.) and the port authority.

Requested time of arrival berth (RTA Berth) – the time the incoming vessel is requested to arrive at the berth.

Requested time of arrival pilot boarding place (RTA PBP) – the time the incoming vessel is requested to arrive at the pilot boarding place.

Requested time of completion service (RTC service) – the time that the service is requested to be completed.

Requested time of departure berth (RTD berth) – the time the outgoing vessel is requested to depart from the berth.

Requested time of start service (RTS service) – the time the service provider is requested to start the service.

Supply chain – network of companies, people, activities, data and resources which are related to the transport of a product or service from a supplier to the end customer.

Time charter – agreement in which the ship, for a specified amount of time, is operationally controlled by the charterer while the ownership and management is still the responsibility of the ship owner.

Time sheets – sheet that quantifies exact operations start and completion times, and cargo quantity and lay time calculation.

Timestamp – combination of a time and location event such as ETA PBP and ATD berth.

Tramp shipping – shipping that is not characterized by fixed routing and schedules. Tramp ships usually transport cargo for one or two users. The number of port visits per trip is often reduced to a few ports. The ships are designed to transport large quantities of uniform goods (e.g. bulk).

Tugs – vessel type that helps other vessels manoeuvring by pushing or pulling them by using a line or direct contact.

Turning basin – specified enlarged area where vessels can turn.

UKHO – agency in the United Kingdom that supplies hydrographic and maritime information to mariners and organisation globally.

Voyage charter – agreement that contains information about the transport of a certain type of cargo from point A to B for a specific price per ton cargo.

1 INTRODUCTION – PLAN OF APPROACH

This thesis provides information about the research to port call processes in relation to the Just-In-Time arrivals and services concept proposed by the IMO. A case study is conducted on MSC container shipping in the Port of Rotterdam.

Before reading this thesis, it is worth noting that the term Just-In-Time originates from the manufacturing industry in which it aims to improve business performance by reducing inventory levels and related costs ('Lean method'). Nowadays, the Just-In-Time concept is spread out to other industries. It generally refers to process improvements needed to decrease redundant waiting and idle times of capital assets. In maritime shipping, it refers to the process improvements which decreases unscheduled ad hoc waiting times and idle times of vessel operations (IMO, 2016).

This chapter shows information about the background of this research. The next sections elaborate on the problem definition, literature gap, objectives and scope of this thesis. The outline of this report is described in the last section of this chapter.

1.1 BACKGROUND

The background of this research can be complex at first sight. Therefore, this section consists of three subsections. First, the Just-In-Time arrivals and services initiative is explained (Section 1.1.1). Thereafter, port call optimization – the pre-requisite of the Just-In-Time concept – is discussed (Section 1.1.2). A summary of this information is given in Section 1.1.3.

1.1.1 Just-In-Time arrivals and services

Sustainability is nowadays an important issue for each major company in the world. This obviously applies to one of the largest shipping companies in the world – Mediterranean Shipping Company (MSC, 2018). Shipping plays a key role in the world; around 80% of global trade is transported by sea and this is still growing each year. In addition, international shipping is one of the most heavily regulated industries (IMO, 2019). Therefore, shipping companies as MSC have to adapt to meet the strict regulations of the IMO (International Maritime Organization) – the organization which primarily sets the rules for this industry (International Chamber of Shipping, 2019). By 2050 the IMO requires a reduction of at least 50% of the total annual greenhouse gas emissions compared to 2008. This desires a carbon dioxide reduction of approximately 85% per ship (IMO, 2019).

The IMO has defined candidate short-term, mid-term and long-term measures to satisfy the IMO2050 requirement (IMO, 2019; IMO, 2020). The Energy Efficiency Design Index (EEDI), one of the leading measures, is developed which requires new ships to meet minimum energy efficiency regulations based on the year it is built in. However, this is only a target for newly build ships. In order to satisfy the IMO2050 requirements, measures to improve the efficiency of existing ships are also needed (Leaper, 2019).

The IMO currently discusses a short-term measure, one that must be finalized and agreed to in 2018-2023, which is stated as follows: "*consider and analyse the use of speed optimization and speed reduction as a measure, taking into account safety issues, distance travelled, distortion of the market or to trade and that such measure does not impact on shipping's capability to serve remote geographic areas*'' (IMO, 2020; Psaraftis, 2019). The main distinction in this measure is speed optimization versus speed regulation. Nowadays, speed limits still show several shortcomings to reduce greenhouse gas emissions (Psaraftis, 2019). According to the port authority of Rotterdam and shipping companies as MSC the emphasis must be on optimization instead of regulation (Van Scherpenzeel, personal communication, September 9, 2019).

MSC participates in several global environmental initiatives and platforms to have a positive impact on the environment (MSC, 2018). As member of the Global Industry Alliance (GIA), MSC is actively cooperating with other leading firms of the industry. GIA is a partnership initiative of the IMO which is launched in June 2017 (IMO GIA, 2019a). Maritime industry leaders such as oil and shipping companies, ports, classification societies, engineering companies and big data suppliers work together in this organisation. The current members are firms as AP Møller-Maersk, DNV GL SE, Lloyd's Register EMEA, Port of Rotterdam, Shell, Wärtsilä Corporation (GloMEEP, 2017). Appendix A.1 displays all members of the IMO GIA. The collective aim of IMO GIA is to address and tackle obstacles towards the decarbonization of the shipping industry.

IMO GIA has currently proposed 'Just-In-Time arrivals and services' as solution for speed optimization (IMO GIA, 2018a). It believes that this Just-In-Time concept can significantly reduce the amount of pollutants emitted by maritime shipping. Besides environmental reasons as proposed by the IMO GIA, this concept is also considered as major process optimization in shipping which will have many more benefits for the maritime industry.

Just-In-Time arrivals and services aims to minimize unnecessary ad hoc waiting times and reduces fuel consumption per mile steamed. Today, ships often sail at relatively high speed towards the destination port. In many cases, the vessels are thereafter waiting at anchorage or manoeuvring at low speeds in the port area. In the Just-In-Time concept, vessels operate at the most efficient speed which is adapted in such a way the ship arrives at the pilot boarding place at the right time. The vessel's efficient speed is considered to be the speed at which the vessel arrives at the right time in the port area. This is the moment when the berth and fairway are accessible and nautical services as pilots, tugs and boatmen are available (IMO GIA, 2019a).

If appropriate data about the requested time of arrival is communicated to the ship in advance, the ship can adapt the speed to arrive just-in-time. This reduces the idle times of vessels waiting outside a port and saves fuel which, in turn, decreases emissions and fuel costs (O'Dwyer, 2019; Greenport, 2019).

1.1.2 Port call optimization

Just-In-Time arrivals and services can only be implemented, if reliable real-time information about the port call processes is available. Without collaboration of all involved stakeholders in the maritime industry, the initiative will not be successful. Shipping companies and port authorities need detailed data such as times of arrival, times of departure, admission requirements and depths, to make a sufficient planning. A ship will only adapt their speed, if it obtains reliable real-time information about the availability of the nautical services and accessibility of the berth and fairway (IMO GIA, 2019a; Port of Rotterdam, 2019a).

In order to correctly implement Just-in-Time arrivals and services, both ports and shipping must be optimized. At this stage, the PCO Taskforce comes into play. In 2014, the project Port Call Optimization Taskforce is launched which uses among others the following slogan: "*A reliable port starts with reliable information*" (PCO Taskforce, 2020). In this project agents of (shipping) companies such as Shell, Maersk, CMA CGM and MSC, and port authorities such as the Port of

Rotterdam actively work together with the International Harbour Masters' Association, United Kingdom Hydrographic Office and GS1. Appendix A.2 gives an overview of all involved parties of the PCO Taskforce. The aim of the PCO Taskforce is to acquire standards of nautical and logistic industries together. The nautical port information must be real-time, complete and based on a standard in order to optimize both ports and shipping (PCO Taskforce, 2019a).

Therefore, agents and shipping companies address the shipping processes which need to be improved in case of data sharing. The port authority and service providers (e.g. pilots, terminals) try to find solutions to obtain high quality data. International associations as BIMCO and International Association of Ports and Harbours are committed to approve the standards. The companies collaborate to optimize the quality and availability of data. The PCO Taskforce also works together with the IMO GIA to optimize port call processes (PCO Taskforce, 2020).

PCO Taskforce has set up two projects to improve the information within a port. A distinction is made between event and master data which are included in the projects 'Pronto' and 'Avanti' respectively. These projects follow the standards of the Port Call Optimization Taskforce.

More reliable master data, such as depths and admission requirements, available for the port users is the aim of 'Avanti'. The project must make sure that information is constantly available and accurate. By obtaining the right information the vessel could make improved decisions about which moment it can enter or leave the port safely (PCO Taskforce, 2020).

The aim of the other project 'Pronto' relates to improving event data in a port. Event data contains information about starting and completion times, such as planned time of arrival and estimated time of completion. An application is launched to improve event data in the Port of Rotterdam. The application, called PortXchange, consists of a common platform provided for shipping companies and their agents, service providers (terminals, bunkers, pilots etc.) and the authority of the Port of Rotterdam. It can be used to enhance the planning, completion and monitoring of the port call activities (Portstrategy, 2019). All involved actors can give updates in the platform about the status of the activities. The application displays this information in a time schedule for each vessel and berth. By combining the updated data of the service providers with public information and forecasts, the application is able to show more accurate port call data (Port of Rotterdam, 2018). Improving the quality and availability of event data is of great importance to implement the Just-In-Time concept (PortXchange, 2020a). Figure 1.1 is an example of the information that can be provided by the application.

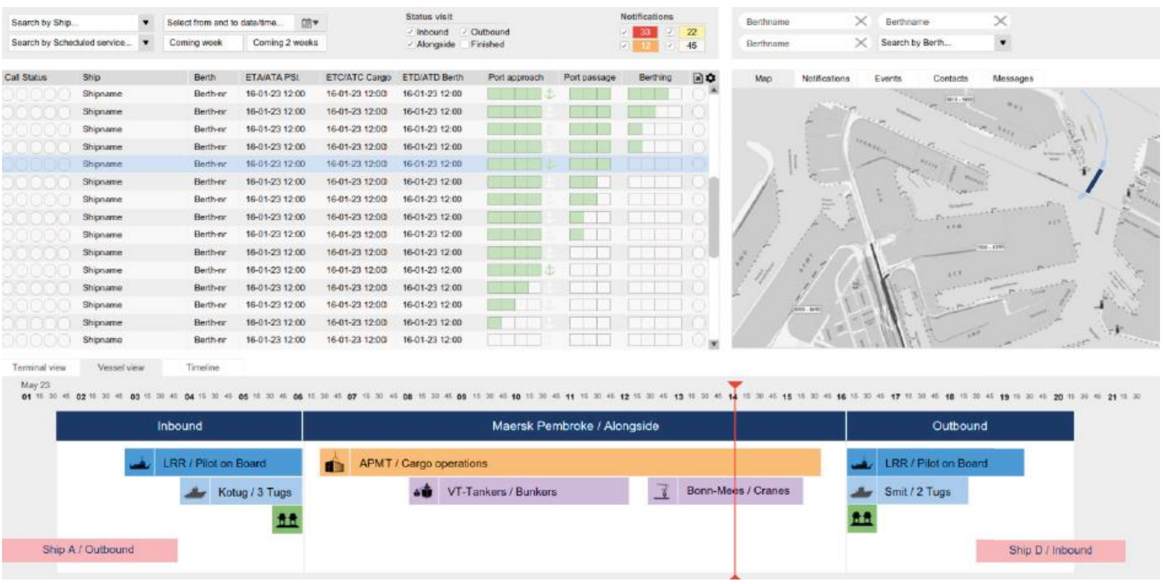

Figure 1.1: Example of the information provided by the application of Pronto project (PCO Taskforce, 2020).

It is worth noting that other ports can use similar applications to obtain the same benefits. Only requirement is that it meets the developed standards by the PCO Taskforce. PortXchange is, thus, interoperable with other applications with the same standards as Pronto and Avanti.

1.1.3 Summary and relation to end-to-end supply chain visibility

More visibility in the supply chain is required to enable the Just-In-Time concept. Figure 1.2 gives an overview of the end-to-end supply chain visibility. It is made to give a clarification of the abovementioned information. The Venn diagram shows the relations in the network.

In the end-to-end supply chain visibility, IMO GIA and PCO Taskforce are closely connected to each other. IMO GIA needs the data standards of PCO Taskforce in order to correctly implement Just-In-Time arrivals and services in a port. The PCO Taskforce, in turn, needs the IMO GIA to adapt the shipping regulations which obliges shipping companies to satisfy the data standards. Data standards will have the most benefits if all involved parties use the standards.

More connections are, however, visible in the Venn diagram. Let's start on the right side with the IMO objective. The IMO has set a target of GHG emission reduction in shipping of at least 50% in 2050 compared to 2008. This could be achieved by speed regulation and/or speed optimization. IMO GIA has proposed 'Just-In-Time arrivals and services' as best initiative for speed optimization. In order to implement this initiative, real-time tracking/data is needed.

At this stage, PCO Taskforce standards are needed. It requires availability and quality of data; obtained data must be complete, accurate and based on a certain data standard. The PCO Taskforce consists of two projects to improve the availability and quality of information. Avanti and Pronto must improve master and event data in a port respectively.

The ports / carriers / service providers are the central point in improving the end-to-end supply chain visibility as shown in Figure 1.2. Without collaboration of these actors it is impossible to reach the IMO target. The end-to-end supply chain visibility is completed by the hinterland planning of the import/export streams towards the port.

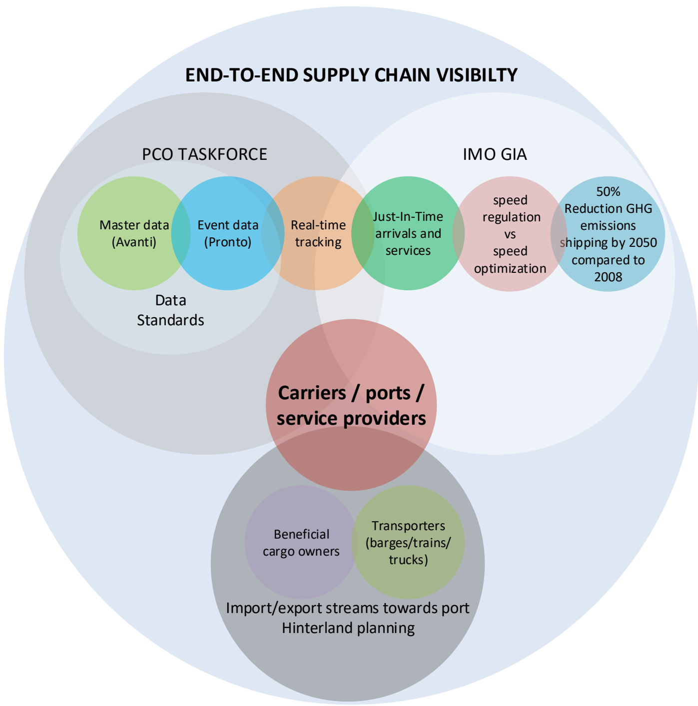

Figure 1.2: Venn Diagram end-to-end supply chain visibility. Source: own figure.

1.2 Problem definition

Not exactly knowing when the previous ship at berth will leave is one of the main reasons why Just-In-Time arrivals and services is currently still not implemented in ports. The ship will only leave the port after the critical services such as loading and discharging of cargo, bunkering and provisioning are finished. However, the terminal and the other service providers share few data and updates with each other (GloMEEP GIA, 2018). This makes it more difficult for the ship operator to communicate a correct estimated time of departure to the port authority. The decision of the port authority to give the vessel permission to leave the berth is based on the traffic in the fairway and the availability of nautical services. This will make last-minute changes to the vessel's planned time of departure.

The next ship that approaches the port needs information about the availability of the berth and services. Currently, it receives these data only two hours before arrival when the ship is in radio range. If updates and data will be sent earlier and more frequently, the next incoming ship can adapt their speed earlier. Consequently, the ship could directly enter the port instead of waiting for an unspecified time at an anchoring location (GloMEEP GIA, 2018). It must be noted that Just-In-Time arrivals and services aims to decrease the unscheduled ad hoc waiting times. It does not aim to reduce waiting times completely. Container vessels may decide, for example, to plan a time buffer in order to be prepared for rough weather conditions.

The importance of Just-In-Time arrivals and services can be emphasised by considering a case in the Port of Rotterdam. The current anchorage locations for vessels for this port will partly disappear, since many new wind farms are going to be built in the North Sea. Consequently, less anchorage options will be provided close to the Port of Rotterdam. Vessels may reroute to anchorage locations further away. It obviously results in less efficient maritime/port operations. If vessels adapt their speed and arrive at the right place at the right time, anchoring may not always be needed (International Chart Series, n.d.).

In order to make a sufficient planning shipping companies and port authorities need detailed information, such as times of arrival, times of departure, admission requirements and depths. However, the communication between the involved parties takes place in several ways. This working method is inefficient (PCO Taskforce, 2020). Information about ships' positions is nowadays available in real time. However, data about current and future activities of the vessels is usually unknown or does not meet any standards (PCO Taskforce, 2019a).

According to a study of XVELA and Navis (De los Santos, 2019; BPI Network, 2017), ports are described as 'black holes' in the logistic chains. 57% of the interviewed stakeholders in the study point out that poor coordination between partners and others is a huge bottleneck within a port. Moreover, 50% of the stakeholders mention that too little transparency and visibility is also top challenge. In addition, another 37% points out that inefficiencies are a barrier in the supply chain.

The quality of port information is low. This is mainly caused by absence of global nautical and supply chain standards, available information is not shared with all the involved parties, no efficient communication (e.g. phone calls, printed documents) and no data quality assurance. The consequence is that parties sometimes obtain different information about the same ship. This makes it even more difficult to make an appropriate planning. Therefore, it is crucial that real time data and predictions satisfy nautical and supply chain standards (PCO Taskforce, 2018).

The PCO Taskforce has developed a framework of the business process of a port call. This refers to the desired situation in terms of definitions and data standards according to the PCO Taskforce. Years of industry experience and scientific research have contributed to the design of the business process map of PCO Taskforce. Today improvements of the port call process in the Port of Rotterdam are already made by the projects Pronto and Avanti. However, there is still a gap between the current situation and the desired situation of the PCO Taskforce. The PCO taskforce initiative is considered as a pre-requisite for Just-In-Time arrivals and, therefore, needed to implement Just-In-Time arrivals and services. Note that it is not excluded that there may also be a gap between the PCO Taskforce and the Just-In-Time arrivals and services initiative. In short, the current port call process must be improved to implement first the PCO Taskforce initiative and thereafter the Just-In-Time arrivals and services initiative.

In addition, it must be clear what the willingness is of each actor in a port call to implement the Just-In-Time initiative. Therefore, the position and motivation of each actor must also be determined. Each actor must be analysed extensively to determine their perceptions and position in a port call.

Thus, it is of great importance to know how far we got until today. Limited amount of literature is currently available about the current port call process for a specific port as the Port of Rotterdam. Therefore, an extensive model of the actors and the port call process in the Port of Rotterdam is needed to get a clear overview of the current port call situation. This research must provide insight into the port call processes. Both qualitative and quantitative research must be conducted to analyse the port call processes and to propose solutions in order to enable Just-In-Time arrivals and services.

1.3 Literature gap - port call processes Port of Rotterdam

Today, several organisations and companies focus on the Just-In-Time arrivals and services initiative. As described, PCO Taskforce (PCO Taskforce, 2018) has designed a port call business process map including appendix to optimize port calls in general. In addition, the DCSA (DCSA, 2020), an association with the aim to bring carriers together and implement data standards, focus on the Just-In-Time initiative from a container perspective. IALA (IALA, 2016), a non-profit organisation which aims to establish standards in the maritime industry, has also conducted research to optimize port calls. However, all these parties focus on port call optimization to enable Just-In-Time arrivals and services globally.

According to expert consultation, it is crucial to research the current port call process in very detail in order to propose solutions to actors involved in a specific vessel, cargo and port type. Many companies have performed research to optimize port calls in relation to the Just-In-Time initiative. However, none have succeeded to optimize port calls in such a way that Just-In-Time arrivals and services can be implemented.

Research on port calls in the Port of Rotterdam is also found. Matti Masovic (Masovic, 2019) has written a master's thesis about port call efficiency in the Port of Rotterdam. This thesis uses information obtained from PCO Taskforce and IALA to describe a port call. However, in his report the port call process is also discussed at a relatively high level of abstraction.

To conclude, several sources are available about general port call process. However, none of the sources have a certain level of abstraction which is required for this research. The available sources will however be used to understand the port call processes in general.

Note that literature is available about optimizing port waiting times. However, these waiting times theories are not very relevant for this research since no waiting times calculations/simulations will be conducted. In addition, the emphasis of this research is on identifying and improving the current port call processes.

1.4 Objective

The main objective of this research is to identify and improve the current port call processes of MSC container shipping in the Port of Rotterdam to enable Just-In-Time arrivals and services. This research must create a framework of the current port call business processes. Improvements of the current port call processes must also be proposed. In addition, the effects must be determined of Just-In-Time arrivals and services in MSC container shipping in the Port of Rotterdam.

1.5 Scope

This section gives a more detailed explanation about the scope of this research. The port call processes are researched by a case study on container shipping of MSC in the Port of Rotterdam.

1.5.1 Network of ports

In an ideal scenario, all ports in the world use the same data standards. In that case, all ports can share real time data with each other to make a Just-In-Time planning. However, since the Port of Rotterdam is one of the first ports that has started projects as Avanti and Pronto, the scope of this research is set to a port call in the Port of Rotterdam.

1.5.2 MSC container vessels & container terminals

Since this research is performed in cooperation with MSC, data about arrival and departure times of container vessels of MSC are going to be used in this research. The container ships generally (un)load containers at the ECT Delta Terminal, APM Terminals Rotterdam and APM Terminals Maasvlakte II in Rotterdam. This means the terminals are also in the scope of this research.

Thus, the port call processes are researched by performing a case study of MSC container shipping in the Port of Rotterdam. This is mainly because MSC has a lot of data and information of their own container vessels.

1.5.3 Involved stakeholders

As already mentioned, this research is all about MSC container shipping in the Port of Rotterdam. Therefore, the scope is set to all MSC container vessels to/from the Port of Rotterdam and everything that can influence the business processes of these vessels. This includes everything that can impede the fairway of the MSC container vessels in the Port of Rotterdam.

Hence, the following stakeholder are, among others, included in the scope: berth operator (terminals), shipping company (MSC), port authority (Port of Rotterdam), captain (via agent) arriving and departing MSC ship, nautical service providers (pilots, tugs, boatmen), vessel service providers.

1.6 OVERVIEW PLAN OF APPROACH

A lot of information is obtained in the previous sections. An overview is made to clarify the relations between the discussed topics (Figure 1.3). The Just-In-Time concept is not yet implemented. Research is required in order to find out what needs to be improved to enable Just-In-Time arrivals and services in MSC container shipping in the Port of Rotterdam.

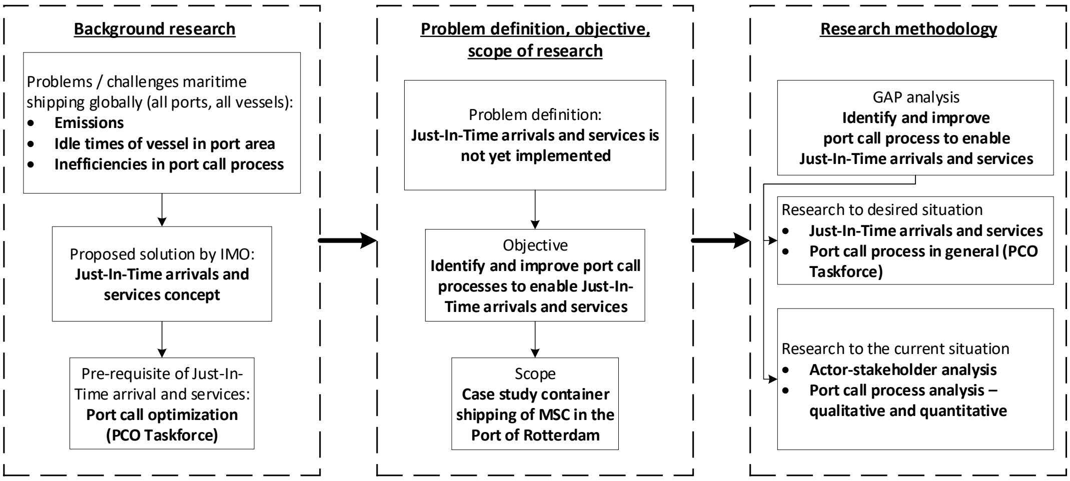

Figure 1.3: Overview of background, problem definition, objective, scope and methodology of research. Source: own figure.

1.7 THESIS OUTLINE

This master's thesis is divided into multiple sections. The sections start with an introduction and end with a conclusion. Figure 1.4 gives an overview of the thesis outline of this study. It is a representation of the structure of this research.

Part I starts with a literature research. The Just-In-Time initiative (Chapter 3) and the port call business process (Chapter 4) are first explained in order to gain more knowledge about the desired situation in general. The methods used in this research are also discussed (Chapter 5).

Part II starts with a case study description (Chapter 8) of MSC container shipping in the Port of Rotterdam to clarify the primary business processes in this area. Subsequently, an actor-stakeholder analysis (Chapter 9) is conducted. Insight in the position and incentives of each involved actor is required to understand what the current port call business process drives.

Part III uses the input of part II to create a model of the current port call processes. By means of this model, the port call processes are analysed by both qualitative and quantitative research (Chapter 12-14). The port call processes are first understood after which a number of gaps are identified. Solutions are proposed which are required to enable the Just-In-Time initiative.

Part IV concludes this research with a proposal of adaptations on the port call process of this case study (Chapter 16). Furthermore, a conclusion of the complete study is given (Chapter 17). The report ends with recommendations for further research (Chapter 18).

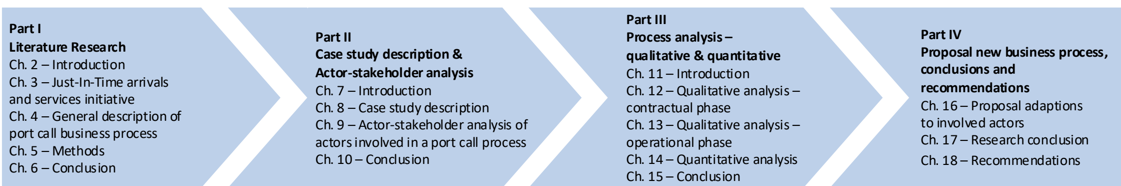

Figure 1.4: Overview of the thesis outline. Source: own figure.

Part I:

Literature research

2 INTRODUCTION

Literature research is an essential part to achieve the objectives of this research. Part I provides information about the conducted literature research. This chapter clarifies the relations between the different topics discussed in the literature research.

The literature research starts with a more detailed explanation about Just-In-Time arrivals and services in Chapter 3. It aims to give a better understanding of the Just-In-Time concept and the importance of it.

Subsequently, the literature research continues with information about the pre-requisite of the Just-In-Time concept – exchange of reliable timestamps. A vessel must know the exact time at which it is requested to be at the pilot boarding place in order to arrive just-in-time. However, the requested time a vessel must be present at the pilot boarding place depends on other timestamps which, in turn, are dependent on many more processes in a port call.

Therefore, PCO Taskforce has designed a business process map of a port call. Years of industry experience and scientific research have contributed to the design of this business process. The business process map of PCO Taskforce is used as reference point in this research, since the standards in this map are considered as pre-requisite for the Just-In-Time arrivals and services initiative by the IMO GIA (IMO GIA, 2019b). Due to the size of this thesis, the detailed explanation of the business process map is provided in Appendix B.

Part I continues with information about the used methods in this research. Chapter 5 gives a general description of these methods. This information is used in a later stage of the research. The methods are then applied in order to identify and improve the port call business process of MSC container shipping in the Port of Rotterdam. Note that literature research is also conducted to compare several methods. The most appropriate methods are only discussed in this report.

First, an actor-stakeholder analysis method is explained in detail. For this research, insight in the relations between the involved actors is required in order to understand what the current port call processes drive. In addition, information is needed about the interest of actors to enable Just-In-Time arrivals and services.

Secondly, several interview techniques will be discussed since interviews are an essential part of this research. By means of interviews, valuable information must be obtained about the current port call processes and the actors' opinion about the Just-In-Time concept.

Thirdly, literature research is conducted to find appropriate ways to map the obtained information. Commonly used techniques to map business processes are discussed. These techniques are used to create a framework of the current port call processes.

As last, a gap analysis method will be introduced. This method is going to be used multiple times in this research. The gap must be identified between the desired state and the current port call situation. Subsequently, the gap must be bridged by improving the current port call processes.

Part I concludes the obtained information in the final section. A short recap is provided in Chapter 6 about the literature research. The knowledge obtained in this section is used and applied in the next parts of this research.

3 JUST-IN-TIME ARRIVALS AND SERVICES CONCEPT

This chapter gives a more detailed explanation about Just-In-Time arrivals and services. The Just-In-Time concept is clarified and the (dis)advantages are discussed. Unless mentioned otherwise, it is made by information provided by the IMO GIA such as PowerPoint slides about the roundtable on "Tackling operational barriers to Just-In-Time operation of ships'' (IMO GIA, 2019a), roundtable on Just-In-Time operation of ships (IMO GIA, 2018a), animation on Just-In-Time operations of ships (GloMEEP GIA, 2018), update on the work of the IMO-GloMEEP GIA to support low carbon shipping, and the Just-In-Time arrival guide (IMO GIA, 2019b).

3.1 CURRENT PRACTICES IN SHIPPING - WAY OF APPROACHING PORT

As mentioned in Chapter 1, the current port call processes need to be optimized. After leaving a port ships usually sail at high speeds to the next destination. Once the vessel has arrived in the port area, it gets notified that either the berth, fairway or nautical services are not available. Reasons for unavailability of berth are, for example, unavailability of cargo (e.g. containers) or delays of another vessel alongside the berth. Many (large) vessels in the fairway can also be the cause for delays of incoming vessels. Unavailability of nautical services can be caused by delays in their previous activities.

Vessels are not often notified in advance about the status in a port. Consequently, vessels do not often slow speed to arrive on time. Late notifications to incoming vessels result in waiting times outside the port. The vessel makes in general use of two options: waiting at anchorage or manoeuvring at low speeds in the port area. Research of the IMO GIA shows that vessels generally spend approximately 5-10% of their time waiting outside the port (IMO GIA, 2019b).

Vessels often choose to manoeuvre around in the port area at very low speeds due to less available anchorage locations, possible anchorage fees, anchorage procedure et cetera. Especially the last-mentioned reason can be an obstacle for many vessels. Anchoring can be a complex and time-consuming process for (larger) vessels, especially in rough weather and bad sea conditions. Preparations are needed such as ground and depth checks. In addition, an anchoring method must be chosen. Besides many preparations, anchoring itself can lead to damages and fatalities if it is not carried out correctly (Jassal, 2016).

However, manoeuvring at low speed in the port area is not a great alternative. In contrast to anchoring, the propellers and engines are still turned on which increases the operation hours. This is disadvantageous in financial and environmental terms. Figure 3.1 illustrates a real example of this phenomenon. MSC Alessia could not enter the Port of Rotterdam at the desired time slot. Consequently, the vessel manoeuvred around in the port area to bridge the waiting time gap. The different colours emphasize the changes in speed.

Figure 3.1: Route details MSC Alessia in the port area of Rotterdam. Source: PortXchange (PortXchange, 2020b).

In both situations anchoring and manoeuvring, the vessel is subject to waiting times outside the port after sailing at relatively high speed to their destination. This working method shows obviously inefficiencies in environmental, economic and safety perspectives. Just-In-Time operations can result, among others, in a reduction of idle times of vessels outside a port.

3.2 Clarification Just-In-Time arrivals and services concept

The Just-In-Time arrivals and services concept enables vessels to operate at the most efficient speed which is adapted in such a way it arrives at the pilot boarding place at the right time. This is the moment the fairway, nautical services (pilots, tugs, boatmen) and berth are available for the incoming vessel. If ships obtain planning notifications earlier, vessels can sail at the efficient speed to arrive at the right place at the right time.

Let's consider the effects of Just-In-Time operations with an example (Figure 3.2). A vessel is ready at port A and sails at relatively high speed to the next destination (port B). The speed is based on a requested arrival time at the pilot boarding place (RTA PBP) of port B. In this example, the vessel is expected in port B at day 14. However, after a few days the port is subject to delays in port operations. Consequently, the vessel can only enter the port at day 17 instead of day 14. This means the RTA PBP of port B has changed to day 17.

Today, it is often still the case that this change is not frequently communicated to the vessel's master. The vessel's management is still of the opinion that it can enter the port at pre-agreed day. It continues their way to the destination at relatively high speed. When the ship reaches the port area, it finally receives the delay information. The only option left is waiting outside the port for three days.

Just-In-Time operations require updated real-time information available to all involved stakeholders. In this case, the vessel would have received updates about the delay in port operations in advance. It could reduce speed and sail at the efficient speed to port B. The vessel then reaches port B at the right time which means it does not have to wait outside the port.

Figure 3.2: Clarification Just-In-Time concept. Source: IMO GIA (IMO GIA, 2019b), adapted by author.

Note that Just-In-Time operations of vessels does not mean slow steaming or speed limits. Figure 3.2 shows that the total duration of the voyage does not change in both situations. Just-In-Time arrivals and services is an optimization of the voyage. It reduces waiting times of the voyage in the port area.

Another important note about Just-In-Time operations is related to the type of waiting times. Just-In-Time arrivals and services aims to decrease the unscheduled ad hoc waiting times. It does not aim to reduce waiting times completely. Shipping companies may decide to arrive earlier due to inspections, maintenance, weather conditions, adaptations in number of containers to (un)load in the port et cetera. For example, container vessels may decide to plan a time buffer in order to be prepared for rough weather conditions.

3.2.1 12-hour notification pilot boarding place

In case of Just-In-Time arrivals and services, it is of great importance that the vessel early knows at which time it must be present at the pilot boarding place. As start point for the implementation of Just-In-Time arrivals and services, a 12-hour notice is proposed in the container sector by IMO GIA (IMO GIA, 2019b). Figure 3.3 clarifies the difference between today's operations and future operations in case of a 12-hour notice for Just-In-Time arrivals and services.

A 12-hour window is considered as a realistic start window given the fact that today ships only get informed about RTA PBP 1.5 to 3 hours (first calling in point VTS area) before arriving at the pilot boarding place. In a 12-hour window, weather and water level predictions are also considered to be accurate enough in order to make a proper planning of the fairway and nautical services. Since container vessels generally sail at a relatively high speed compared to other ship types (e.g. bulk vessels and tankers), a 12-hour window is assumed as a significant improvement compared to the current situation.

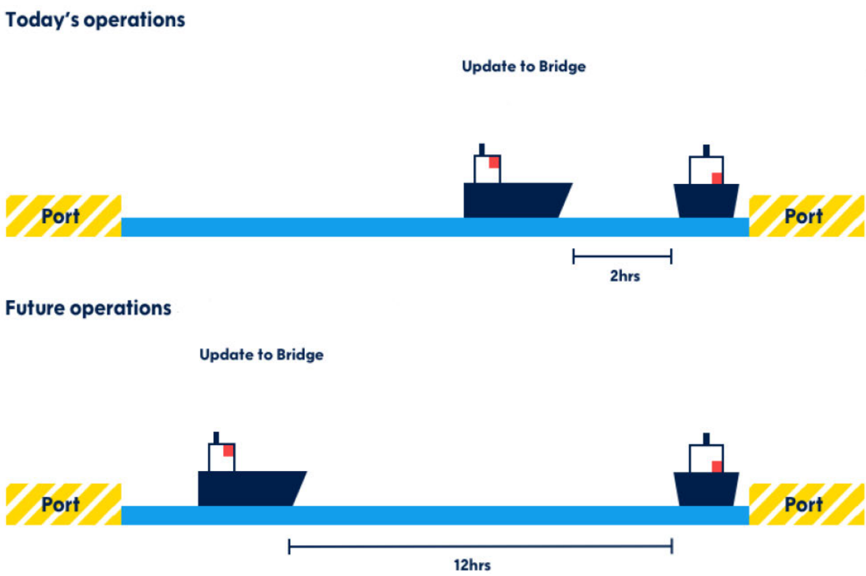

Figure 3.3: Visualisation of 12-hour notice in case of Just-In-Time arrivals and services compared to today's operations. Source: IMO GIA (IMO GIA, 2019b), adapted by author.

Since the RTA PBP is dependent on many processes within a port, it may still happen that RTA PBP changes within the 12-hour window. A narrowing down method is proposed in order to update the vessel about changes in RTA PBP. The vessel should, therefore, receive updates about RTA PBP by the port authority at -12, -8, -4, -2, -1, -0.5 hours before arrival at pilot boarding place.

It must be noted that the larger the notice window is, the longer the period is that vessels can adapt its speed to arrive Just-In-Time. A larger notice window increases the opportunities for emission reduction and fuel savings.

3.3 Optimization port call processes within a port

Besides improvements in the ship's voyage, optimization of the port call process by Just-In-Time operations could also lead to improvements of other port operators. In fact, all involved stakeholders will have benefits of more aligned port operations. A port as a whole can also strengthen their competitiveness since the Just-In-Time initiative results in an optimization of the port's assets utilization and resource planning.

In a Just-In-Time scenario, there will be collaboration between all stakeholders involved in a port call. Information and updates are then regularly shared with the right parties. The continuous exchange of information in the form of updates/notifications will lead to optimizations of the port call process. Ports would be able to create a more aligned planning by using more accurate and reliable information about the availability of service providers. For example, this may lead to an increase of the activity rate of several service providers (e.g. terminal, tugs).

Moreover, the competitive position of a port can be improved with the Just-In-Time initiative. Optimized port call processes are beneficial for several parties. Just-In-Time arrivals and services can result in improved predictability and shorter turnaround times of vessels in a port. The port's reputation improves if delays and inefficiencies are reduced in a port. These advantages could make a port more suitable for ship owners and operators. Overall, turnover and trade in a port can be increased by the Just-In-Time initiative.

3.4 Additional advantages to actors involved in a port call

An increase in supply chain visibility is obviously a step forward in efficiency. Implementation of Just-In-Time arrivals and services results in benefits in terms of economics, environment and safety. If port call processes are more aligned, time savings and thus cost savings would be achieved in the supply chain. The environment will obviously also benefit from the initiative. For example, ships that reduce their speed after receiving notifications of delays in terminal operations, consume less fuel and release therefore less carbon dioxide. Additional benefit of Just-In-Time arrivals and services is related to an increase of safety in the port area which includes anchoring locations outside the port.

So far, the main advantages of this concept are indicated. However, each involved stakeholder will be affected in a different way by the Just-In-Time initiative. This relates to an essential point of this concept. Each actor must perceive benefits before it collaborates to enable Just-In-Time arrivals and services. Therefore, the advantages are in more detail discussed for several stakeholders in this section.

The ship owner or operator will greatly benefit from the initiative. The main benefit is a reduction of fuel consumption which is an advantage in terms of costs and environment. Lube oil consumption will also decrease if vessels can sail at the optimal speed to the next destination. This is also beneficial in environmental perspective since it decreases exhaustion of raw materials. Moreover, vessels can decrease emissions of pollutants in case of speed reduction. In perspective of safety, the chance of damage at anchorage also decreases.

The port itself may expect a growth in trade and turnover when the initiative is rightly implemented. As discussed in the previous section, the competitive position of a port can be improved because of shorter turnaround times of vessels. Note that this must be considered as a first-mover advantage. The port is only better than the other port if it is the only one that has implemented Just-In-Time operations. In the ideal scenario of Just-In-Time arrivals and services, all ports are connected and have implemented the initiative. In that case, all ports improve their performances. Moreover, the competitive position of each port improves then.

If more information is shared about the status and planning of the involved stakeholders, terminal operators can create a better berth and resources planning. This may increase the activity rate of the terminal.

Barges, trains and trucks can also benefit from the Just-In-Time arrivals and services initiative. The hinterland modalities mainly depend on the planning of deep-sea vessels. If the planning of these vessels is more aligned, the transporter which is the next step in the supply chain can better adapt their planning.

3.5 Disadvantages to involved actors in a port call

Besides the advantages of Just-In-Time arrivals and services, possible disadvantages must also be considered. At first sight, two possible disadvantages need more explanation. These mainly concern the ship operator or owner.

Just-In-Time arrivals and services must result in less waiting times at anchorage. However, vessels sometimes use the time at anchorage to perform maintenance work on board or to perform preparations for the next cargo intake such as cleaning and vetting by experts. It may consequently happen that vessels do not have sufficient time for these tasks.

Another possible disadvantage is related to the optimal speed of vessels. Figure 3.2 assumes that the vessel must slow down speed in order to arrive at the destination at the right time. Although this example gives an image of a common problem, it must be noted that this is not always the case. In some situations, it may be preferable if vessels speed up to arrive at the right time.

On the other hand, both disadvantages are not common practice. Vessels do not always need the (complete) anchorage time to perform maintenance and preparation tasks. Furthermore, it is less likely that speeding up will happen more often than slowing down in order to arrive Just-In-Time.

4 PORT CALL PROCESSES – GENERAL DESCRIPTION

A prerequisite to realise Just-In-Time arrivals and services is the exchange of real-time timestamps. The most important timestamp is related to the time at which the port requests the vessel to be at the pilot boarding place – Requested Time of Arrival Pilot Boarding Place (RTA PBP). If this information is communicated in advance to the vessel's captain, it can optimize their speed to arrive just in time.

In order to receive an accurate RTA PBP in advance, exchange of information between involved stakeholders in the port must be improved. Optimization of the port call process is needed to realize Just-In-Time arrivals and services. As start point, six key stamps are introduced which are considered as most crucial in the optimization of a port call. The timestamps are important to give the right information, more specific RTA PBP, to the incoming ship.

Besides the six key stamps a port call process is, however, more complex. It is therefore essential that a common understanding is obtained about the desired port call business process. Without a common understanding of a port call process among the involved parties, it is almost impossible to optimize the processes by Just-In-Time arrivals and services. At this point, the PCO taskforce comes into play. The organisation has created a map of a high-level business process of port calls. As quoted by PCO Taskforce (PCO Taskforce, 2019b):

"To improve a process together all stakeholders first need to agree how this process looks like, based on international contracts and IMO resolutions which apply to any port and trade".

The port call business process is depicted in Figure 4.2. It is designed by PCO Taskforce and is used as reference point in this research, since the standards in this map are considered as pre-requisite for the Just-In-Time arrivals and services initiative by IMO GIA (IMO GIA, 2019b). It should be noted that this framework requires that the relevant information is shared, real-time and based on a standard. Confusion among several actors about different timestamps with the same definition must not occur.

This section provides information about this business process of a port call. The port information manual (PCO Taskforce, 2019a) and the business process handbook (PCO Taskforce, 2019c) created by PCO Taskforce are often used to obtain the information of this section. The blocks of the business process map are clarified in a sub-section. The process descriptions of a current port call (Chapter 12 and 13) of MSC container shipping in the Port of Rotterdam will be made by using the information of this section. The port call business process in this section is the reference point for the implementation of Just-In-Time arrivals and services.

4.1 TIMESTAMPS

Just-In-Time arrivals and services depends on the exchange of reliable timestamps. It requires collaboration among the involved parties – vessels, agents, terminal operators, port authorities, nautical services and vessel services. Today, limited amount of up-to-date and reliable data is shared between the stakeholders. For this reason, timestamps and locations are identified which are crucial in order to optimize the port call processes. The exchange of these timestamps is essential in the implementation of the Just-In-Time initiative.

A strict planning can only be made if it meets the criteria of each involved party. Therefore, an event (e.g. arrival) usually consists of four stamps: estimated, requested, planned and actual timestamp. To optimize the planning, an event must follow this sequence. For example, party A delivers an estimated time slot to party B. Party B accepts or changes the estimated time based on their planning. Subsequently, it sends back a requested time slot to party A. If party A accepts this time slot, the requested time is converted to planned time. The desired time slot is now established. Last minute changes can, however, cause changes/deviations. Therefore, the actual time is not always the same as the planned time.

More specific, six key timestamps are considered as most essential in a port visit of a vessel. Figure 4.1 shows the relations between these key stamps. The timestamps are important to give the right information, more specific RTA PBP, to the incoming ship.

In short, the incoming vessel needs information in advance about the availability of the berth. In most cases, the berth is occupied and not free at the moment the container vessel is at sea. Most incoming container vessels need to exchange berth with a predecessor, also called outgoing vessel. Compared to other sectors (e.g. bulk/tanker), about 80% of delays in container shipping is the result of occupied berths. Hence, it is important that the incoming vessel is notified in advance. It must obtain information about the status of the outgoing vessel, so that it can arrive at the right time. The stamps in Figure 4.1 are essential to provide this information.

These key timestamps are all related to two positions. The two most important locations for an incoming vessel are the pilot boarding place and the berth position. These places are also considered as key locations of a port call.

The pilot boarding place is the location where the vessel (dis)embarks the pilot. It is the first place of the port area at which an incoming vessel is required to give an estimated time of arrival (ETA).

The berth position is a specific location/point, such as a bollard, along the berth at which the ship can moor. The berth is the part of a quay used by a vessel to anchor or lay alongside.

The exact definitions of the timestamps are important in order to rule out confusion among the involved parties. Two of the timestamps are related to the incoming vessel. The other four stamps concern the outgoing vessel. The incoming vessel needs the information of the outgoing vessel. The definition of the key stamps is as follows:

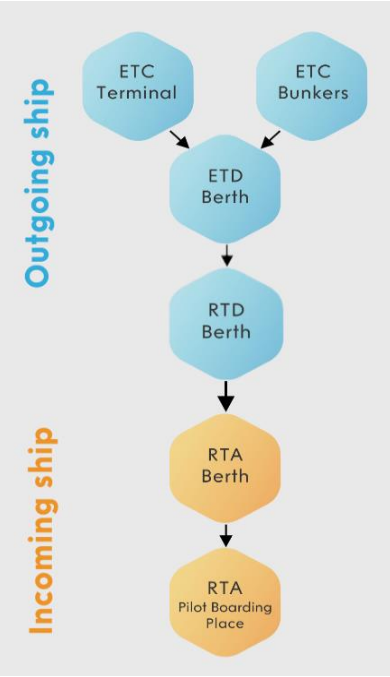

Figure 4.1: Key stamps port call (IMO GIA, 2019b).

- **Estimated time of completion (ETC) terminal** – the estimated time the terminal operations on the involved vessel are finished/completed. This time step is provided by the terminal operator.
- **Estimated time of completion (ETC) bunkers** – the estimated time the bunker operations related to the involved vessel are finished/completed. This time step is delivered by the bunker barge.
- **Estimated time of departure (ETD) berth** – the estimated time the outgoing vessel departs from the berth. It is provided by the ship or the agent. ETD berth depends on the completion time of all operations and services related to the ship. This includes terminal/cargo operations (e.g. lashing) and critical services (e.g. bunkers, clearances, paperwork).
- **Requested time of departure (RTD) berth** – the time the outgoing vessel is requested to depart from the berth. It is delivered by the local authority/harbour master. RTD berth depends on the vessel's ETD berth, availability of the nautical service providers (boatmen, tugs, pilots) and specific constraints such as weather, tide and fairway conditions.
- **Requested time of arrival (RTA) berth** – the time the incoming vessel is requested to arrive at the berth. It is provided by the terminal operator and depends on the terminal/berth planning.
- **Requested time of arrival pilot boarding place (RTA PBP)** – the time the incoming vessel is requested to arrive at the pilot boarding place. It is delivered by the local authority/harbour master. RTA PBP depends on the planning of the port and nautical service providers.

The most important timestamp in Just-In-Time arrivals and services is the RTA PBP delivered to the incoming vessel. If the incoming vessel obtains this timestamp in advance, it can optimize their speed to arrive at the right time. However, RTA PBP depends on the time the berth is available. This is, in turn, dependent on the status of the outgoing vessel. The relation of the six key stamps is therefore important.

The time at which the vessel is requested to be at the pilot boarding place depends on the vessel's destination – the berth. Thus, RTA PBP is influenced by RTA berth. If the berth is not available at the pre-agreed time, the vessel cannot usually enter the port. The terminal delivers the RTA berth which is later than what was first stated. Consequently, RTA PBP should be later than expected.

The berth is usually related to both the incoming and outgoing vessel. In most cases, the incoming vessel must exchange berth with an outgoing vessel. Hence, the RTA berth of the incoming vessel is dependent on the RTD berth of the outgoing vessel. The RTD berth is determined by the port authority. It depends on the availability of the nautical service providers and on the weather and traffic conditions in the fairway.

However, this moment is when the outgoing vessel has already completed all operations. RTD berth is based on the provided ETD berth by the outgoing vessel. ETD berth indicates at which time the vessel itself is ready to depart. It depends on the operators related to the vessel. The vessel bases the ETD berth on the completion time of terminal and bunker operations. It can leave the berth if all the required cargo is (un)loaded, clearances and paperwork is provided and when the bunker operations have finished. This shows the link between ETD berth and ETC terminal and ETC bunkers.

The connection between the six key timestamps emphasises the importance of real-time information exchange between different stakeholders. Just-In-Time arrivals and services concerns in fewer extent about the planning of the processes itself. It is more about clear and constantly updating involved stakeholders about planning changes, so that parties can adapt themselves to these changes.

If one of the service providers does not update (on time) other parties about a delay, the involved stakeholder will not adapt their planning. For example, delay in terminal operations which is not communicated in advance can, besides a delay in the vessel at the terminal, also result in waiting times for the next incoming vessel and service providers (bunker barges, tugs, pilots).

It is worth noting that the discussed key timestamps are dependent of many more processes. More information will be provided in the complete description of a port call business process (section 4.2).

4.2 DESCRIPTION BUSINESS PROCESS OF PORT CALL

Figure 4.2, displayed on the next page, shows the map of the port call business process developed by PCO Taskforce. It shows all activities that should be in a port call process. The map also displays which parties are involved in each action. As explained, the port call business process map, designed by PCO Taskforce, is used as reference point in this research, since the standards in this map are considered as pre-requisite for the Just-In-Time arrivals and services initiative by IMO GIA (IMO GIA, 2019b).

Years of industry experience and scientific research have contributed to the design of the business process map of PCO Taskforce. In addition, the business processes are based on BIMCO contracts and IMO decisions which are both applied in each port and trade. BIMCO is an international shipping association with members such as shipowners, agents, brokers. It aims to create commercial contracts between parties on behalf of its members (BIMCO, n.d.).

The business process of PCO Taskforce can be divided into two main phases: contractual and operational phase. A port call starts with contractual agreements such as contract of carriage, hiring ships and hiring terminal service. Subsequently, the operational phase takes place which includes the planning of the passage, berth arrival, port arrival, vessel and cargo service and port departure.

Due to the size of this report, the detailed explanation about the business process of a port call (Figure 4.2) is provided in Appendix B. The port call business process map is visible on the next page. The blocks of this map are clarified in sub-sections in Appendix B.

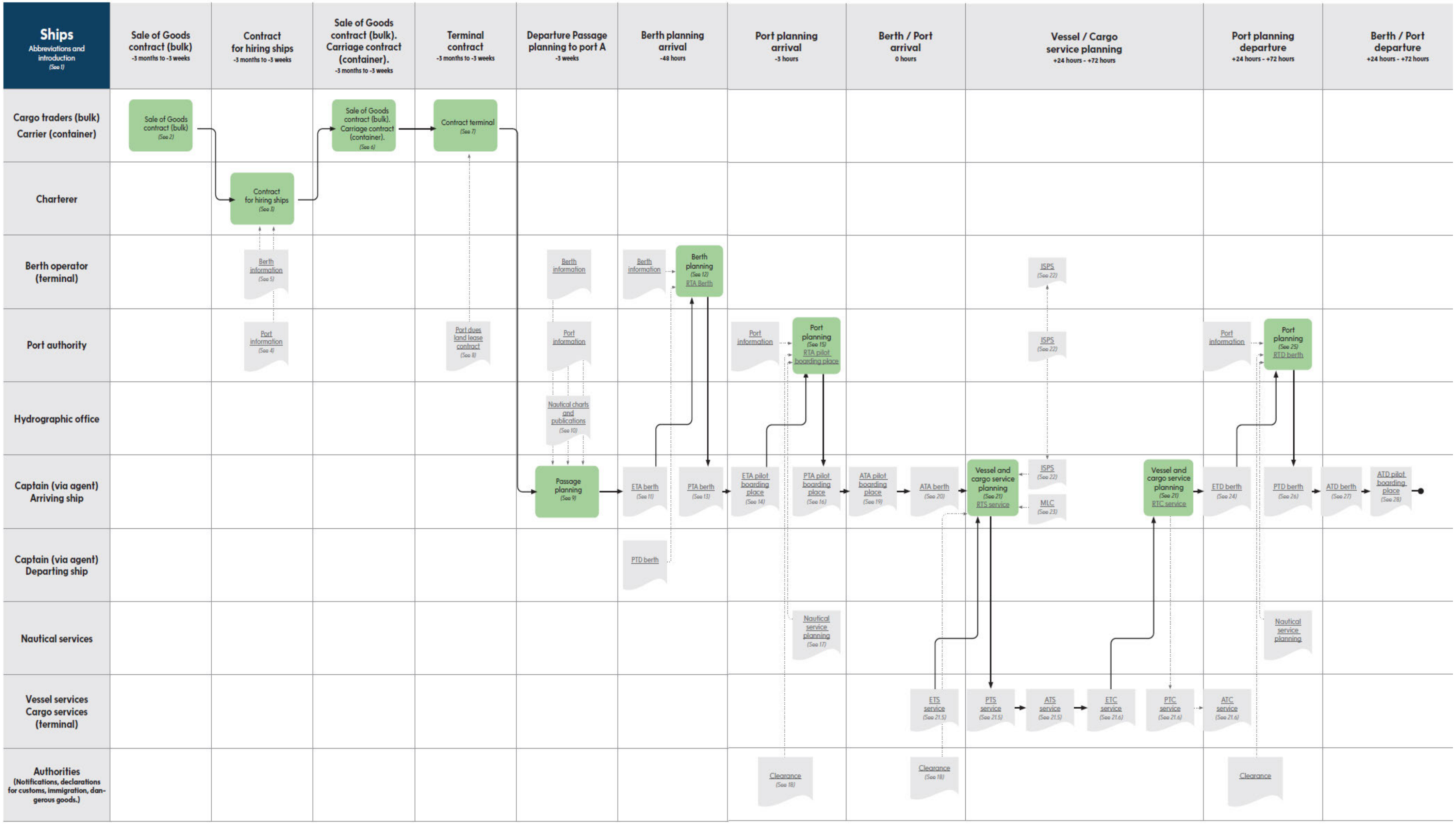

Figure 4.2: PCO Taskforce map of business process shipping (PCO Taskforce, 2018).

5 Applied methods in this research

This chapter gives an overview of the methods which are used and applied in this research. Literature research is conducted in order to find the most appropriate methods which are needed to reach the objective of this research. This section provides a general description of these methods. By means of the information in this chapter, the current port call business process of MSC container shipping in the Port of Rotterdam can be identified and improved.

The following methods are discussed in this section: actor-stakeholder analysis method, methods to obtain information by interviews, methods to model/map business processes and the GAP analysis method. Note that literature research is conducted to compare several methods. The most appropriate methods are only discussed in this report.

5.1 Actor-Stakeholder analysis method

In order to understand what the current port call processes drive, the involved actors in a port call must first be analysed. In addition, it must be researched if actors are interested in the Just-In-Time arrivals and services concept. Therefore, an actor analysis must be conducted.

An actor analysis must provide information about the range and networks of the actors. Actors are defined as parties with a certain interest and/or ability to have influence on a certain system. The interest and/or influence can be directly or indirectly.

Several methods are used to perform an actor analysis. The mostly used method is the stakeholder analysis. Enserink et al. explains in his book (Enserink, et al., 2010) the steps to be taken for a general actor analysis. The steps are based on the stakeholder analysis method. However, stakeholder analyses usually concentrate only on the power and interest of involved actors. The actor analysis of Enserink et al. also considers the network structure and views/perceptions of actors. Therefore, this method is used in this research.

The actor-stakeholder analysis of Enserink et al. contains six steps (Enserink, et al., 2010):

1. Problem formulation
2. Inventory of involved actors
3. Map formal relations of actors
4. Determine the interests, objectives and problem perceptions of actors
5. Analyse interdependencies between actors
6. Confront the initial problem formulations with the results

5.1.1 Step 1: Problem formulation

The first step in the actor-stakeholder analysis method is the formulation of the initial problem. A problem formulation can be formulated by the problem owner or analyst doing the research.

5.1.2 Step 2: Inventory of involved actors

Finding out which actors are involved is the next step in the actor-stakeholder analysis. This is considered as an iterative process. During the research, new insights can lead to changes in the relevance of certain actors. It can also happen that new parties appear as relevant actors. In this research, most involved actors are already determined beforehand.

An important note of attention for this research is related to ‘composed’ actors. A company can be involved in the problem in more than one way. For example, several departments can be involved in the problem in a different way. When the departments have different objectives/interest, these departments must be considered as separate actors.

5.1.3 Step 3: Map formal relations of actors

The positions and relations of the actors are characterized by a formal and informal side. Formal relationships between people and activities are defined by regulations and standard procedures. On the contrary, informal relations are not related to rules but are interactions among people outside the established network/format of an organisation. Both formal and informal sides must be considered to get a full understanding of the actors and their influences on the environment. Both sides do have influence on the behaviour of actors.

Step 3 of the analysis starts with mapping the formal positions and relations of actors. This can usually be performed by consulting available documents. The formal relations are important since it provides understanding about which regulations apply to an actor. Certain laws and procedures often have great influence on actors' interests and objectives. The obtained formal chart can be used to find the informal relations and resource dependencies between actors.

Formal relations can be mapped in three ways (Enserink, et al., 2010):

- Define the formal positions of actors including their tasks and responsibilities – this is usually described in certain laws and regulations for government actors. In most cases, it is less formal for non-government organisations. The positions and tasks for these actors are often presented on websites, annual reports et cetera.
- Show the formal relations between actors and display it in an organisation chart if possible – this can provide insight in the relationship, responsibility, position, decision-making process between several actors.
- Explain shortly the most important laws, legislation, procedures and authorities which are related to the problem situation – this is usually considered as an additional step which gives extra information about the interest, influence and position of actors.

Some information can be depicted in a diagram. This can be a useful way to display the relations between several actors. The diagrams do often not show all relations, but it can still be a tool that provides insight in most dependencies.

5.1.4 Step 4: Determine interests, objectives and problem perceptions

The next step in the stakeholder analysis consists of determining the interests, objectives and problem perceptions of each actor. In order to find causes and propose possible solutions for the problem formulation, it is essential to understand the motives of each actor.

Interests of actors are the most important. In most cases, interests have a certain direction. In contrast to objectives, interests are usually not directly related to the problem situation. The interest of an actor is often relatively stable. A for-profit organisation has an interest in making profit, while the direction is to increase profits. A non-profit organisation can have interests as continuity of business. The interest of actors can be determined by answering questions as: *How is the actor influenced by the problem situation and why does it matter for the actor?*

Objectives show what each actor want to achieve over a certain period. This can be either realizing changes or maintaining. In general, each actor has clearly defined their objectives. It uses the objectives to assess to which extent the desired situation is achieved. The objectives are specific and measurable terms derived from the actors' interests. The gap between the objectives (desired situation) and the current situation shows the scale of the problem.

Actors usually have several objectives, which are not necessarily related to the problem formulation. In this actor analysis, only directly related objectives are considered. The actors' objectives can be defined by questions as: *What is the desired situation for an actor? What are the costs and benefits for an actor in current/problem situation and desired/problem situation?*

Each actor can have a different perception of the problem situation. It is important to know how actors look at the problem situation. All perceptions should be compared to find similarities and differences. To obtain an impression about the actors' perceptions, a number of questions can be asked such as: *How does the actor view the problem? What are the main causes of the problem in the actor's opinion? And what solutions does the actor propose?*

The interest, objectives and problem perceptions of each actor is recommended to analyse. It can be useful to find similarities and differences, but also shared interests and common objectives, as well as potential conflicts between actors. In addition, it can be useful to propose recommendations to the problem owner and involved actors.

5.1.5 Step 5: Analyse interdependencies between actors

By completing the previous steps, actor information can be obtained such as interests, formal network structure, objectives and perceptions. What is missing is resources, power and influence of each actor. This is needed to acquire information about the dependency relations of actors. These relations can be determined by looking at three things: the importance of each actor's recourses, the replaceability of the resources, and the extent of shared interests and common objectives among actors. Moreover, it is crucial to understand if the actors are willing to solve the problem. This can depend whether the actors expect benefits or not.

The importance of the actor's resources depends on the critical actors. Critical actors are actors with a certain extent of power and cannot therefore be ignored in the analysis. Actors' resources are means to reach objectives. A distinction can be made between formal (e.g. authority by power, instruments as subsidies) and informal (e.g. information) resources. The next resources can be separated (Enserink, et al., 2010): information, knowledge/skills, manpower, money, authority (formal power), position in the network (to collaborate with other actors), legitimacy, organisation (degree of effectively and efficiently use of resources).

Resource dependency among actors is dependent on resources' importance and replaceability (Table 5.1). Note that it is important that not only resources of actors are considered which try to solve the problem (power of realisation). Actors with resources that have conflicting interests must also be studied (blocking power). Actors with either power of realisation or blocking power are defined as critical actors. Table 5.2 can be used to find the critical actors.

Table 5.1: Table to determine resource dependency, inspired by (Hanf & Scharpf, 1978).

	Limited importance	**Great importance**
Limited options to replace	Medium dependency	High dependency
Can easily be replaced	Limited dependency	Medium dependency

Table 5.2: Table to study (non-)critical actors, inspired by (Enserink, et al., 2010).

Actors	**Important resources**	**Replaceable (yes/no)**	**Dependency (limited, medium, high)**	**Critical actor (yes/no)**
Actor 1				
Actor 2				
….				
Actor N				

The actors' dependency is not only dependent on the resources. The willingness and interest to use the resources also play an important role. This is, in turn, dependent on the problem formulation of each actor. If an actor is affected by the problem solution and possibly perceives benefits and costs, it is defined as a 'dedicated actor'. In contrary, if an actor is not affected by the problem and does not see associated benefits and costs, it will show less motivation to exert influence. Such an actor is called a 'non-dedicated actor'.

The information from the previous steps gives insight in the interest, objectives and problem perceptions of the actors. This step provides information about the resource dependency, (non-)critical actors and (non-)dedicated actors. Combining the information of both steps leads to a complete overview of the actors' dependencies (Table 5.3). If Table 5.3 is correctly filled in, it shows which actors are more/less willing to solve the problem.

Table 5.3: Table to determine interdependencies between actors, inspired by (Enserink, et al., 2010).

	Dedicated actors		**Non-dedicated actors**	
	Critical actors	**Non-critical actors**	**Critical actors**	**Non-critical actors**
Similar / supportive interest and objectives	Actors that will probably participate and are potentially strong allies	Actors that will probably participate and are potentially weak allies	Indispensable potential allies that are hard to activate	Actors that do not have to be involved initially
Conflicting interests and objectives	Potential blockers of certain changes (biting dogs)	Potential critics of certain changes (barking dogs)	Potential blockers that will not act immediately (sleeping dogs)	Actors that need little attention initially (stray dogs)

The information depicted in Table 5.3 can also be visualised in another way. The interdependencies between actors can be made clear in so called stakeholder maps or power-interest matrices. These maps can sometimes give a quicker insight in the power and interests of actors. It provides the same information as in a table. It is only presented in a different way. Figure 5.1 depicts a power-interest stakeholder map. It displays the power and interest of each actor. Critical actors are the actors with a high level of power (upper row). Dedicated actors are the actors with a high level of interest (right column).

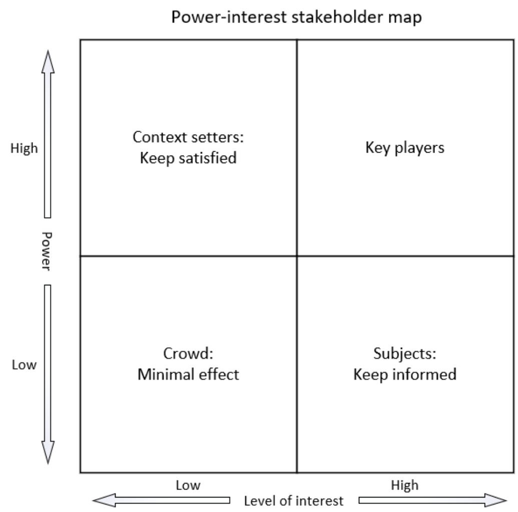

Figure 5.1 : Power-interest stakeholder map to determine actors' dependencies (Enserink, et al., 2010).

5.1.6 Step 6: Confront the initial problem formulations with the results

The more steps of the actor analysis have been taken, the higher the chance that new insights are obtained about the positions of actors. New opportunities and threats may be discovered. This can impact the problem formulation, dependencies of actors and research activities.

5.2 INTERVIEW TECHNIQUES

To obtain valuable information about the current port call processes and the actors' opinion about the Just-In-Time concept, interviews are an essential part of this research. Research interviews are one of the most popular and widely used data collection methods in qualitative research. Interviews are a useful method to gather in-dept information of actors about their views and experiences. Several matters are crucial when conducting interviews such as the question types, questioning techniques and interaction with the interviewee (Easwaramoorthy & Zarinpoush, n.d.; Coughlan, Ryan, & Cronin, 2009).

Interviews can be conducted in person, over phone, email or online. Personal interviews in this research will be conducted face-to-face in order to capture emotions of interviewees better. Moreover, personal interviews are characterized by closer interaction between the interviewer and interviewee (Steber, 2016).

5.2.1 Interviewer criteria and types of interview questions

An interviewer plays a key role during an interview. It must take the lead and behave in the right way. Interviewers must have certain qualities in order to conduct a high-quality interview. According to Kvale (Kvale, 1996), a successful interviewer must meet the following ten criteria.

1. Knowledgeable – interviewer must be familiar with the topic of the interview.
2. Structuring – interviewer must give objectives for the interview, ask questions in a structured way, give the interviewee the opportunity to ask questions in the end.
3. Clear – questions are asked which are considered not too long, complex and difficult.
4. Gentle – interviewer must give the interviewee time to finish and accepts pauses.
5. Sensitive – interviewer must listen well to the information provided by interviewee.
6. Open – interviewer has an open and flexible attitude.
7. Steering – interviewer has clearly defined what the person wants to know.
8. Critical – interviewer is able to react on inconsistencies in the interviewee's answers.
9. Remembering – interviewer remembers previously mentioned interviewee's answers.
10. Interpreting – interviewer clarifies and, if possible, extends the interviewee's answers.

Subsequently, high-skilled interviewers know at which time a certain question can be asked. The interviewer can make use of different question types during the interviews. Kvale (Kvale, 1996) makes a distinction between nine types of questions:

- Introducing questions – questions to get to know interviewee's interests, position etc.
- Follow-up questions – questions to gain more information about the interviewee's previous answer. The interviewer attempts to let the interviewee elaborate. It does not explicitly ask the question, but it tries to make clear that it wants more information.
- Probing questions – questions to gain more information about the previous answer of the interviewee. This type of questions shows similarities with follow-up questions. The difference is that probing questions are characterized by direct questions. The interviewer directly asks a next question if it wants more information.
- Specifying questions – questions which are relatively specific about a certain topic. For instance, the interviewer asks what the interviewee exactly did at a specified moment.
- Direct questions – questions which are relatively direct and can be sensible for the interviewee. These questions can be unexpected for the interviewee.
- Indirect questions – questions indirectly related to the interviewee's view. By asking questions about other people's view, interviewees occasionally give their own view.
- Structuring questions – questions used to change a topic during the interview.

- Silence – signals to give the interviewee more time to reflect and clarify the answer.
- Interpreting questions – questions which are used to clarify if the interviewer understands the interviewee's answer in the right way. This can also be questions which are asked to verify if the right connections are made between certain matters.

5.2.2 Interview types

Quality interviews can be categorized in many ways. However, most textbooks make use of a distinction between three interview types. The differences are mostly related to the interview structure of each type. Wilson also sorted the interview types in three groups (Wilson, 2014):

- **Structured interviews** – interviews in which the interviewee gets asked a number of standards, predetermined questions in a certain order. Structured interviews can contain both open and closed questions. In most cases, the interviewee answers the question by selecting an option from a list and can give clarification on some questions. Structured interviews do usually have a certain format. Each interviewee gets the same questions in the same predetermined order. This interview type is often used in survey research. Structured interviews are therefore preferred in quantitative research.
- **Semi-structured interviews** – interviews in which the interviewee gets asked a number of predetermined (open) questions. It answers the questions in own words. Each interviewee usually gets the same questions, although additional questions can be asked if needed. Deviation to the predetermined questions is possible when the situation demands it. Semi-structured interviews are mainly preferred, if there is already information and knowledge about a topic but more details are required.
- **Unstructured interviews** – interviews not characterized by guidelines and prespecified questions and procedures. The interviewer asks a number of broad questions to start an open, informal discussion about a certain topic. Unstructured interviews are usually conducted to collect in-depth information about someone experiences or to gain information about topics where little is known about. This interview type is not an unprepared interview. The interviewer still wants to reach the goal of the interview.

The research in this thesis is perfectly suited for semi-structured interviews. Knowledge is already obtained about port call processes. However, more qualitative information can be obtained by conducting interviews with the stakeholders. Most questions will be determined in advance. If the situation demands it, additional questions will be asked.

5.2.3 Interview procedures semi-structured interviews

In order to acquire information by interviews, a few useful steps must be taken. As first, the interviewer must take proper preparations. Wilson (Wilson, 2014) has extensively described the procedures to prepare, conduct and finish an interview. The procedures differ per interview type. Since semi-structured interviews are going to be used in this thesis, the steps and procedures are only described for this interview type.

5.2.3.1 Steps before the interview

The planning and developing of interviews are the first stage of the interview procedure. The following steps are recommended to take:

1. Define clearly objectives or research focus of the interview – this can include, among others, getting a better understanding and more insight of a certain topic.
2. Prepare questions – semi-structured interviews are characterized by predetermined questions and ad hoc questions. The predefined questions are part of the preparations.

These questions are measures to achieve stated objectives. Besides the information in section 5.2.1, a few tips must be taken in mind when preparing the questions.

I. Do not ask double questions but split it up into two questions.
II. Use a specific order for the questions. Do not ask a threating question in the beginning that may influence the interviewee's attitude.

3. Develop an interview guide which includes the predetermined questions and a certain structure of the interview – Table 5.4 shows an example of an interview guide.

Table 5.4: Example of interview guide, inspired by (Wilson, 2014).

Activity	Comments / Questions	Approximate time
Introduction	Introduce yourself, describe the objectives, repeat interview method and matters as confidentiality.	5 min
Structured subjects	Topic 1: Question 1: … Question 2: … Topic 2: Question 3: … Etc.	30 min
General questions, open discussion		20 min
Final comments		5 min

4. Contact the required persons for the interviews.
5. Collect or create documents such as an interview guide and introduction letter.
6. Practice first minutes of the interview since these are crucial for a successful interview.

5.2.3.2 Steps during the interview

The next stage of the interview procedure is the interview itself. The next steps are recommended during an interview. The steps are based on the step-by-step plans from Wilson (Wilson, 2014) and Easwaramoorthy et al (Easwaramoorthy & Zarinpoush, n.d.).

1. Introduce yourself and start a short conversation. It is important that the interviewee feels comfortable from the beginning.
2. Explain matters as interview objectives, importance of their involvement, and the time allocated to the interview. If needed, ask approval for recording the session and the recording method (e.g. phone). Discuss also what happens with the record.
3. Point out the structure of the interview.
4. Start the interview with introductory questions which are not difficult and threatening. Information about the interviewee's background can be useful for the rest of the interview.
5. In the central part of the interview, it is important that the interviewer keeps focussing on the topic. It must also try to approach the interviewee as neutral as possible. The body language and tone of the interviewer is therefore also important.
6. Finish the session by thanking the interviewee and explaining again what will happen with the data. As last, ask if the interviewee does have any comments or questions.

5.2.3.3 Steps after the interview

The last stage of the interview procedure consists of the steps after the interview.

1. After putting away the notes, there is often a follow-up conversation with the interviewee. Try to record/remember this since it can contain valuable information.
2. Stop recording or update the notes of the interview. In case of notes, read it through again and adapt if needed. See if all obtained information is captured in the notes.
3. Analyse the obtained information. This step depends on the type of research.

5.3 Modelling/Mapping of business processes

In this research, a framework must be created of the current port call processes. Therefore, literature research is conducted in order to obtain knowledge about the way certain processes can be mapped.

A process can be defined as a number of transactions/activities that converts input to a certain result/output. Processes can be distinguished into primary and supporting processes. Primary processes are the value-creating and core processes, while support processes are the nonvalue-creating processes which assist the primary processes. Business processes are further depended on the strategy, stakeholders and expectations. Figure 5.2 shows the relations between the elements.

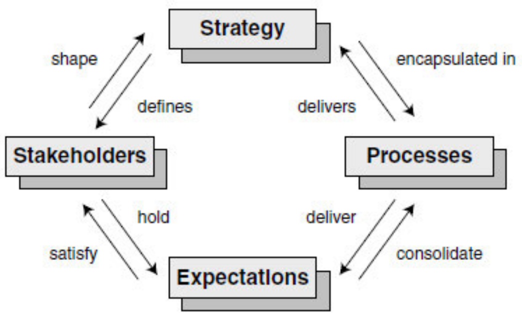

Figure 5.2: Relationship business processes (Andersen, 2007).

In order to improve these processes, it is crucial to know the current state of the processes. Without information about the working of the current processes, it is almost impossible to find and research improvement initiatives. The first step in improvements is making the current business processes transparent. Andersen (Andersen, 2007) describes five commonly used modelling approaches which are relevant for this research:

- Relationship mapping
- Traditional flowchart
- Cross-functional flowchart
- Flowchart divided into process segments
- Several-levelled flowchart.

The characteristics and procedures for creating these charts are discussed in this section. The information is mainly obtained by the book of Andersen (Andersen, 2007). Additional information is derived from Damelio's book (Damelio, 2011). Damelio shows where each map type can be used for. Table 5.5 displays the so called Three Levels of Performance Framework.

Table 5.5: Three Levels of Performance Framework, inspired by (Damelio, 2011).

Performance level	Map type	Show insight in
Organisation	Relationship map	Organisation: the supplier-customer relationships that exist between parts of organisations
Job/Performer	Flowchart	Activity: the (non)value-creating work performed
Process	Cross-functional flowchart – swimlane diagram	Workflow: the path of work that crosses several functions, plus the architecture that connects the relevant activities, people, information systems, and other resources along that path.

5.3.1 Relationship mapping

A relationship map displays parts of a larger whole and shows internal and external relationships among those parts. This can especially be useful for complex processes with many involved individuals and departments. A relationship map does not show information about activities and the sequence of it. Figure 5.3 shows an example of a relationship map of a company. Note that relationship mapping can be used in this thesis for many companies together.

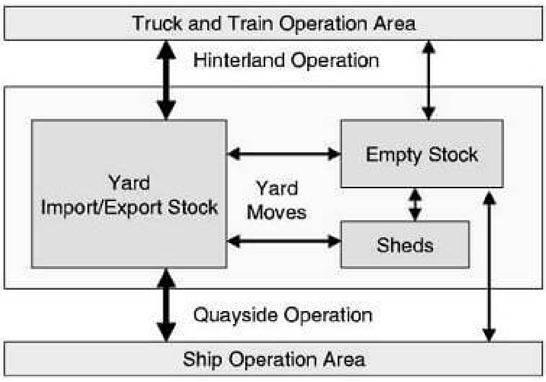

Figure 5.3: Example of relationship map (xChange Solutions GmbH, n.d.).

The following steps are suggested in order to create a relationship map:

1. Find the internal and external parts that are involved in the business process.
2. Draw on an empty sheet these involved units of a process in a logical order.
3. Display relationships between units in the diagram by arrows. The type of relationship can be made visible by using different arrow types. Figure 5.3 gives a few options for different arrow types. These types are only suggestions. There is no standard for arrow meanings. The arrow-relationship legend may be created by the author of the chart.
4. After connecting the units, remove the remaining units without connections.
5. Check if the relationship map is easy to interpret. If not, rearrange the diagram by placing units with extended connections closer together.

5.3.2 Traditional flowchart

Flowcharts visualize the sequence of activities in a process. A graphic depiction is often considered easier to understand than the same information explained in words. Multiple ways are used for drawing flowcharts. The most basic method uses a variety of symbols and arrows. Symbols display the activities and arrows the connections of the activities. There is no standard for the symbols and arrows. The most important point is that users can understand the meanings of the symbols and arrows. Figure 5.4 shows some widely used symbols.

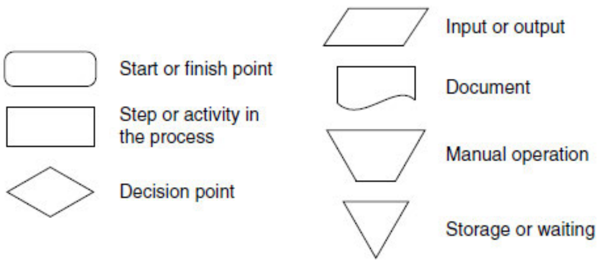

Figure 5.4: Commonly used symbols in flowcharts (Andersen, 2007).

Inside the symbols, additional information can be presented about the activity. Figure 5.5 clarifies this by an example of a flowchart for a supply process. The level of detail can vary per flowchart. This is up to the modelling team. The most important is that the flowchart gives a clear and understandable overview of the activities involved in the process.

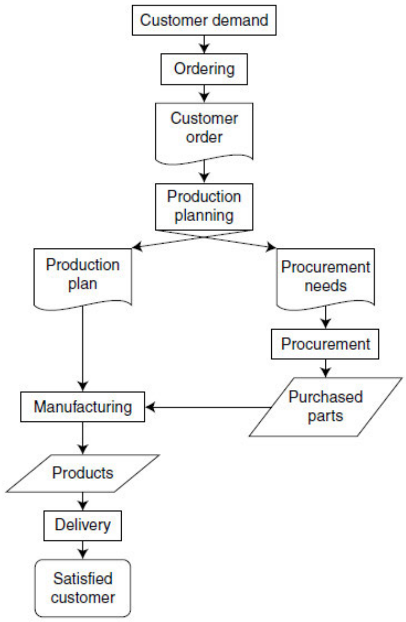

Figure 5.5: Example flowchart of a supply process (Andersen, 2007).

The steps to be taken for creating a flowchart are as follows:

1. Define the boundaries of the process including start (input) and end points (outputs).
2. Beginning at the end point, determine the activities performed in the process. Consider also matters as waiting times and generated outputs.
3. Create the flowchart by putting the activities in the right sequence. Take further the following things into account:
    - I. Work from the end point of the process backward.
    - II. Display the work from right to left, or from top to bottom.
    - III. Use a legend for the symbols and arrows.
    - IV. Do not use crossing lines; instead make use of bridges (Figure 5.6).
    - V. Keep the same space between the symbols.
    - VI. Label the outputs of the decision symbols with yes / no (Figure 5.7).
    - VII. Use the symbol in Figure 5.8 to show that an activity is elaborated in a separate flowchart.

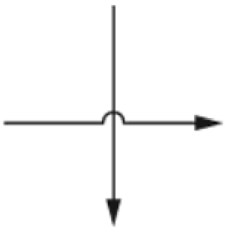

Figure 5.6: Crossing lines (Andersen, 2007).

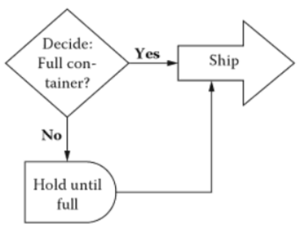

Figure 5.7: Output decision symbols (Andersen, 2007).

Figure 5.8: Separate workflow symbol. (Andersen, 2007).

4. Review the created flowchart by checking if it displays all required information.
5. After agreeing on the firstly created flowchart, it is recommended to redraw the flowchart to improve the clarity.

5.3.3 Cross-functional flowchart

In addition to a traditional flowchart, processes can also be visualized in a cross-functional flowchart. A traditional flowchart gives a description about the activities in a process. A cross-functional flowchart, also called swimlane diagram, also adds information about the person/department/company who performs the activity or is responsible for it.

Figure 5.9 displays a template for a cross-function flowchart. Each swimlane (A) specifies which entity is responsible for which activities. The workflow of the activities is indicated with B, and the relationship between two entities is shown with C.

Compared with a traditional flowchart, a cross-functional flowchart does not take much longer to create. The sequence and activities are already determined in a traditional flowchart. It only adds responsible entities to activities. A cross-functional flowchart provides insight in these responsibilities. It shows when and where an activity happens and who is involved. A cross-functional flowchart can also provide information such as external parties, locations of process steps. As explained, it can capture a relatively large amount of information. If desired, it can also add things as time spent, costs, added value, completion of the process.

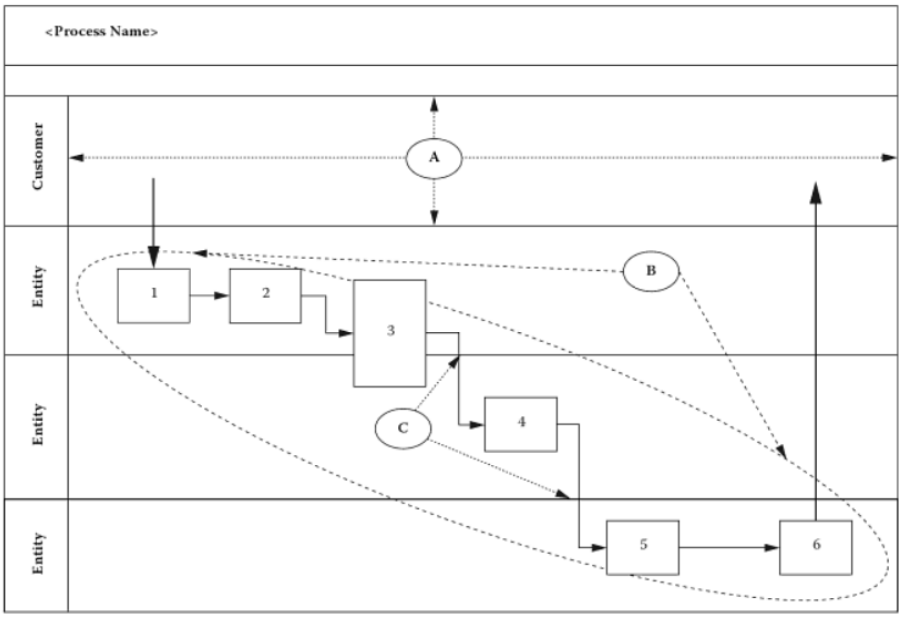

Figure 5.9: Cross functional flowchart (Damelio, 2011): A-swimlane, B-workflow, C-relationship between entities.

The first steps in creating a cross-functional flowchart are similar to the traditional flowchart, because the sequence and activities of a traditional flowchart are part of a cross-functional flowchart. The same methods (symbols, arrows, structure) also apply to a cross-functional flowchart. Hence, the steps to construct a cross-functional flow chart show many similarities with the method of a traditional flowchart (section 5.3.2).

The following steps are recommended to make a cross-functional flowchart:

1. Define the boundaries of the process including start (input) and end points (outputs).
2. Beginning at the end point, determine the activities performed in the process. Consider also matters as waiting times and generated outputs.
3. Add to each item which entity is responsible for it.
4. Create the cross-functional flowchart by making swim lanes (or columns) including the involved entities. Try to place items with close cooperation next to each other. This increases the clarity of the diagram.

5. Continue by putting the activities in the right sequence and in the right swim lane. Take further the following things into account:
    I. Work from the end point of the process backward
    II. Display the work from right to left, or from top to bottom.
    III. Use a legend for the symbols and arrows.
    IV. Do not use crossing lines; instead make use of bridges (Figure 5.6).
    V. Keep the same space between the symbols.
    VI. Label the outputs of the decision symbols with yes / no (Figure 5.7).
    VII. Use the symbol shown in Figure 5.8 to show an activity is elaborated in a separate flowchart.
6. Review the created flowchart by checking if it displays all required information.
7. It is recommended to redraw the flowchart a few times to improve the clarity.

5.3.4 Flowchart divided into process areas and several-leveled flowchart

For a long and complex process, it can become difficult to understand the flowchart. Two types of flowcharts are recommended to display the information of such a process. A flowchart divided into process area and a several-leveled flowchart can be useful.

The first option is about creating segments in which processes can be grouped. Figure 5.10 shows an example of a flowchart divided into process areas. In this example, the process is divided into three segments: deep sea transporter, land logistics coordinator and land transporter. The segments are separated by three rectangles with borders. However, this can be done in other ways. Areas with different colors or shaded areas are also options.

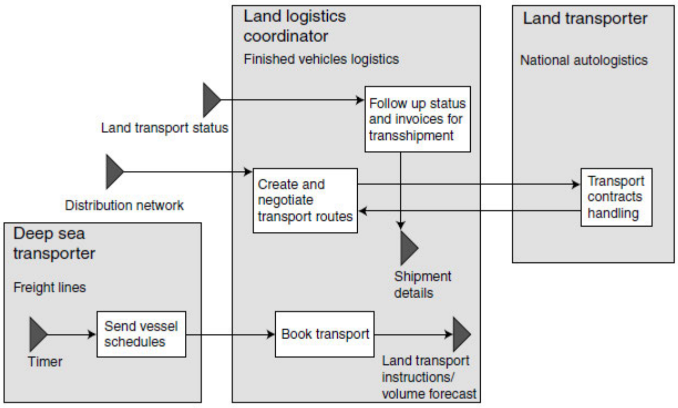

Figure 5.10: Example of a flowchart which is divided into process areas (Andersen, 2007).

Several-leveled flowcharts can also be useful when dealing with complex and long processes. The idea is that the whole process including main activities is firstly shown. An example of a so-called level 0 chart, labeled with 1.0, 1.2 etc., is depicted in Figure 5.11. More details about these activities is shown in level 1 flowcharts which are labeled with, 1.1, 1.2 depending on the main activity. In this way, more details can be obtained by zooming in the process.

Both flowchart types discussed in this section are only variants of traditional flowcharts. The working method to create a flowchart divided into process areas or several-leveled flowcharts are almost the same. Therefore, the required steps are not discussed again.

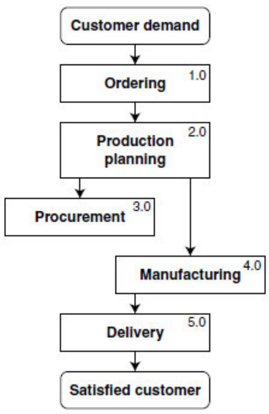

Figure 5.11: Example of a top-level flowchart (Andersen, 2007).

5.4 GAP ANALYSIS METHOD

In order to find the gap between the desired situation (Just-In-Time arrivals and services) and the current situation, a gap analysis must be performed. A gap analysis is a tool that helps to determine where we are right now, where we want to go and what we need to do to reach the desired state. A gap analysis process looks mainly at three elements (Peterson, 2019):

- Current situation – performance
- Desired / Ideal situation – potential
- Gap between the first two elements (performance – potential)

Another element can be added if the improvement stage is also considered in the gap analysis process. Figure 5.12 shows the relations between the phases of a gap analysis.

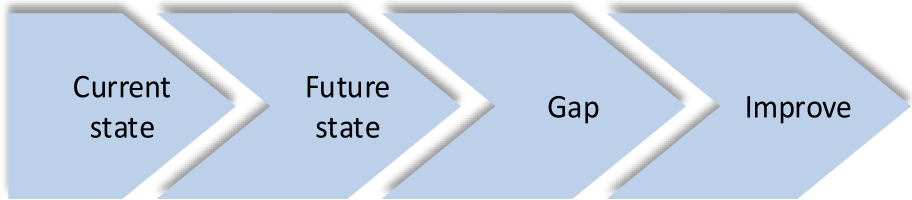

Figure 5.12: gap analysis elements, inspired by (Peterson, 2019).

The current state of a process can be described by using qualitative and quantitative information. It is important to know what must be analysed and which methods are going to be used for this. The current state can already provide information about certain bottlenecks in the processes. Methods as interviews, internal process documentation, feedback from clients can be useful when performing qualitative research.

The future state contains the desired state or the goal. This can already be specified beforehand. The future state can consist of business goals or objectives. In this research, the future state is based on the Just-In-Time arrivals and services concept.

The next step in the gap analysis is understanding the gap between the current and desired situation. Both states must be compared to find the differences. It must find out which processes must be optimized to reach the desired situation.

The final step is about bridging the gap between the current and future state. After finding the gap, solutions must be found in order to bridge this gap. Research must be performed to propose useful solutions.

6 CONCLUSION

In Part I, information is obtained about the literature research. Since a large amount of information is discussed, an extra section is added to conclude Part I. This section concludes the information of Chapter 3-5.

Part I has first discussed the desired situation in general. In the Just-In-Time arrivals and services concept, vessels operate at the most efficient speed which is adapted in such a way it arrives at the pilot boarding place at the right time. The right time is considered as the time when the berth, fairway and nautical service providers (tugs, pilots and boatmen) are available for the incoming vessel. However, the vessel is only able to sail Just-In-Time if it obtains planning information in an early stage.

Several timestamps are introduced to exchange information about the planning. The most important timestamp is related to the time at which the port requests the vessel to be at the pilot boarding place (RTA PBP). In order to send this timestamp in advance, many other timestamps should frequently be exchanged among actors in a port call. PCO Taskforce has developed a general description of a port call business process. It also includes the required timestamps of a port call. IMO GIA considers this business process of PCO Taskforce as pre-requisite of the Just-In-Time initiative. The port call business process map is also used in this master's thesis. By using the work of PCO Taskforce, it can be researched if the current port call processes need to be improved to enable Just-In-Time arrivals and services.

In addition, Part I discusses the methods of this research. First, an actor-stakeholder analysis is going to be used to assess the perceptions, incentives and positions of actors in a current port call process. The method of Enserink et al. (Enserink, et al., 2010) is used as method to conduct an actor-stakeholder analysis.

In order to collect the relevant information for the actor-stakeholder analysis, interviews are going to be conducted with the involved actors. It is chosen to conduct semi-structured interviews because this research is perfectly suited for this interview type.

Furthermore, knowledge is obtained about the way business processes can be modelled/mapped. Several modelling approaches can be relevant for this research. The techniques are going to be used to create a model of the current port call processes. Andersen (Andersen, 2007) has described the five commonly used modelling approaches:

- Relationship mapping
- Traditional flowchart
- Cross-functional flowchart
- Flowchart divided into process segments
- Several-levelled flowchart

As last, the GAP analysis method is introduced which will be applied in this research. This method is used in order to identify the gap between the desired state and the current port call situation.

Part II:

Case study description

&

Actor-stakeholder analysis

7 INTRODUCTION

The Just-In-Time arrivals and services initiative is researched by performing a case study of MSC container shipping in the Port of Rotterdam. Both MSC and the Port of Rotterdam play a large role in global shipping. Today, MSC is the second largest shipping company in the world and the Port of Rotterdam is the biggest port in Europe. In addition, container shipping is an interesting start point for the implementation of the Just-In-Time arrivals and services concept. In general, vessels sail at a relatively higher speed in container shipping compared to other shipping sectors such as dry and liquid bulk (Stopford, 2009).

In order to assess the port call processes of MSC container shipping in the Port of Rotterdam, it must first be clear what the primary business processes entails in this particular area. Therefore, this section (Part II) first describes the case study in Chapter 8. Information is provided about the primary processes of a port call including the most important actors in this case study. In this thesis, the primary processes refer to the vessel's processes in a port call which include an in- and outbound voyage.

Chapter 8, however, gives a brief explanation about the case study. In fact, a port call process consists of many more actors and complex processes. The involved actors have different relations, objectives and working methods. Besides, each stakeholder has a different position in a port call depending on the activities, power, resources et cetera. This type of information is very essential to obtain in order to understand what the current port call business processes drive. Moreover, if the position of each stakeholder is clear, the perceptions of these stakeholders about the Just-In-Time concept can also be clarified. An extensive actor-stakeholder analysis is, therefore, performed to obtain these insights. Due to the size of this report, the complete actor-stakeholder analysis is discussed in Appendix C. Chapter 9 shows a brief description of this analysis. The used actor-stakeholder analysis method is already discussed in section 5.1.

In Chapter 9 and Appendix C, each stakeholder is separately introduced and widely discussed. The actor-stakeholder analysis contains a large amount of information. Therefore, a final section is made to conclude the analysis. Chapter 10 presents the information of all stakeholders together in order to conclude the actor-stakeholder analysis. Information is visualized in charts to get more insights in the obtained information.

8 DESCRIPTION OF CASE STUDY

Over the past decade MSC has expanded its operations in the Port of Rotterdam. Each week many MSC vessels enter and leave the Port of Rotterdam. The Port of Rotterdam belongs to the world's largest ports. It is, therefore, not an 'easy' port. Many ships want to enter and leave the port each day. Multiple stakeholders work together and are involved in the processes. Therefore, the Port of Rotterdam is considered as a good start to research the port call processes in relation to the Just-In-Time initiative. One might suggest that if it works in this port, it should work in many more ports. In addition, MSC is a large player in the Port of Rotterdam with not only a few port calls per month.

In this research, a case study is performed about a current port call of MSC container shipping in the Port of Rotterdam. This section will, therefore, first introduce MSC and the Port of Rotterdam. Subsequently, the activities of MSC in the Port of Rotterdam are explained. This section ends with a brief description of the operational procedure of a port call of MSC vessels. A distinction is made between an in- and outbound voyage.

8.1 MSC GROUP

The MSC Group, a shipping conglomerate, is family-owned and founded in 1970 by Capt. Gianluigi Aponte. After the purchase of the first vessel in this year, the company has grown exponentially in both volume and fleet capacity to a worldwide leader in container shipping. It has made huge investments in the container business such as ports, intermodal transport, ship management and crewing. Besides container shipping, MSC has expanded its services into passenger services including MSC cruises and ferry companies. MSC Group is currently the global employer of 70 000 people.

The companies of MSC Group are, thus, divided into two business divisions: cargo division and passenger division. Figure 8.1 gives an overview of the companies within these divisions.

- **Cargo division**
  - MSC Cargo – cargo division
  - Terminal Investment Limited (TiL) – terminal division
  - MEDLOG – logistic division
- **Passenger division**
  - MSC Cruises – one of the world's largest cruise lines
  - Grandi Navi Veloci (GNV) – ferry company operating in the Mediterranean Sea
  - Società Nivigazione Alta Velocità (SNAV) – ferry company operating in Italy, Croatia and Sicily

Figure 8.1: Portfolio of MSC Group (MSC, 2020).

The cargo division of MSC plays a vital role in this thesis. The Just-In-Time arrivals and services initiative is studied with a case study of MSC container shipping in the Port of Rotterdam. For this reason, the passenger division of MSC is not explained in further detail. Note that the information in this section is obtained by the intranet team site of MSC (MSC, 2020).

8.1.1 MSC Cargo division

As already shown, the Cargo division consists of MSC Cargo, TiL and MEDLOG. Over the past decades, this division has significantly been growing. In total, the cargo division is currently represented by 493 offices in 155 countries and 47 000 employees. Each company of the MSC Cargo division will be shortly explained below.

8.1.1.1 MSC Cargo – Mediterranean Shipping Company

MSC Cargo, often known as MSC, is a global leader in container shipping. This division was the start of MSC Group. MSC offers sea freight by 200 ocean liner services which includes 500 port calls. It provides services with a fleet of 520 container vessels with a total intake capacity of 3.5 million TEU. The agency network of MSC is spread across approximately 80% of all countries in the world. In 2019, the MSC fleet carried 21 million of full TEUs.

MSC offers services to transport dry cargo, reefer cargo and project cargo. Dry cargo is the most traded commodity. MSC transports this type of cargo in 20- and 40-foot containers. Reefer cargo is transported by containers with temperature control. Project cargo is delivered with flat racks or open containers.

According to data of Alphaliner top 100 (Alphaliner, 2020), MSC has a global capacity share of 16,3% on 20 March 2020. This makes MSC the second largest container shipping company in the world in terms of container vessel capacity. The current market leader is Maersk with a market share of 17,6%.

8.1.1.2 TiL – Terminal Investment Limited

Terminal Investment Limited (TiL) is founded by MSC in the year 2000. It globally invests in, develops and manages multiple container terminals. The company is established to ensure terminal berths and capacity in important ports for MSC. During the past decades, it has grown to one of the global largest container terminal managing investors. The investments of TiL in terminals can result in priority of the vessels of MSC. TiL's preferences are to cooperate in joint ventures with other terminals operators that take the responsibility to operate these terminals.

TiL and MSC have invested in 62 container terminals in total. The terminals achieve more than 34 million moves per year. TiL is active in 29 countries divided over 5 continents. TiL invested in seven of the world's busiest ports by volume such as Rotterdam, Bremerhaven and Antwerp.

8.1.1.3 MEDLOG – logistic division

MEDLOG is the logistical extension of the supply chain of MSC. It provides solutions for the hinterland transport. MEDLOG complements the logistic chain by offering transport by barges, trains and trucks. Besides, it also offers services as depot yards (container maintenance and repairs), reefer services and warehousing & distribution.

MEDLOG is globally presented in more than 70 countries. It provides their services by 18 barges, 74 locomotives, 4200 rail wagons, 5000 trucks and 10000 trailers. Moreover, it owns more than 45 warehouses and 150 operating yards.

8.2 THE PORT OF ROTTERDAM

The Port of Rotterdam is one the most important ports of Europe. It is the gateway to the European market and belongs to the largest ports in the world. It is the 11th largest container port in the world (World Shipping Council, 2019). Moreover, it is Europe's largest port based on cargo tonnage and container traffic in TEU.

The accessibility of the Port of Rotterdam is one of the strong points compared to the competitors in North-Western Europe. The maximum water depth in the port is 24 metres. The approach route from the North Sea to the port, which consists of the Euro- and Maasgeul, has a maximum depth of 26 metres. Therefore, the port is accessible for the majority of the largest deep-sea container vessels. This makes the Port of Rotterdam unique in North-Western Europe (Linbins, 2019).

The Port of Rotterdam extends a large region. The entire port area is equal to 12 713 ha and the total length of the Rotterdam's port area is equal to 42 km. Figure 8.2 visualizes the extensive area and the activities of the Port of Rotterdam (Port of Rotterdam, 2017).

Container transport is an important aspect for the Port of Rotterdam. As largest container port in Europe, the number of possibilities regarding transhipment are huge. The port of Rotterdam has line connections with more than 1000 seaports. Besides this, the port offers numerous hinterland connections. Through the Port of Rotterdam, containers can be delivered to other parts of the world but also to destinations within Europe.

Container traffic through the port has increased by more than 17% over the last years (2016-2018). In 2018, a total of 8 635 782 containers and 14 512 661 TEU is transported through the Dutch port. The Port of Rotterdam currently consists of 6 deep-sea terminals, 3 shortsea terminals and 24 empty depots for containers (Port of Rotterdam, 2019b).

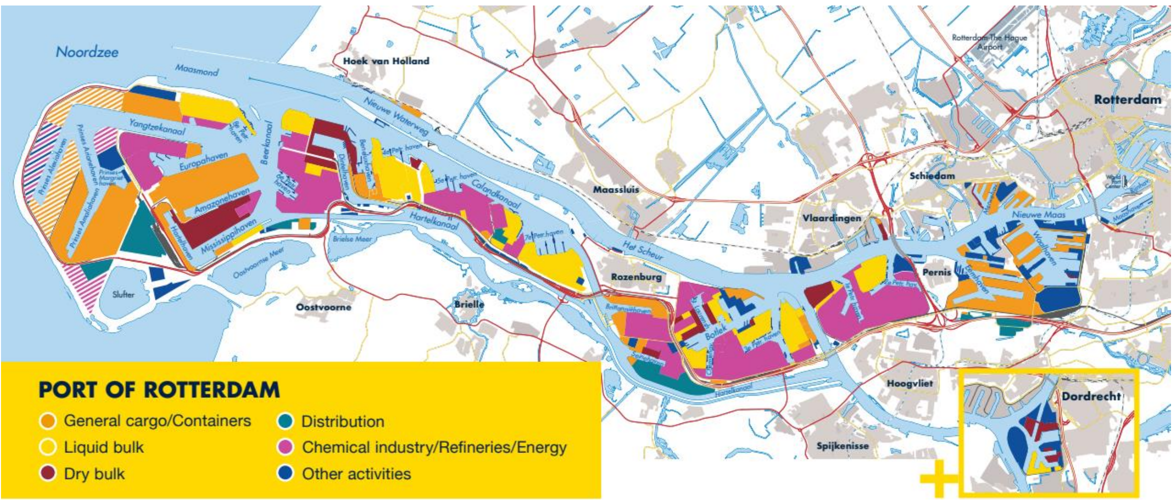

Figure 8.2: Port of Rotterdam map (Port of Rotterdam, 2017).

8.3 MSC in the Port of Rotterdam

MSC has been largely involved in the Port of Antwerp for a relatively long time. However, it has also extended its operations in the Port of Rotterdam in the last decade. In 2011, MSC and the ECT Delta Terminal entered a joint venture based on volume commitment. Before 2011, more than 95% of the customers, that made reservations via the Rotterdam agency of MSC, got their products via the Port of Antwerp. After the joint venture arrangement, MSC has grown substantially in the Port of Rotterdam. The impact of the joint venture is visible in the total number of TEUs transported by MSC through the Port of Rotterdam in the period 2010-2012 (Figure 8.3). In 2018, MSC was responsible for the transport of [redacted] through the Port of Rotterdam.

[redacted]

Figure 8.3: Number of TEUs transported by MSC through the Port of Rotterdam in the period 2010-2012.

Anno 2020, MSC is looking for new opportunities in the Port of Rotterdam. It wants to expand their activities in this region. Over the last years MSC has been largely involved in the Port of Rotterdam. In 2018, It transported [redacted] through the Port of Rotterdam, which is [redacted] the total container throughput in the Port of Rotterdam.

More quantitative facts about MSC in the Port of Rotterdam follow in Chapter 14. The next sub-sections provide more detailed information about a few stakeholders that are important for MSC during a port call in the Port of Rotterdam. The container terminals will first be discussed. The nautical service providers are thereafter covered.

8.3.1 Container terminals

In general, MSC (un)load containers at three container terminals in the Port of Rotterdam: the ECT Delta Terminal, APM Terminals Rotterdam, and APM Terminals Maasvlakte II. Figure 8.4 shows an overview of the locations of the deep-sea container terminals at the Maasvlakte in the Port of Rotterdam. The map also visualizes the locations of the three abovementioned terminals. ECT Delta Terminal and APM Terminals Rotterdam are (partly) located in the Europahaven at the Maasvlakte I. APM Terminals Maasvlakte II is further away for incoming vessels. It is located in the Prinses Amaliahaven at the Maasvlakte II.

As already mentioned, most containers of MSC are transhipped at ECT Delta Terminal. More specific, most MSC vessels (un)load their containers at ECT's Delta Dedicated North (DDN) terminal. The joint venture between MSC and ECT Delta is based on a volume commitment at the DDN terminal.

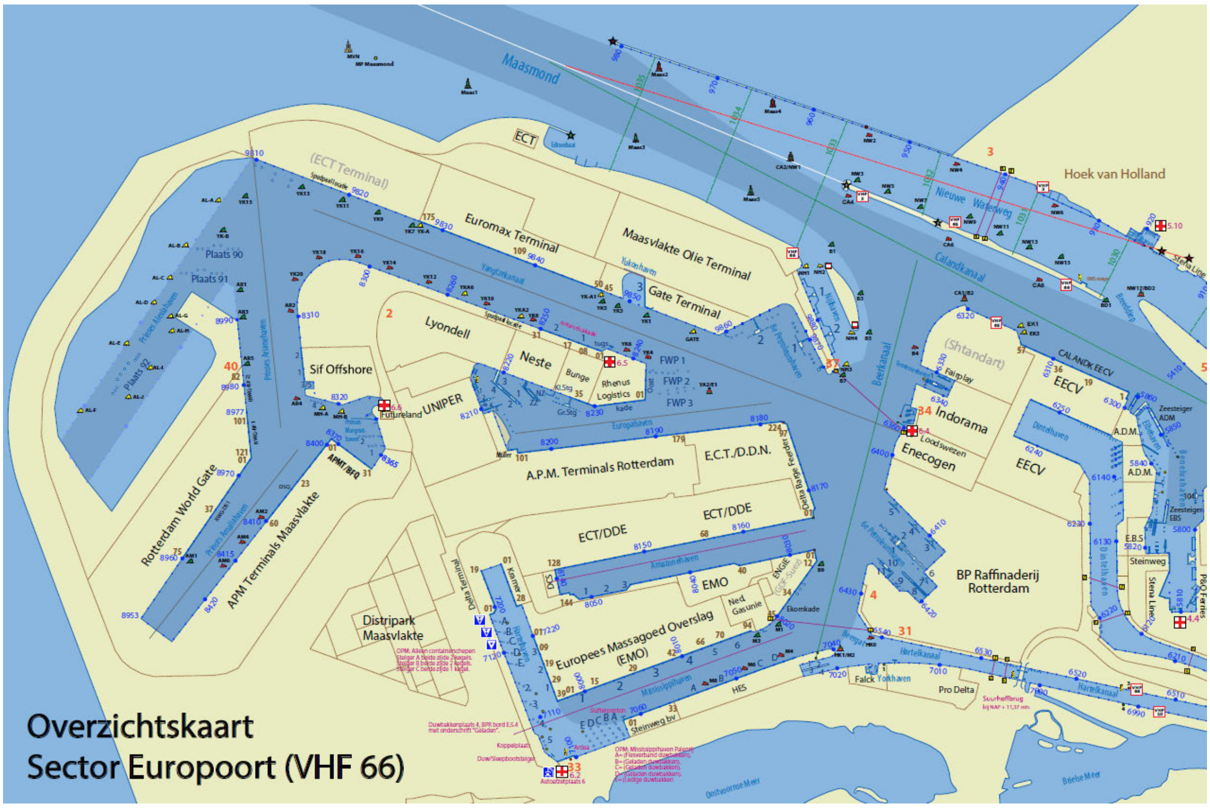

Figure 8.4: Overview map of the deep-sea container terminals in the sector Maasvlakte area (MT Maritiemfreelancer, 2020).

8.3.2 Nautical service providers

Incoming and outgoing deep-sea vessels of MSC need the assistance of the nautical service providers to sail to and from the three container terminals at the Maasvlakte in the Port of Rotterdam. The nautical service providers consist of pilots, tugs and boatmen.

In the Port of Rotterdam, the only company providing pilot services is Loodswezen. This also counts for the boatmen; KRVE (Royal Dutch Boatmen's Association) is the only operator in their particular field in the Port of Rotterdam. There are currently three tug companies providing towage services: Fairplay, Boluda Towage and Svitzer. MSC has contractual arrangements with Boluda Towage. This company is responsible for towage services of MSC operated vessels in Rotterdam. Figure 8.5 - Figure 8.7 show the logos of each organisation.

Loodswezen

Figure 8.5: Logo Loodswezen (Loodswezen, n.d.).

BOLUDA TOWAGE EUROPE

Figure 8.6: Logo Boluda Towage (Boluda, n.d.).

KRVE ROTTERDAM BOATMEN

Figure 8.7: Logo KRVE (KRVE, n.d.).

8.4 Brief operational description of a port call of MSC vessels in the Port of Rotterdam

A port call of MSC vessels consists of an inbound and outbound voyage. The inbound voyage is related to incoming vessels with the Port of Rotterdam as destination. The outbound voyage comprises outgoing vessels that leave the Port of Rotterdam. Most vessels are required to get assistance from the nautical service providers during an in- and outbound voyage.

The inbound and outbound voyage can differ per vessel, because the approach route is not always the same for each vessel. The port of Rotterdam is reachable through the North Sea. Vessels have multiple options, also called approach routes, to reach/leave the Port of Rotterdam. The chosen route depends on the ship's previous destination, type and size.

This section first provides an overview of the approach routes from the North Sea to the Port of Rotterdam. It shows at which locations pilots come on board to navigate the vessel to the destination in the Port of Rotterdam. Subsequently, an illustration is given about an in- and outbound voyage. These sub-sections visualize the operational procedure of an incoming and outgoing MSC vessel. Most information of this section is obtained by knowledge of experts from the industry (Oskam & Peekstok, personal communication, February 19, 2020; De Vries, personal communication, February 20, 2020; Vermeulen, personal communication, December 20, 2019).

It is important to note that the sub-sections aim to introduce the primary operational processes of an incoming and outgoing vessel. More detailed information about the business processes and information systems is provided in a later stage of this thesis (Chapter 13).

8.4.1 Approaches to Hoek van Holland – Maas approach

Figure 8.8 shows an overview map of approaches to Hoek van Holland. The arrows represent the sailing directions that should be maintained. As shown in the figure, incoming MSC vessels can reach the Port of Rotterdam via the Pilot Maas area from several directions. Vessels can come from Maas North, Maas West, Maas North West direction. Subsequently, the vessels enter the Pilot Maas area, which is in front of the entrance of the Port of Rotterdam (Maas Entrance). Appendix D.2 gives an enlarged image of the Pilot Maas area. The figure also visualizes the different approaching routes that vessels can take in order to sail in Maas North, Maas West, Maas North West direction.

The same obviously counts for outgoing vessels. These vessels also have different possibilities to continue their way through the North Sea from the Port of Rotterdam. The outgoing vessels first enter the Pilot Maas area before going into Maas North, Maas West, Maas North West direction.

Large deep-sea container vessels of MSC do only have one approach route option to enter/leave the Port of Rotterdam. These vessels are restricted to the approach route via the Euro- and Maasgeul. Figure 8.8 also visualizes the Euro- and Maasgeul. Vessels with a depth larger than 17.40 metres are 'geul restricted' which means that these vessels are only allowed to enter/leave the Port of Rotterdam via the Euro- and Maasgeul (Rijkswaterstaat, 2016).

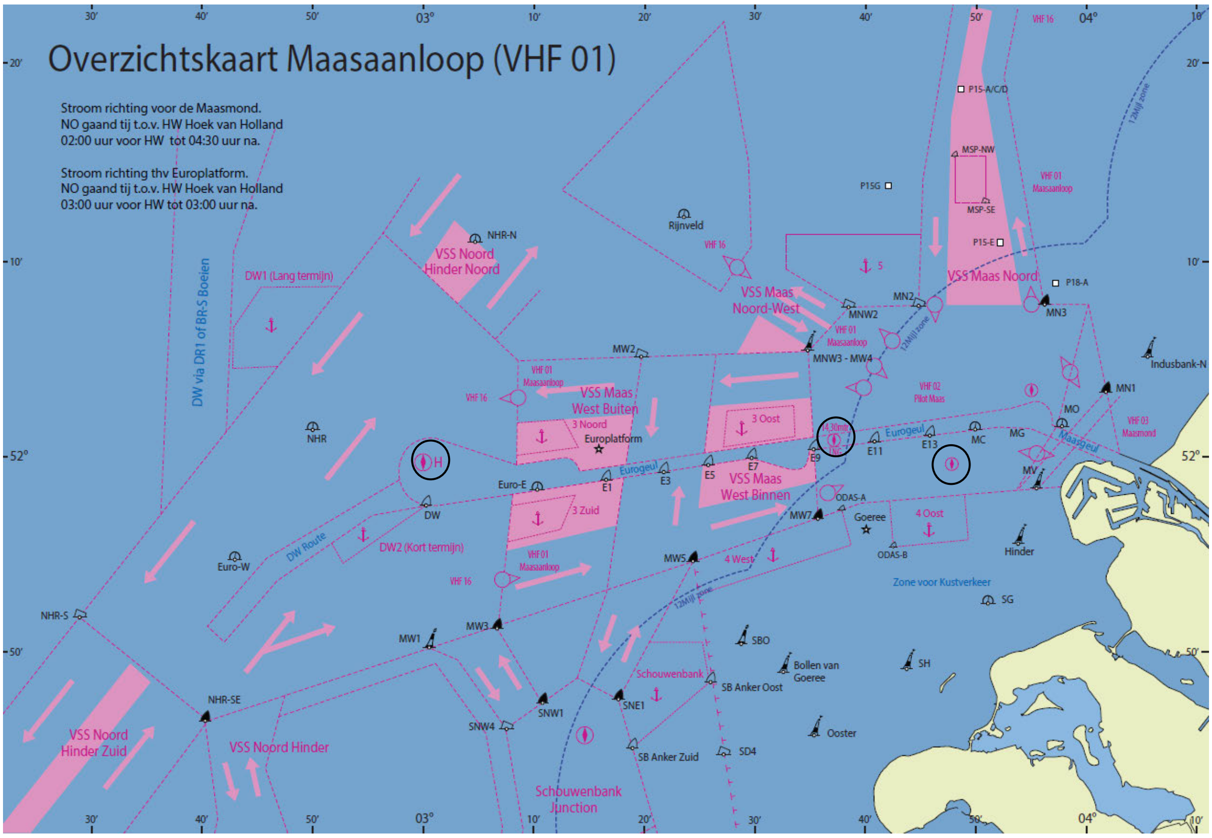

Figure 8.8: Overview map of Maas approach (MT Maritiemfreelancer, 2020).

The black circles in Figure 8.8 represent the locations where pilots embark. These locations are dependent on the vessel type and size. Pilots goes on board at three locations, also called pilotage points (Loodswezen, 2020a):

- Gully Pilotage point – Eurobuoy (left encircled point): Vessels with a depth of more than 17.40 (gully vessels) metres are obliged to sail the Euro- and Maasgeul.
- LNG Pilotage point – Eurobuoy 9 (centre encircled point): LNG carriers with a length over 180 metres also require earlier pilot services compared to most vessels.
- Regular Pilotage point – 1 mile south of Maas Center buoy (right encircled point): 98% of all vessels get the pilots from this point. This is also the location of the pilot station.

MSC vessels usually take a pilot on board from the regular pilotage points. The pilot navigates the ship to the destination in the Port of Rotterdam.

8.4.2 Voyage of incoming MSC vessel

Figure 8.9 presents an illustration of the voyage of an incoming MSC vessel. The vessel's destination is the ECT DDN at the Maasvlakte I. As already explained, most MSC vessels (un)load containers at this terminal. A brief description of the operational processes is made by dividing it in a few steps. The steps show the interaction of the vessel with the nautical service providers. Figure 8.9 displays the numbers which corresponds to the following steps:

1) An incoming MSC vessel passes the regular pilotage point which is 1 mile south of the Maas Center buoy. At this point, the pilot comes on board. Pilots are usually transported to the vessel by a tender. The pilot guides the vessel safely to their destination in the Port of Rotterdam.

When the vessel enters the Port of Rotterdam, the pilot has two route possibilities. It can navigate the vessel in portside direction to the Nieuwe Waterweg. If it navigates in starboard direction, it enters the Calandkanaal. Figure 8.4 gives an enlarged view of this junction at the Maasmond. Since the destination of the MSC vessel is in the Maasvlakte area, the pilot will navigate the vessel in starboard direction.

2) The incoming vessel has now passed the Maasmond. This location is popularly known as the Maasmond – Lage Licht which is the lighthouse on the central pier. The lighthouse is circled in red in Figure 8.9. At this point the tugs of Boluda gets connected to the vessel by lines. The tugs will assist the vessel when it sails to the ECT DDN.
   The pilot will navigate the vessel again in starboard direction to enter the Beerkanaal. Subsequently, it will sail into the Europahaven to find the destination on portside.
3) The MSC vessel almost reaches the destination. The pilot sails the vessel to the ECT DDN and get assistance of the tugs. Moreover, the boatmen of the KRVE have joined the operations. The boatman will also assist during the mooring procedure. The crew of the vessel gives the noose of the rope to the boatmen. The boatmen will then bring them ashore and puts the noose around the bollard.
4) The vessel is moored at the ECT DDN. The pilot, tugs and boatmen have completed their operations. The container terminal can now start cargo operations.

Abovementioned steps give an illustration of the voyage of the incoming MSC vessel. Below, these steps are summarized:

1) The pilot embarks and will navigate the vessel to the destination.
2) The tugs get connected to the vessel for assistance during manoeuvring operations.
3) The boatmen also assist the vessel during the mooring procedure.
4) The vessel is moored. The pilot, tugs and boatmen have done their job.

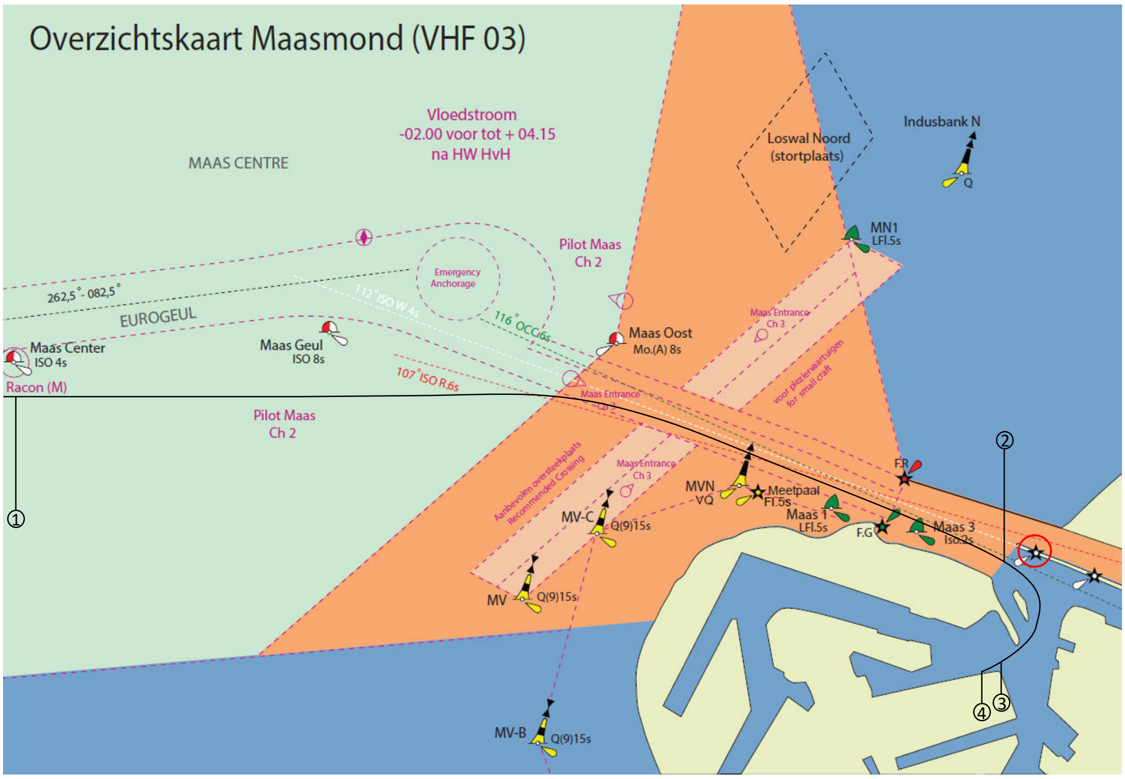

Figure 8.9: Voyage of incoming vessel from North Sea to ECT DDN, inspired by (MT Maritiemfreelancer, 2020).

8.4.3 Voyage of outgoing MSC vessel

Figure 8.10 presents an illustration of the voyage of an outgoing MSC vessel. It is a continuation of information explained in the previous section. The vessel (un)loaded containers at the ECT DDN at the Maasvlakte I. A brief description of the operational processes is made by dividing it in a few steps. Figure 8.10 displays the numbers which corresponds to the following steps:

1) The terminal has completed cargo operations. The nautical service providers are present. The pilot is already on board and will guide the vessel during the outbound voyage. The tugs are connected to the vessel by lines and assist the vessel during the operations. Lastly, the boatmen are also ready to assist the vessel. This group will let go the lines form the shore bollards. The unmooring procedure will start now.
2) The boatmen have completed their job. The lines have been let go. The pilot is now able to navigate the vessel through the port. Since the ship is sailing backwards, it must first turn. The vessel will turn in the Beerkanaal and then sail to the Calandkanaal.
3) Tugs are now no longer needed for assistance. The pilot is able to navigate the vessel safely without tugs. The tugs are disconnected from the vessel. The ship enters the Calandkanaal. It navigates in portside direction to reach the Maasmond area.
4) The vessel left the Maasmond area and has safely left the Port of Rotterdam. The pilot has also done their job. It will leave the vessel. The pilot will usually be picked up by a tender. After disembarking the pilot, the ship continues its way to the next destination.

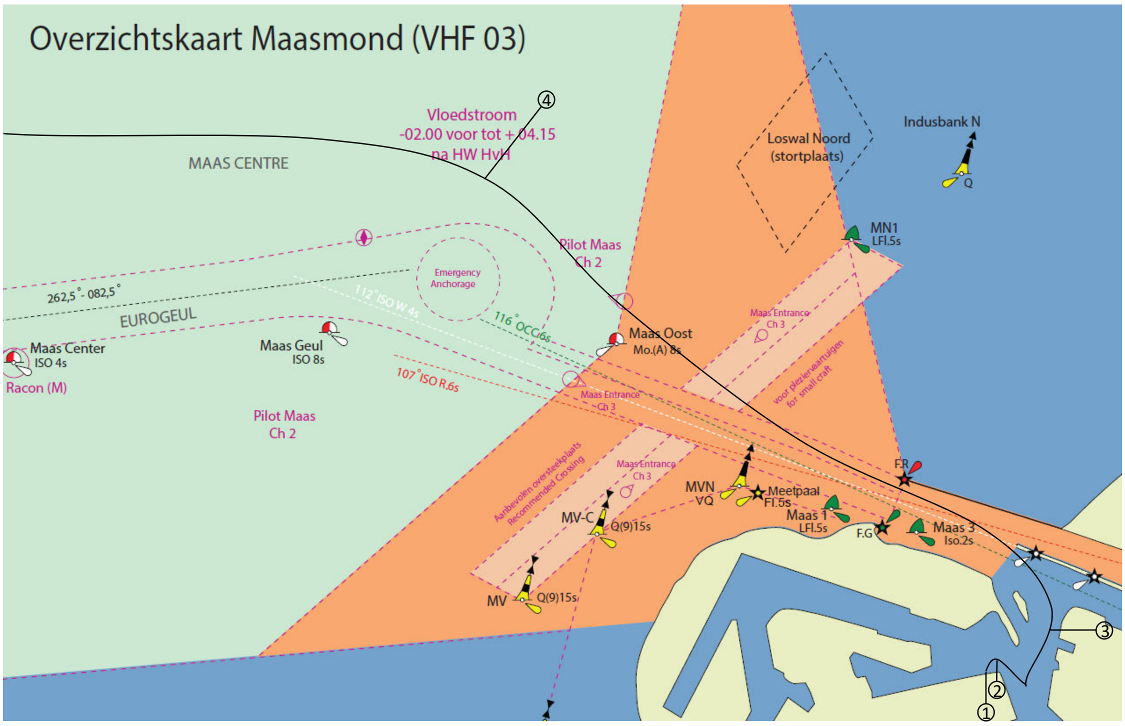

Figure 8.10: Voyage of outgoing vessel from ECT DDN to North Sea, inspired by (MT Maritiemfreelancer, 2020).

Abovementioned steps give an illustration of the voyage of the outgoing MSC vessel. Below, these steps are summarized:

1) The unmooring procedure will start. The pilot, tugs and boatmen are present. The nautical service providers assist the vessel so that it safely navigates through the port.
2) The lines have been let go by the boatmen. The vessel is now unmoored.
3) The tugs have also done their job. Therefore, the tugs are disconnected from the ship.
4) The pilot disembarks after having safely navigated the vessel through the port.

9 ACTOR-STAKEHOLDER ANALYSIS OF THE ACTORS INVOLVED IN A PORT CALL PROCESS

Several stakeholders are involved in a port call process; many actors contribute to the in- and outbound voyage of a vessel. However, these parties can have different relations, interests and objectives. In addition, each stakeholder can be different in terms of resources, power and influence on other actors. In this thesis, it is crucial to obtain this type of information about each involved party. It is important to know what the current business processes drive. Moreover, the opinion of involved actors about the Just-In-Time initiative must be determined.

Therefore, an actor-stakeholder analysis is performed of the involved actors in a port call. The method of Enserink et al. (Enserink, et al., 2010) is a useful method to obtain these insights. The theory behind this actor-stakeholder analysis method is widely discussed in Section 5.1. This chapter aims to provide details about the applied actor-stakeholder method. The method of Enserink et al. (Enserink, et al., 2010) contains the following steps:

1. Problem formulation
2. Inventory of involved actors
3. Map formal relations of actors
4. Determine the interests, objectives and problem perceptions of actors
5. Analyse interdependencies between actors
6. Confront the initial problem formulations with the results

Problem formulation – actor-stakeholder analysis

The **problem formulation** (step 1) is related to the fact that Just-In-Time arrivals and services is not yet implemented in MSC container shipping in the Port of Rotterdam. The current port call processes are not optimized in a way that the initiative can be implemented. Insight in the current port call processes is required. The current port call processes must be mapped and analysed in detail. The position and motives of each actor is of great importance in this analysis. The actor-stakeholder analysis must provide these insights. Note that the actors' perceptions about the Just-In-Time initiative is also part of the actor-stakeholder analysis.

In short, the role and incentives of each actor must be determined in order to gain an understanding of what the current port call processes drive. The actors' perceptions about the initiative must also be included. The actor-stakeholder analysis is used to find this information.

Inventory of involved actors – actor-stakeholder analysis

The **involved actors** (step 2) in this research contains actors that can influence the arrival/departure times of container vessels of MSC in the Port of Rotterdam. This is, however, a very wide definition. For this reason, a list of the involved stakeholders is provided.

The involved stakeholders are: MSC – shipping company, Loodswezen – pilots, Boluda – towage company, KRVE – boatmen, Port of Rotterdam Authority, harbour master, ECT Delta Terminals, APM Terminals Rotterdam, AMP Terminals Maasvlakte II.

Two platform enablers in the Port of Rotterdam are PortXchange (Pronto) and Portbase (Port Community System). These parties are also considered as stakeholders because both play an important role in the current port call processes. PCO Taskforce is obviously also part of the actor-stakeholder analysis.

An important note for attention is that MSC is a 'composed' actor in the analysis. Several MSC departments (internal stakeholders) are involved in a port call process.

Analysis of involved actors in port call process

The **next steps (3-5)** of the actor-stakeholder model are different for each actor. For this reason, these steps are separately applied for each actor. Due to the size of this report, the complete analysis of each actor is added to Appendix C. Below, each actor is shortly introduced in order to give an indication of the actors' role in a port call. The conclusions of the complete actor-stakeholder analysis are discussed for each separate step (3-5) in Chapter 10. As shown in Appendix C, most information in these sections is obtained by means of interviews and literature research.

It is highly recommended to read the complete actor-stakeholder analysis in Appendix C. It is a very detailed description which shows the complexity of the involved actors in a port call. Many things do have a relation to the position, incentives, objectives, influence on others and power of an actor. All these kind of things determine the role of an actor in the port call process. In addition, it makes clear if and why an actor supports the Just-In-Time initiative.

As mentioned, each actor involved in a port call of MSC container shipping in the Port of Rotterdam is shortly discussed below.

***Shipping company – MSC* |** MSC is the second largest shipping company in the world. The headquarters are based in Geneva. MSC is globally presented by its extensive agency network which is spread across 80% of all countries in the world. MSC Nederland is the local agent of MSC Geneva. It is the representative for the captain when the vessel is in the Port of Rotterdam area. For this research, two divisions of MSC Nederland play an important role in the operational port call processes: port captains and the captains' room.

Port captains of MSC are the link between the terminal and MSC Geneva. Their task is to optimize the berth capacity and to communicate with MSC Geneva operations and planning department. The port captains do also play a role in the berth planning of the terminals where MSC operated vessels (un)load cargo in the Port of Rotterdam.

The captains' room is the representative of the captain in the Port of Rotterdam area. It is in charge for the vessel services, except terminal services, in a port call. This includes ordering and controlling nautical services, bunker services, ships' stores deliveries, crew changes, doctor visits et cetera. In addition, the captains' room performs the administrative tasks such as charging waiting time costs to service providers.

***Terminals – ECT Delta, APMT-R and APMT-MVII* |** Container terminals (un)load containers on and from vessels. It is the place where containers are transhipped from vessels to other vessels or inland carriers (barges, trains, trucks) and vice versa. In the Port of Rotterdam, terminal operators lease ground and 'basic infrastructure' of the Port of Rotterdam Authority.

Three terminal operators are in the scope of this research. MSC generally (un)loads cargo at ECT Delta Terminal, APM Terminals Rotterdam (APMT-R) and APM Terminals Maasvlakte II (APMT-MVII). Figure 8.4 shows the locations of these terminals in the Port of Rotterdam. Emphasis in the analysis is laid on the terminal types since this may impact the interest in the Just-In-Time initiative (Chapter 10).

The ECT Delta terminal is divided in three parts: DDE – Delta Dedicated East, DBF – Delta Barge Feeder, DDN – Delta Dedicated North. More than 80% of MSC operated vessels in the Port of Rotterdam (un)load cargo at the ECT DDN terminal since MSC has a joint venture based on volume commitment with the terminal. The DDN quay offers space for two larger deep-sea vessels or three smaller vessels. ECT Delta operates using automated guided vehicles (AGVs) and automated stacking cranes (ASCs). The quay cranes are manually operated. In addition to cargo operations on vessels, ECT Delta terminal also operates on barges.

APMT-R and APMT-MVII are both operated by APM Terminals which are owned by A.P. Møller – Maersk (Maersk, 2020). APMT-R does not operate using AGVs and ASCs; straddle carriers and stacking cranes are manually operated. APMT-R also uses the possibility to tranship containers from/to barges at their terminal.

APMT-MVII is the world's most fully automated terminal; 80% of the movements are automated and remaining operations are remotely controlled. The very largest container vessels in the world generally (un)load containers at the APMT-MVII. In contrast to APMT-R and ECT DDN, the APMT-MVII can take less advantage of spaces in the planning since this terminal concept has separated barge and deep-sea vessel quays. In this way, APMT-MVII cannot bridge time gaps between deep-sea vessels by (un)loading containers from/to barges.

***Pilot organisation – Loodswezen* |** Pilots guide sea-going vessels into and out of seaports. Their aim is to navigate a vessel safely to, through and from a specific port. During this process, pilots communicate and collaborate with other actors such as tugs, boatmen and the harbour master. In the Port of Rotterdam, Loodswezen is responsible for the guidance of vessels which are subject to compulsory pilotage. It is the only party within the Netherlands which is qualified to provide pilotage services.

The pilots of Loodswezen are specialized to navigate a certain vessel in a specific area in the Port of Rotterdam. For inbound voyages, Loodswezen can guarantee that a vessel is embarked within three hours if a pilot is available. This is mainly caused by the fact that pilots are called from and must be transported to the incoming vessel. For outbound voyages, pilots can be called with a notice of 1.5 hours.

***Towage company – Boluda* |** Towage companies assist vessels during (un)berthing procedures, manoeuvres in the port area and shifting of vessels. By pushing and pulling a vessel, a tug gives assistance in the navigation of a vessel. In the Port of Rotterdam, three companies provide towage services: Fairplay, Boluda and Svitzer. Boluda holds the largest part of the towage market in the Port of Rotterdam; it has 65% market share (Daling & Lalkens, 2019). Boluda is a new entrant in the market. In 2019, it acquired towage company Kotug Smit.

Boluda has a contract with MSC to provide towage services for MSC operated vessels in the Port of Rotterdam. For inbound voyages, it often receives last-minute information of the responsible pilot about the required number of tugs. For outbound voyage, Boluda's tugs are ordered 1.5 hours in advance.

***Boatmen – KRVE* |** Boatmen assist vessels during berthing, unberthing and shifting. In a mooring procedure, boatmen first sail to the vessel to collect their ropes. Thereafter, it brings these ropes to the boatmen ashore who attach the ropes to the shore bollards. Boatmen make sure that vessels are moored and unmoored properly. The Royal Dutch Boatmen's Association (KRVE) is responsible for (un)mooring services in the Port of Rotterdam. In this port, KRVE is the only organisation providing these services.

The order time of the boatmen of KRVE is around 30-45 minutes; boatmen can provide services at the desired location if it is communicated 30-45 minutes in advance. It is worth noting that the interviewed actors are generally content with the work ethic of KRVE. KRVE has almost never caused a delay in a port call process the last decade.

***Port authority – Port of Rotterdam Authority* |** The Port of Rotterdam Authority is an institution which takes responsibility for managing, operating and developing the port and industry area around Rotterdam. Besides, its task is to ensure a safe and smooth handling of vessel traffic in the port area. The Port of Rotterdam Authority aims to enhance the competitive position, both in terms of size and quality, of the Port of Rotterdam.

The Port of Rotterdam Authority is a commercial oriented company, as public influence is only indirectly exerted through the shareholders – the Dutch State and municipality of Rotterdam (Van Steenderen, 2019). The Port of Rotterdam Authority generally obtains revenues by rental income and port dues of vessels. The Port of Rotterdam is a landlord port which means that the port authority leases infrastructure to operators.

Besides commercial tasks, the port authority is also involved in public duties. These tasks are performed by the Harbour Master's Division. Since the public side may have different incentives/interests than the private side of the port authority, both parts must be considered. In this thesis, the Port of Rotterdam Authority refers to the private side of the company. The harbour master, responsible for public duties, is considered as the public side of the company.

***Harbour Master – Harbour Coordination Centre* |** The Harbour Master performs the public tasks of the port authority. It aims to ensure a safe and smooth handling of vessels in the Port of Rotterdam. The most important subdivision of the Harbour Master related to this research is the Harbour Coordination Centre (HCC). HCC is involved in the vessel planning. It is responsible for a safe planning and the admission policy. HCC gives permission to vessels to enter/leave the Port of Rotterdam. HCC cooperates and communicates with other actors such as nautical service providers and vessel operators.

***Port Community System – Portbase* |** Portbase is a neutral company offering services for the port community. It is a non-profit and public organisation. Portbase operates as IT company and logistic service provider. It has developed a central platform – Port Community System (PCS) – in which authorities and companies in a port can easily and safely exchange data with each other. Portbase offers several services. The most relevant services for this research are the ship call's services. In the Port of Rotterdam, it is mandatory for shipping operators to pre-report a vessel via PCS. In addition, nautical services must be requested through this system.

***PortXchange* |** PortXchange is a shared digital platform in which actors exchange information related to port calls. The application is developed as part of the Pronto project of the PCO Taskforce (Section 1.1.2). Its aim is to improve event data such as start and completion times of activities. Shipping companies, service providers (terminals, bunkers, pilots etc.) and the port authority can exchange data in the PortXchange application. It can be used to enhance the planning, completion and monitoring of port call activities. All involved actors can give updates about the status of activities in the PortXchange application. Today, developers of the company PortXchange Products BV ("PortXchange") are still improving the application.

***PCO Taskforce* |** PCO Taskforce is an international taskforce in which shipping industry and ports collaborate and promote port call optimization. PCO Taskforce members collaborate to find solutions that work for each trade (e.g. container, bulk, chemical), each port and from port to port. PCO Taskforce is a non-profit oriented project. Members do not pay membership fees. The involved members see it as a challenge to optimize port calls.

PCO Taskforce write papers to achieve port call optimization. Subsequently, the IMO or IHO (International Hydrographic Organization) decides if proposed changes must be endorsed and included in official books.

10 CONCLUSION

All involved stakeholders involved in a port call process of MSC container shipping are discussed. A large amount of information, especially in Chapter 9 and Appendix C, is obtained. This chapter puts the information of each involved stakeholder together and concludes the actor-stakeholder analysis. Extra tables and figures are made in order to get more insight in the obtained information in this chapter. In a port call several actors are involved with different incentives, power, resources et cetera. All this information can be important in order to understand the motivation of actors to support the Just-In-Time arrivals and services initiative.

Subsection 10.1 summarizes and concludes step 3 of the actor-stakeholder analysis which consists of mapping the formal relations of involved actors. The interest, objectives, problem perception and interdependencies between actors (step 4 and 5) is also put together. Subsection 10.2 and 10.3 give more insight in these steps of the actor-stakeholder analysis.

10.1 FORMAL RELATIONS

Figure 10.1 visualizes the most important formal relations between involved actors. Informal relations are not given in this chart. In the formal chart, single-sided arrows show the hierarchical structure and two-sided arrows present the formal relationship. The formal chart is shown on the next page (Figure 10.1). All links between actors in the formal chart are extensively described in detail in the complete actor-stakeholder analysis (Appendix C). Therefore, most information in the chart is not repeated in this section.

In short, the shipping company, which is MSC in this case, has formal connections to all other actors. Therefore, it is centrally located in the chart. In contrast, the port authority only has two types of clients: shipping companies and terminal operators. Other service providers (pilots, towage companies, boatmen, bunker barges) are no clients of the port authority. These actors are clients of shipping companies and support their processes in the Port of Rotterdam.

As explained, most formal relations are shown in the formal chart (Figure 10.1). Since this thesis is narrowed down to container shipping of MSC, Maersk is not visualized in the chart. It must, however, be noted that there is also an indirect relation between APM Terminals and MSC. MSC has a 2M-alliance with Maersk Group which, in turn, is the owner of APM Terminals.

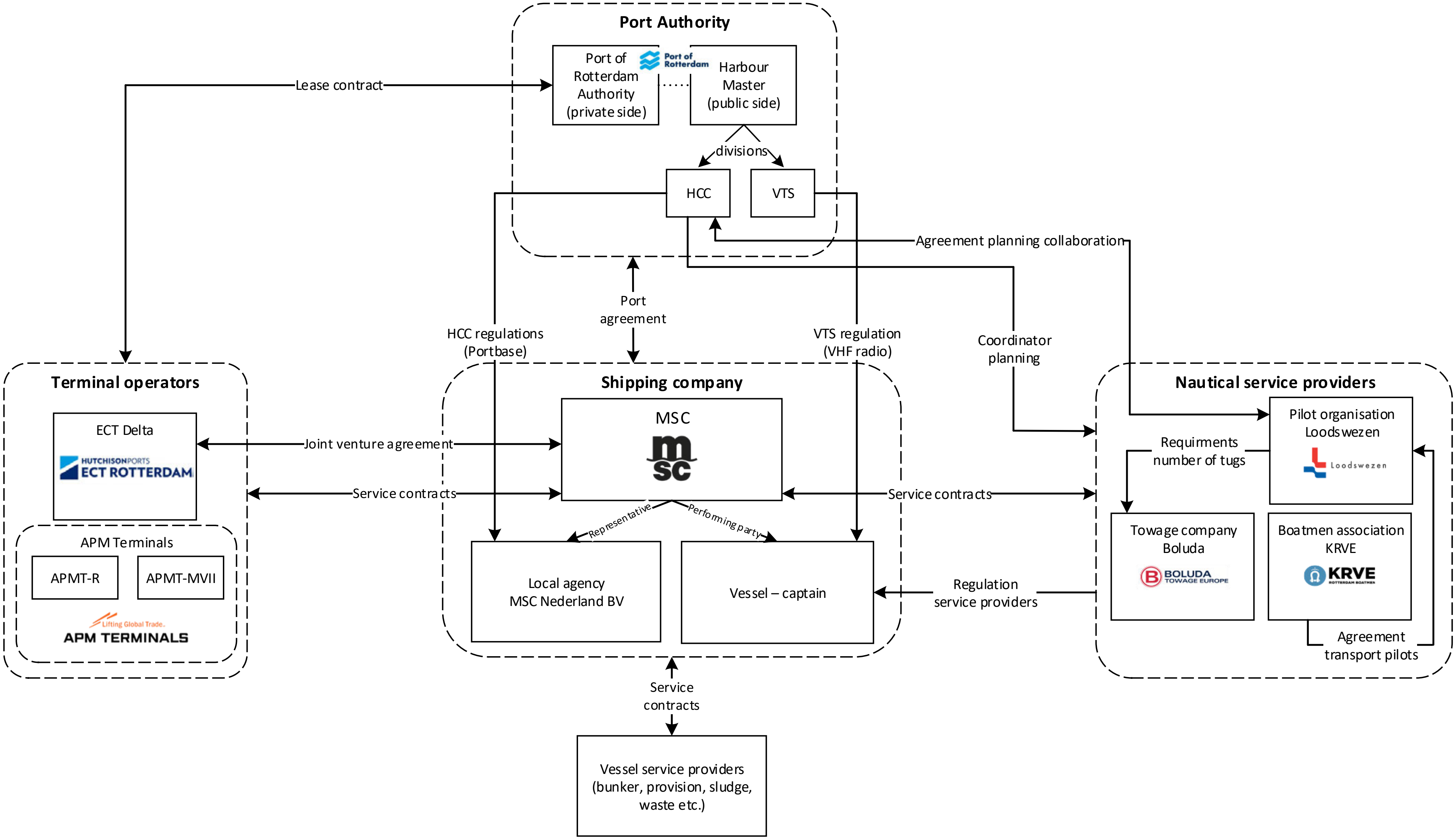

Figure 10.1: Formal chart for a port call of MSC container shipping in the Port of Rotterdam. Source: own figure.

10.2 INTEREST, OBJECTIVES, PROBLEM PERCEPTION AND INTERDEPENDENCIES BETWEEN ACTORS

Table 10.1 summarizes all information of both interest, objectives and problem perception (step 4) and interdependencies between actors (step 5). The information is for each actor summarized and enclosed in the table. The objectives of the actors are related to a port call. Moreover, it should be noted that the table is a summary of the aforementioned sub-sections. The interests and objectives are, thus, also summarized. Each actor may have more objectives and interests. The reasoning behind the information in Table 10.1 is extensively discussed in the complete actor-stakeholder analysis (Appendix C).

The involved actors of a port call have different interests since a distinction is visible between for-profit and non-profit companies. Most involved parties in a port call are commercial companies. However, it does not mean obtaining profits is always the largest driver for these companies. Parties as Loodswezen and KRVE have a monopolistic position in the Port of Rotterdam. Both organisations do not want to lose this position. It is, therefore, not only concerned about profit but also about continuity of business. Both want to provide high-quality services so that clients do not ask for competitors in their field.

It is also visible that most actors are not replaceable and that the dependency of resources is high. An exception is PortXchange which is interoperable with other platforms that satisfy standards of PCO Taskforce. Today MSC does not have contracts or agreements with PortXchange. The application is also not compulsory in the Port of Rotterdam.

The replicability and dependency relations can be linked to the critical actor column (Table 10.1). Critical actors are actors that have a certain extent of power and cannot therefore be ignored in the analysis. Since all parties contribute to a port call or may have a significant contribution to Just-In-Time arrivals and services implementation, all actors are considered as critical. All parties can influence the arrival/departure times of container vessels of MSC. However, the interdependencies are not exactly the same for all actors. More information is provided by the power-interest matrix in the next section.

Most involved actors are considered as dedicated actors. Dedicated actors are actors affected by the problem solution and possibly perceives benefits and costs. Based on expert consultation it is considered that the only non-dedicated actor is the Harbour Coordination Centre (HCC) of the harbour master. Main reason is the public entity of the organisation. It does not get the same benefits as other companies in the chain such as a possible increase in profits. Moreover, interviews showed that HCC is not really involved in the Just-In-Time initiative. It does not mean that HCC is a potential blocker, but it cannot be considered as a party that will probably participate. It is worth noting that the initiative may increase safety in the Port of Rotterdam which can be related to the objective of HCC.

Table 10.1: Summary actor-stakeholder analysis of involved actors in a port call. Source: own table.

Actors	Interests*	Objectives*	Important resources	Replaceable (yes/no)	Dependency (limited, medium, high)	Critical actor (yes/no)	Dedicated actor (yes/no)
MSC – Shipping company	obtain profits	improve turnaround times of MSC operated vessels in a port call	position in the network	no	high	yes	yes
ECT Delta, APMT-R, APMT-MVII – Container terminals	obtain profits	improve terminal services and operations	position in the network	no	high	yes	yes
Loodswezen – Pilot organisation	continuity of business in Port of Rotterdam	ensure safe and quick vessel passage	knowledge/skills and formal power	no	high	yes	yes
Boluda – Towage company	obtain profits	provide quality services and growth	knowledge/skills, formal power and position in the network	no	high	yes	yes
KRVE – Boatmen association	continuity of business in Port of Rotterdam	provide best possible boatmen services	knowledge/skills and formal power	no	high	yes	yes
Port of Rotterdam Authority (private side)	obtain profits by keeping public tasks in mind	enhance competitive position and create jobs in Port of Rotterdam	position in the network	no	high	yes	yes
Harbour Master – Harbour coordination centre (public side)	perform public tasks	ensure safe and smooth vessel traffic by keeping sustainability in mind	formal power	no	high	yes	no
Portbase – Port community system	satisfy needs of shareholders and clients	optimize logistic data exchange	knowledge/skills and formal power	no	high	yes	yes
PortXchange – Pronto	continue business and growth internationally	reduce emissions caused by global shipping	knowledge/skills	yes	medium	yes	yes
PCO Taskforce – Port call optimization	improve shipping	optimize port calls	knowledge/skills	no	high	yes	yes

* As explained, interests and objectives of actors are summarized in this table. Actors may have more interests and objectives. More information about this table is given in the sub-sections of the complete actor-stakeholder analysis (Appendix C).

10.3 POWER-INTEREST STAKEHOLDER MAP

Figure 10.2, presented on the next page, displays the power-interest stakeholder map as part of the actor-stakeholder analysis. It is a more detailed visualisation of the information in Table 10.1. The matrix shows the power and interest of each party. All involved actors are positioned on a specific place. Critical actors are actors with a high level of power (upper row). Dedicated actors are actors with high level of interest (right column). This information can be derived from Table 10.1.

However, a more detailed view is needed to determine the exact location of actors in the matrix. MSC, the shipping company, is considered as party with most power and interest. It possibly perceives most benefits in comparison with other stakeholders. In addition, the shipping company including its vessels are central in a port call. Most involved actors provide services for a shipping company as MSC.

Terminal operators are also considered as parties with relatively more power. It provides one of the most important services to a vessel. The interest in the Just-In-Time initiative may be different per terminal based on the terminal concept. As discussed, APMT-MVII is mainly operated automatically. Its terminal concept is different than ECT Delta and APMT-R terminals. APMT-MVII is less flexible in adaptations to planning due to separate barge and deep-sea vessel quays. Therefore, it may have less interest in the Just-In-Time initiative since it obtains relatively less benefits compared to the other terminals.

The Port of Rotterdam Authority (private side) can improve the competitive position of the port when implementing the Just-In-Time initiative. In the implementation, it is dependent on their two major clients: shipping companies and terminal operators. Many interviews revealed that this is also considered as the triangle – shipping company, terminal operator and port authority – which is the fastest way to get the initiative implemented.

The nautical service providers have less power in a port than shipping companies and terminal operators. Loodswezen and KRVE both are supporters of the initiative. It wants to satisfy their clients. Moreover, it can also optimize their planning. This also counts for Boluda. However, the towage companies have a different position in the Port of Rotterdam. It does not have a monopolistic position. In addition, Just-In-Time arrivals and services does not have the same benefits as for other stakeholders. In their eyes, Just-In-Time means that it first guides a vessel outside the port and, subsequently, uses the same tugs to guide the next vessel into the port. The Just-In-Time initiative, as proposed by IMO GIA, may require more capacity of towage companies.

It is also important to note that nearly all vessels must join the initiative because nautical service providers must take them all into account for the planning. Shipping companies in other shipping sectors as dry and liquid bulk are also clients of the nautical service providers. If these sectors do not join the initiative and do not share information earlier in advance, the nautical service providers cannot guarantee earlier to container vessels that it has enough capacity at the desired time slot.

Portbase and PortXchange are both organisations interested in facilitating a platform to enable Just-In-Time arrivals and services. It should be noted that both organisations are not competitors of each other. Talks on collaboration are in progress. Portbase wants to be the public platform providing links with organisations to exchange data. PortXchange wants to use this data in their application to provide more insight in the port call processes. Today Portbase has currently more power in a port call than PortXchange since it already provides mandatory services for shipping companies.

As last, PCO Taskforce is obviously very interested in Just-In-Time arrivals and services. Their work is considered as a pre-requisite of the initiative. PCO Taskforce also gets more and more power since it gets recognition of powerful organisations as the IMO.

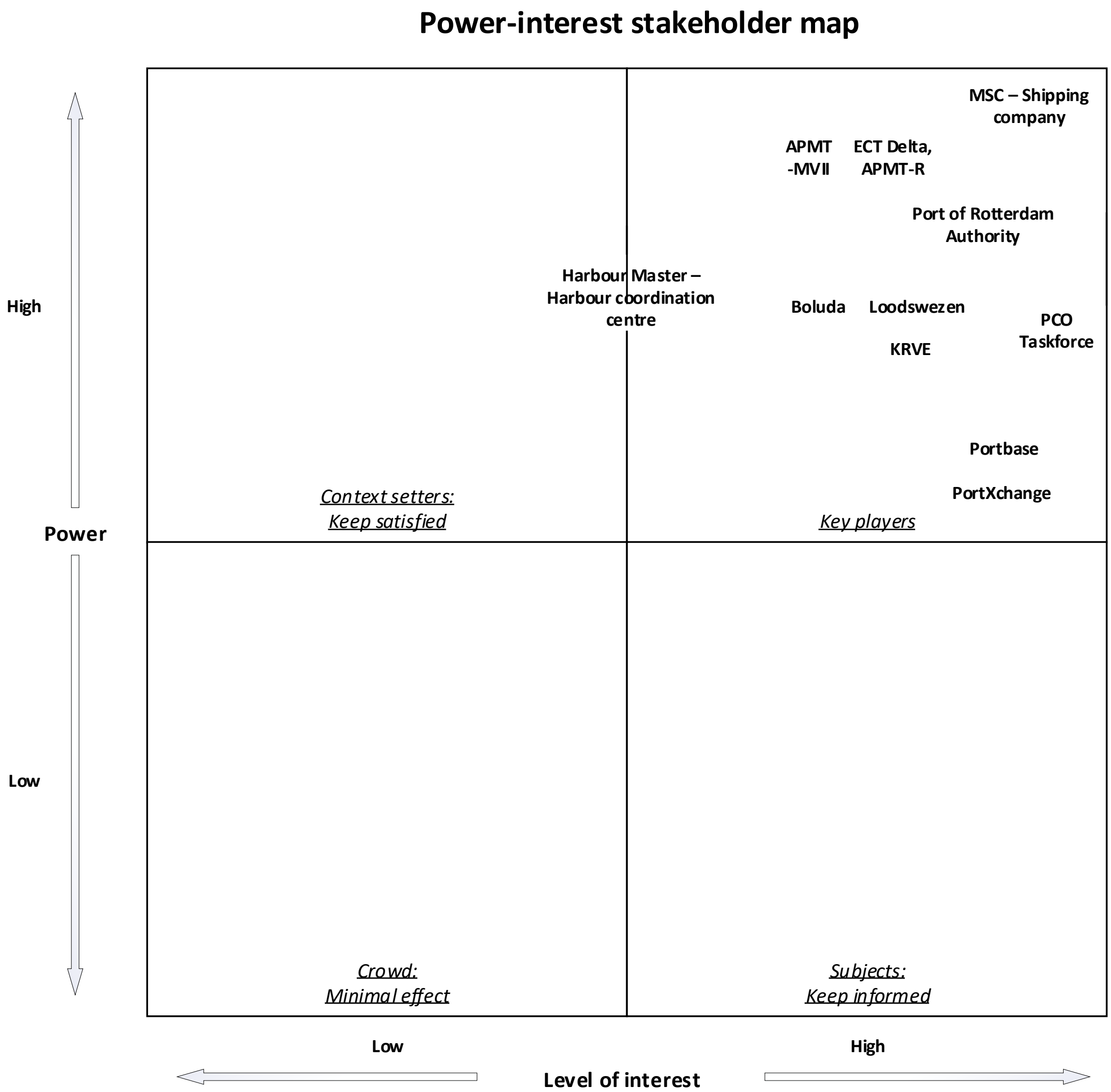

Figure 10.2: Power-interest stakeholder map of port call of MSC container shipping in the Port of Rotterdam. Source: own figure.

Part III:
Process analysis – qualitative & quantitative

11 INTRODUCTION

In the previous section (Part II), it is made clear what the current business processes drive. The incentives of involved stakeholders are identified. This information is, subsequently, used to make a model of the current port call process. A clear description of the current port call process is an important part of the research. It must be clear what a port call process today entails to find out what needs to be improved to implement Just-In-Time arrivals and services. This thesis is narrowed down to a port call of MSC container shipping in the Port of Rotterdam. Therefore, this case is described in this section (Part III). The current port call processes are both qualitatively and quantitatively researched. The information is provided in Chapter 12-14.

The port call processes are first qualitatively analysed. The business process map of a port call, designed by the PCO Taskforce (Figure 4.2), is used as reference point in the analysis, since the standards in this map are considered as pre-requisite for the Just-In-Time initiative by the IMO GIA (IMO GIA, 2019b). Years of industry experience and scientific research have contributed to the design of the business process map of PCO Taskforce. In addition, the business processes are based on BIMCO contracts and IMO decisions which are both applied in each port and trade. A detailed explanation of the business process map is given in Appendix B.

The current port call process is, thus, described by using some parts of the business process map of PCO Taskforce. However, it is worth noting that this map is relatively brief since it must be applicable for each port call independent of cargo, vessel and port type. This thesis is more specific to a certain cargo, vessel and port type – MSC container shipping in the Port of Rotterdam. Therefore, many extra sections are added to get a better and much deeper understanding of the current (operational) port call processes.

The description of the port call is divided into two main phases. A distinction is made between a contractual and operational phase. This is also visible in the PCO Taskforce business process map (Figure 4.2). Both phases are discussed in respectively Chapter 12 and 13. Contractual phase contains cargo, vessel hiring and terminal contracts. Operational phase includes berth planning, port planning arrival, vessel and cargo service planning, and port planning departure.

Most emphasis is obviously on the operational phase since this part must be improved to implement Just-In-Time arrivals and services. However, knowledge about the contractual phase of the business process map is required since it can also influence a port call and may impact the operational phase. It is known that contractual barriers counteract the Just-In-Time initiative in other shipping sectors. For example, many bulkers and tankers operate under voyage charter which often includes a due despatch clause. In this clause, it is contractually determined that the vessel must continue to the following port with utmost despatch regardless of the berth is free or not. In addition, demurrage clauses enter into force if these vessels enter the port area. Vessel operators then receive a demurrage rate, a compensation for the lost time, which is often higher compared to fuel savings by arriving just-in-time (IMO GIA, 2019b). Both examples show that the contractual phase can have impact on the operational phase. It is, therefore, essential that these are considered in the case study of MSC container shipping in the Port of Rotterdam.

Subsequently, the knowledge obtained in the qualitative analysis is used to interpret a quantitative analyses (Chapter 14). Without knowledge of the port call processes it is nearly impossible to understand the data. Therefore, this chapter follows up the qualitative analysis. Conclusions of both the qualitative and quantitative analysis are given in Chapter 15.

12 QUALITATIVE ANALYSIS - CONTRACTUAL PHASE[1]

It is important that there are no contractual barriers which counteract Just-In-Time arrivals and services. As mentioned, contractual agreements in the bulk and tanker sectors are in conflict with the Just-In-Time initiative. Therefore, it is crucial that the contractual agreements in container shipping of MSC in the Port of Rotterdam are also considered. It must be researched to what extent the contractual phase impacts the Just-In-Time initiative. In addition, knowledge about the contractual phase is required since this phase can impact the operational procedures. For example, MSC has a joint venture with the ECT DDN terminal and has, therefore, more influence on the berth planning in the operational phase of a port call.

This chapter provides information about the contractual phase of a port call of MSC container shipping in the Port of Rotterdam. The contractual phase of a port call process consists of cargo, hiring vessel and terminal contracts (Section 12.1-12.3). This is also visible in the port call business process of PCO Taskforce (Figure 4.2).

12.1 CARGO CONTRACT

MSC is an ocean carrier; it globally transports goods for their clients. In short, clients contact MSC about the transportation of cargo. After an agreement, clients finalise the booking. MSC brings an empty container which will be filled and locked. Subsequently, MSC ships the full container to the destination. Next, the client takes the cargo out of the container and MSC gets their container back. MSC tries to find a new client to fill the empty container with cargo again.

12.1.1 MSC Liner shipping

MSC started with tramp services; it sailed to places where cargo was available to transport. After a while, MSC had enough customers to provide regular liner services. Today, MSC is a global leader in container shipping. Customers are divided over different trade zones. A trade is a cargo flow between two individual markets (e.g. USA west coast / North Europe).

MSC offers specific trades mainly depending on the clients and markets. Sailing routes are usually between two trade zones. The sailing routes and rotations, which is the sequence of the roundtrips, are also dependent on vessel and terminal/port requirements. Figure 12.1 shows an example of a liner service of MSC between North Europe and the East Coast of USA.

[redacted]

Figure 12.1: Liner service between North Europe and East Coast of USA (MSC, 2020).

[1] Most information in this section is obtained by working as an intern in MSC, interviews with MSC employees (De Jong, personal communication, February 6, 2020; De Klerk, personal communication, February 14, 2020; Den Ouden, personal communication, September 5, 2019; Jairam, personal communication, February 13, 2020), and by literature of the intranet of MSC (MSC, 2020). References are placed when other sources are used.

After having selected the desired ports and vessels, MSC calculates the full rotation by taking into account the loading/discharging and sailing times of a specific route. It aims to provide regular (e.g. weekly) liner services. By using all information MSC publishes the schedules of the liner services. The schedules, also called long term (pro forma) schedules, are timetables including arrival and departure times of vessels at different ports.

Note that container transport does not stop in the port. Products must often be transported further to the destination. In the inland movement of a container, a distinction can be made between carrier and merchant haulage. In carrier haulage MSC is, besides sea transport, also responsible for hinterland transport. In merchant haulage MSC is only responsible for transport between seaports; hinterland transport falls under the responsibility of another party. In both options the Just-In-Time initiative can have benefits. Regardless of carrier or merchant haulage, hinterland transporters can improve the planning if real-time data of arrival times is available. It increases the end-to-end supply chain visibility as shown in Section 1.1 (Figure 1.2).

To conclude, MSC offers globally multiple liner services. Liner shipping is characterized by services on fixed schedules. Vessels sail pre-determined routes and load/discharge at fixed ports. Quick loading/discharging is important in this type of shipping. In liner shipping, berth planning schedules are already known a longer period in advance. More information about these procedures is given in Section 13.1 (long term berth planning).

12.1.2 Carrier contracts

MSC is not the only carrier offering liner services. In order to reach more markets and serve clients more regular, carriers can make interline agreements. In simple words, carrier A (e.g. MSC) takes cargo from carrier B (e.g. Maersk) to ports which carrier B do not have liner services to, and vice-versa. In this way, it can expand services to other markets. In addition, carriers can share liner services with their vessels to provide more regular services. MSC makes use of both options: slot charter agreements and vessel sharing agreements. These options also decrease risk for shipping companies that vessels sail with low utilization rates at specific liner services.

Slot Charter Agreements (SCA) takes place when a partner leases part of the slots – container spaces – of their vessel to other partners. It is an agreement between two or more parties in which parties charter an agreed number of TEUs on a vessel operated by a specific party. In this agreement, the vessel is usually operated by one party.

Vessel Sharing Agreements (VSA) are agreements between two or more parties about sharing vessel space in a liner service. Each involved party delivers vessel capacity. VSA partners deliver the same or different number of vessels for a liner service. [redacted] Besides, space on board of vessels is shared between involved parties. MSC operated vessels in abovementioned services have containers on board [redacted] Thus, multiple parties can operate a liner service by means of a VSA; agreements about both vessel and space contribution are made between involved parties.

A VSA is usually limited to a certain liner service. A collection of VSAs are found in alliances which are well-known in container shipping. These alliances are cooperation agreements between container shipping companies. It consists of agreements about sharing vessels and chartering slots on their vessels. Its aim is to widen service areas and to benefit from economies of scale. Since April 2017, three alliances (2M, Ocean and THE Alliance) take approximately 80% of the container shipping market. The nine largest container carriers are involved in these alliances. Figure 12.2 shows the market share and involved partners of the three largest shipping liner alliances. Information is based on data of Alphaliner (Alphaliner, 2020).

MSC has an alliance agreement with Maersk. The two world's largest container carriers form the 2M-alliance since 2015. The operational relationship between Maersk and MSC is agreed for 10 years. Both carriers have a market share of 32.5% in container shipping.

Compared to other shipping sectors, the container market is relatively consolidated. The three largest alliances take about 80% of the market. In addition, the market is characterized by SCAs and VSAs which means that more than one carrier is usually involved in the transport of containers from point A to B. Since the container lines are relatively consolidated, it can result in a faster adoption of required standards needed for Just-In-Time arrivals and services.

This is also visible in the DCSA – Digital Container Shipping Association – an association with the aim to bring carriers together and implement data standards. The nine members have approximately 70% market share in container shipping. From all shipping lines in Figure 12.2, COSCO is the only member not involved in DCSA. If the members of DCSA collaborate, it can lead to a faster adoption of the required standards across the container industry. As explained (Section 1.1), data standards are needed to successfully implement the Just-In-Time initiative.

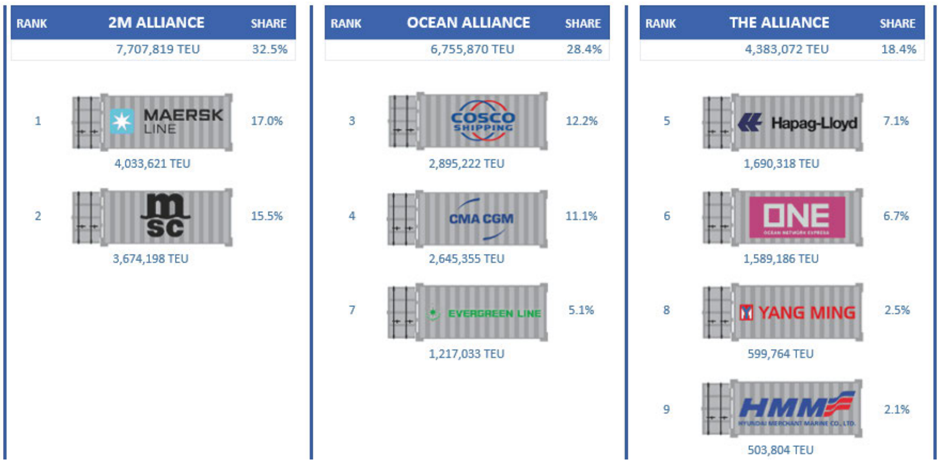

Figure 12.2: Market share and involved partners in three largest shipping liner alliances on 18 May 2020 (Alphaliner, 2020). Author: own source, inspired by DR Group (DR Group, 2018).

12.1.3 Position of MSC Nederland BV

MSC currently offers 207 liner services including 500 port calls. MSC liner services reach a large part of the world. Most services are shared by partners such as Maersk in the 2M-alliance. However, the Port of Rotterdam is obviously not involved in all liner services. In total, the Port of Rotterdam is one of the destinations in [redacted] liner services of MSC. The Port of Rotterdam falls under North-West Continent (NWC) which consists of ports between Le Havre and Hamburg.

MSC Nederland BV is the local agency of MSC in the Port of Rotterdam. The captains' room and port captains are only involved in operational procedures of MSC operated vessels in a port call. For example, vessels of both MSC and Maersk are involved in the 2M-alliance. The captains' room and port captains of MSC Nederland are only responsible for MSC operated vessels in this alliance. Cargo of MSC in Maersk vessels falls under responsibility of Maersk, and vice versa. Since data is only available about MSC operated vessels, the scope of this research is set to MSC operated vessels. More details of MSC operated ships follow in the next section.

12.2 CONTRACT FOR HIRING SHIPS

MSC transports cargo by using own ships and chartered vessels. Chartering is the process whereby a vessel owners hires out a vessel to a charterer. A charterer makes an agreement with a ship owner or operator to transport the cargo from point A to B. A so-called charter party is a contract between both parties (ship owner and charterer) in which the cargo owner pays the charterer freight to transport cargo. Different charter types are distinguished: voyage charter, time charter, bare boat charter and contract of affreightment. More information about these charter types is discussed in Appendix B.

According to the data of Alphaliner (Alphaliner, 2020), MSC currently has 550 ships of which 136 ships are owned and 414 ships are chartered by MSC. It makes use of different charter types such as bareboat charter and time charter agreements. In comparison with the bulk and tanker sectors, there are no contractual barriers in place to reduce speed in container shipping. Since almost all vessels are owned or time chartered, the contractual issues related to voyage charters such as due dispatch and demurrage clause do not form any problem. Therefore, container shipping is an interesting start point to implement Just-In-Time arrivals and services. In addition, MSC Nederland does not experience differences in contact and operational procedures in a port call with owned or chartered MSC vessels.

12.3 CONTRACT TERMINAL

Container terminals are involved in activities as handling, storage, (un)loading containers. A terminal can be divided into five categories based on ownership: public/state run terminals, carrier-leased dedicated terminals, terminal-operator built and operations terminals, carrier built and operation terminals, joint venture of carriers and terminal operators (Ting, 2007). Appendix B shows more details about the differences of these container terminal types.

As explained, MSC deep-sea vessels (un)load at one of the following three terminals in the Port of Rotterdam: ECT Delta, APMT-R, APMT-MVII. These terminals are operated by Hutchison Ports and APM Terminals respectively. The three terminals fall under the group terminal-operator built and operation terminals. The Port of Rotterdam is a landlord port with a land lease construction; terminal operators leases ground and 'basic infrastructure' of the Port of Rotterdam Authority. Terminal operators invest in the buildings, cranes, equipment et cetera.

MSC has contractual agreements with these terminals to load and discharge cargo to and from MSC vessels. MSC is not owner of a quay or part of one of the ECT Delta, APMT-R or APMT-MVII terminals in the Port of Rotterdam.

MSC has a joint venture agreement based on volume with ECT Delta Terminal. MSC brings volumes to the terminal and, in turn, ECT reserves their DDN quay for MSC vessels. MSC has, therefore, relatively much influence on the planning of the ECT DDN Terminal. Note that MSC is not owner of the quay or part of the terminal.

The relations with APM Terminals are slightly different. MSC has contractual agreements with these terminals. However, Maersk Group is owner of APM Terminals. Maersk Line has, therefore, relatively much influence on the planning of APM Terminals. Since MSC collaborates with Maersk in the 2M-alliance, MSC has an indirect relation to APM Terminals.

As explained, many shipping liners have contracts with terminals in container shipping. The shipping companies may, therefore, require more frequent real-time data exchange of terminal operators. As known, real-time data exchange is essential for Just-In-Time operations.

13 QUALITATIVE ANALYSIS – OPERATIONAL PHASE[2]

The operational phase (Chapter 13) is the largest part of the qualitative analysis. An own model is made to get more insight in the operational port call processes. It is crucial to get extensive knowledge of the current port call operations in order to determine what must exactly be improved to implement the Just-In-Time initiative. Figure 13.1 gives a global overview of the operational processes involved in a port call.

A distinction is made between primary and supporting processes. The primary processes show a port call in main lines. In simple words, a vessel coming from another port sails to the next port area. It enters the port and (un)loads cargo. After cargo operations the vessel continues its trip to the next port. At first sight the processes look simply. In reality, these processes are relatively complex and involve complex planning phases (supporting processes). In order to maintain smooth operations of the primary processes, the supporting processes are of great importance. In the chart below, the supporting processes are shadowed since these sections are extensively explained in separate sub-sections of this chapter. The charts of the supporting processes are in chronological order. The time span of the processes is displayed in the charts.

Within each sub-section a distinction is further made between business processes and information systems. Information systems are the combined set for collecting, storing and processing information. Business processes rely on information systems in order to carry out the operations. It is crucial to analyse the business processes to understand in what way information systems support these business processes (Kroenke & Boyle, 2016).

In addition to the business process and information systems, the port call processes are linked to Just-In-Time arrivals and services in each sub-section. It is indicated which aspects need to be improved to implement the Just-In-Time initiative.

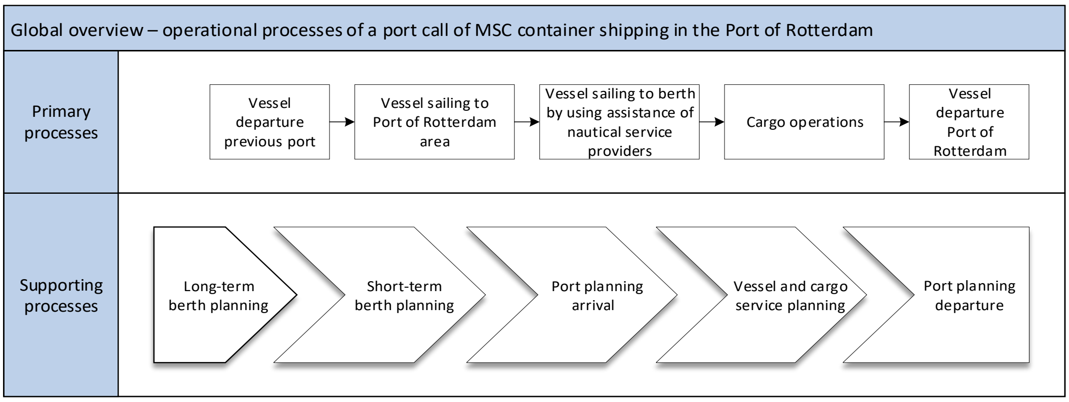

Figure 13.1: Global overview of port call process MSC container shipping in Port of Rotterdam. Source: own figure.

2 [redacted]

13.1 LONG-TERM BERTH PLANNING

The long-term berth planning is an extra section compared to the business process map of PCO Taskforce (Figure 4.2). In container shipping, liner schedules are already available a few months in advance. Therefore, a distinction is made between long- and short-term berth planning.

Figure 13.2 shows the processes involved in long-term berth planning in container shipping. The time period is ±6 months until 1 à 2 week before the vessel arrives at the berth. In the long-term berth planning, the main players are the shipping company, agent and terminals.

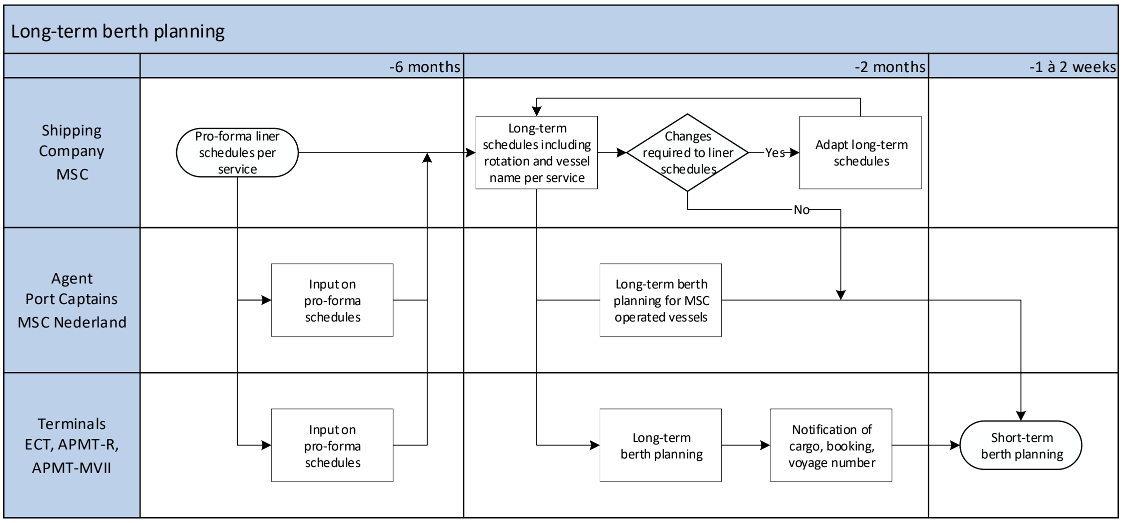

Figure 13.2: Overview of long-term berth planning processes. Source: own figure.

***Pro-forma liner schedules per service* |** As already explained, MSC offers multiple liner schedules based on certain trade routes. Approximately six months before arrival of the vessel, MSC Geneva determines the pro-forma schedules per service. These schedules consist of time windows that vessels load and discharge containers at a specific terminal. The schedules are made by using input of both port captains and terminal operators at location.

***Long-term schedules including rotation and vessel name per service* |** A few months in advance, MSC determines the final schedules of MSC operated vessels for each service. These schedules consist of a timetable that shows what vessels sail in the liner service and in what rotations the vessels must sail. It includes estimated arrival and departure times of each vessel per port. In addition, an estimation of the expected number of moves is made.

By using the liner schedules per service, the port captains of MSC Nederland determine which vessels are going to the terminals in Rotterdam. It collects the information and creates a berth planning of MSC operated vessels per terminal.

The terminal also uses the information of the liner schedules of all involved shipping companies. It makes a long-term berth planning of their berth(s) including vessel names. Terminals also process information in their systems such as cargo, voyage codes and bookings.

***Changes long-term schedules* |** The long-term schedules are, however, subject to changes. It may happen that the planning must be changed. In this case, MSC adapts the long-term schedules. Terminals processes the changes in their planning (systems).

***Short-term berth planning* |** The long-term berth planning is a framework also used in the short-term. However, delays may cause changes in the long-term schedules. In the short-term berth planning, the long-term planning is finetuned. More details are provided in Section 13.2.

13.1.1 Information flows & systems

Most information flows in the long-term berth planning are from shipping liner to the terminal operator and agents. The shipping company establishes the schedules. Terminal operators and agents receive the information and make a berth planning. This information is mainly sent by emails with attached excel files.

Appendix G.1 gives an impression of the information which is obtained and sent in this phase. As explained, MSC first makes a pro-forma schedule which includes information about arrival and departure times of a specific service in a port. Figure G.1 shows an example of the pro-forma per service in the Port of Rotterdam. This schedule is nearly the same for each week.

A more extensive version, the long-term schedules, are published in a later stage. Vessels names and specific codes are added to the service. A long-term schedule consists of a timetable of vessels in a specific service. It shows which vessels are expected in which port for a liner service. An example of a long-term schedule is also shown in Figure G.2. In the long-term berth planning, ETA berth and ETD berth are the only used timestamps.

13.1.2 Findings in relation to Just-In-Time arrivals and services

The reliability of the long-term berth planning is relatively important in case of Just-In-Time arrivals and services. It all starts with the pro-forma schedules made by the shipping companies. This determines the workflow of the terminals. Terminals make a planning based on the pro-forma schedules. The pro-forma schedules must be reliable and not subject to continuous changes. Otherwise, other service providers (e.g. terminals) cannot make a reliable planning. It must then continuously update the planning based on changes in pro-forma schedules of shipping companies. In this way, it cannot provide a reliable planning which makes it also more difficult for vessels to adapt the speed since it cannot rely on the planning.

Abovementioned problem can be illustrated by an example. Let's have a look at reefer services. Liner services with reefer containers on board are dependent on the number of plugs on terminals. A terminal has a certain amount of plugs available for reefer containers. If a shipping company plans in a way that liner services with many reefer containers arrive at the same terminal in the same time span, this terminal may have capacity issues. This can cause delays and/or ad hoc changes in the planning. The next vessels then experience last-minute updates and cannot, therefore, always adapt the speed since it is already in the port area for example. In case of Just-In-Time arrivals and services, it is important that the long-term berth planning is reliable and not subject to ad hoc last-minute changes.

13.2 SHORT-TERM BERTH PLANNING

The short-term berth planning is a continuation of the long-term berth planning. In the short-term phase, the long-term berthing schedules are finetuned. Pro-forma schedules change in 'live' schedules which include updates of time windows. The pro-forma windows are the time windows which are planned in advance. When vessels sail according to these schedules, plans may be changed. The pro-forma schedules become live schedules then.

Figure 13.3 shows the short-term berth planning processes of MSC container shipping in the Port of Rotterdam. Each item/activity in Figure 13.3 is separately explained in this section. In the short-term berth planning, a timeframe is used of 1 à 2 weeks before the vessel arrives at the berth. The involved players are again the shipping company, agent and terminals.

However, the local agency (MSC Nederland) is split into two actors. Both internal and external stakeholders of MSC Nederland are part of this research. The internal stakeholders consist of two divisions of MSC Nederland. Both play an important role in the operational processes. Port captains and captains' room are, therefore, distinguished in order to clarify also the internal processes. Information about the role of both divisions is already provided in the actor-stakeholder analysis (Chapter 9 and Appendix C).

It is also important to note that the shipping company (MSC Geneva) overlooks the situation. MSC Nederland is the representative for the captain when it is in the Port of Rotterdam area. Most communication goes via the agent which is MSC Nederland. However, MSC Geneva still monitors the situation and makes changes if it feels this is better for MSC. Most information related to short-term berth planning is also sent to MSC Geneva.

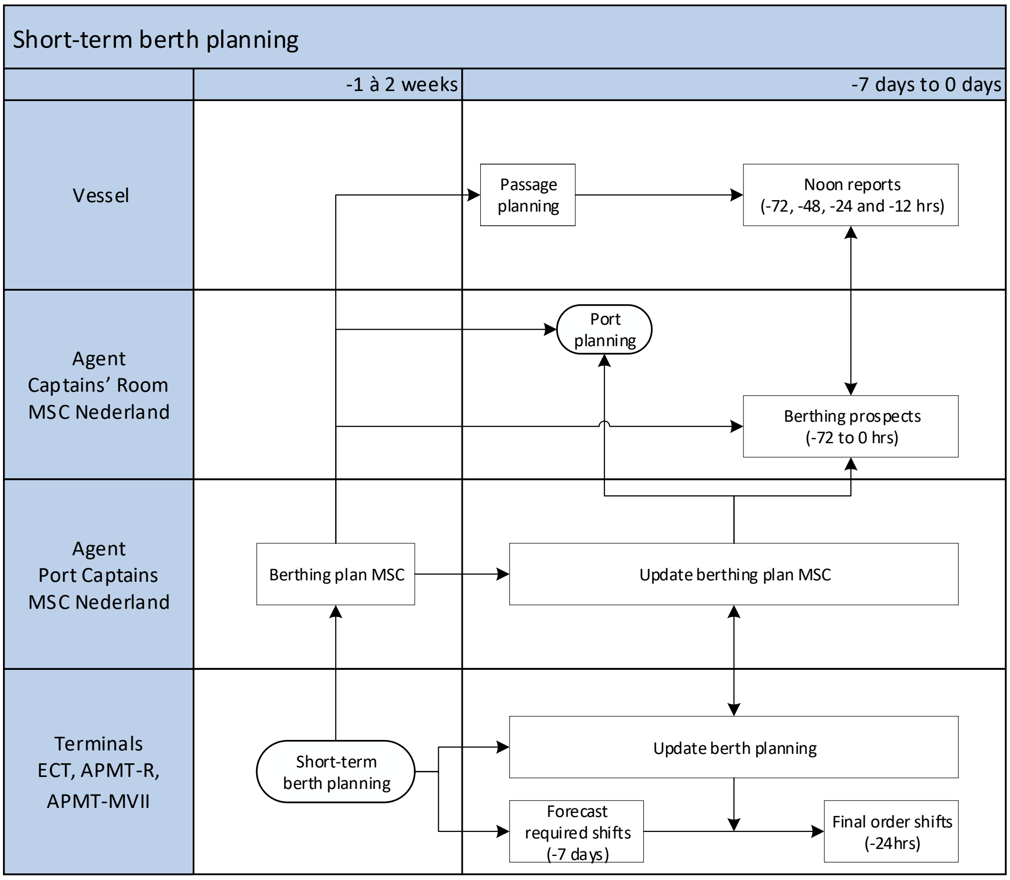

Figure 13.3: Overview processes involved in short-term berth planning. Source: own figure.

***Short-term berth planning* |** The short-term berthing plan of the terminal is usually made 1 à 2 weeks ahead. As explained, the long-term berth planning is also used in the short-term. However, delays and updates cause changes in the planning. Terminal operators use different methods to make the short-term berth planning. For example, APM Terminals meets at the Maersk office in Rotterdam once a week in order to make a berth planning for the upcoming 7-14 days. The berth planning consists of an overview of vessels which are planned to lay along the berth for a specific time window.

***Update berth planning* |** The short-term berth planning is continuously subject to changes 1 à 2 weeks before vessel arrival. A large amount of reasons can cause changes in short-term planning such as equipment failure terminal, change in productivity, delay of vessels et cetera. Therefore, the terminals communicate and exchange information with the agent (port captains MSC) to update the berth planning.

These processes are, however, slightly different per terminal. Due to the joint venture of MSC and ECT DDN, MSC has relatively more control over the berth planning on the ECT DDN. MSC makes clear how the planning should look like. ECT Delta will check if it can satisfy the needs based on number of available shifts and cranes. APMT-R and APMT-MVII are less flexible for MSC since it has no joint venture with these terminals. The port captains indicate when the vessels are estimated to arrive. Subsequently, the terminals determine the berth planning.

Since most vessels on the ECT DDN are operated by MSC, MSC can change the berth if this fits better in the planning. If another vessel is earlier than expected, it can change this vessel in the berth planning with a vessel that is expected to arrive later. However, at the APMT-R and APMT-MVII is this not possible for MSC. In terms of Just-In-Time arrivals and services, the next vessel needs to get accurate information of the previous vessel, which is often not an MSC operated vessel at APMT-R and APMT-MVII, to arrive Just-In-Time. In case of a previous vessel of MSC, MSC has more information available of expected completion time.

***Planning shifts* |** Based on the berth planning, terminal order a specific number of shifts. A distinction is also made between long- and short-term. In general, forecasts are made 7 days in advance about the number of workers which are needed per shift. It is based on the expected amount of volume of containers in this period. This planning is considered as long term. The final decision comes 24 hours in advance on weekdays and 72 hours for weekends. At this moment, the exact amount of people is ordered for each shift. The terminals use their own planning systems to order shifts.

The planning of the shifts is based on expected work/volume. Each terminal has a certain amount of own people it can use for the shifts. In addition, terminals use a pool where extra temporarily agency workers can be asked for peak periods. It can also ask their own workers to work longer shifts in peak periods. In off-peak periods, these people can get extra days off.

MSC asks for a certain amount of 'shifts' at the terminals based on the expected vessels. Experience of MSC employees revealed that APM terminals usually have the same amount of persons available. ECT DDN is sometimes able to scale up number of persons available for MSC.

***Berthing plan MSC* |** Within MSC Nederland, the operational departments work with a berthing plan made by port captains. A berthing plan consists of vessels coming to the Port of Rotterdam including the estimated time of arrival at the pilot boarding place, berth and start cargo operations. In addition, estimated moves (loading and/or discharging) is also given per vessel. A berthing plan works ahead approximately two weeks; vessels for the upcoming two weeks are indicated in the planning. A berthing plan is based on information of the terminals' berth planning, vessel's location and port captains of other ports. Port captains in each port make and update the berthing plan of their 'own' port. Subsequently, this information is uploaded on the intranet of MSC. In this way, information about the berth planning of each port is available for port captains of MSC.

Port captains obtain an estimated time of departure of a vessel from the terminal. It uses this information to calculate when the next vessel must arrive at the pilot boarding place and terminal. Based on past experiences, it assumes that a vessel needs approximately 2, 2.5 and 3 hours to sail from the pilot boarding place to the ECT DDN, APMT-R and APMT-MVII berth respectively. Abovementioned time windows are also the expected exchange times of vessels. It means if vessel A leaves at 13:00 hrs, vessel B is expected to lay along the same berth at 15:00 hrs at the ECT DDN.

***Update berthing plan MSC* |** As explained under 'update berth planning', the berthing plan is continuously subject to changes 1 à 2 weeks before vessel arrival. Port captains actively communicate and exchange information with both terminals and port captains in other ports. Terminals have the overview about cargo operations. Port captains have an overview of the status in 'their' port.

***Passage planning* |** If a vessel departures at port A, it must already have planned the trip to port B. As explained in Appendix B, the master must satisfy the IMO SOLAS regulation. The port state control can come in board to check if the captain has made a port passage plan. If this is not the case, the port state control shall keep records. The captain of a vessel makes a passage plan based on the estimated time of arrival at the pilot boarding place in the next port.

***Berthing prospects* |** Based on the berthing plan MSC, the captains' room checks which vessels are coming to the Port of Rotterdam. The captains' room is the communication line for the captain of an MSC vessel. It updates the captain of vessels that are expected in the Port of Rotterdam within two/three days. The captains' room communicates at which time the vessel is expected at the pilot boarding place and terminal, and when it is expected to depart. The captain replies on the message and confirms if it can arrive on time or not. Closer to arrival, the berthing prospects states what kind of order the vessel must enter the port of Rotterdam. More information about this process follows in the port planning arrival phase (Section 13.3).

***Noon reports* |** The vessel's captain informs MSC about the current status. It communicates information about current location and ETD berth, when it is another port, but also about technical matters such as quantity of fresh water, sludge, plugged reefers et cetera.

***Port planning* |** The port planning starts when the agent of a shipping company registers the vessel and cargo in Portbase. This activity is usually conducted one or two weeks in advance. Therefore, this end activity is not the rightmost block in the cross-functional flowchart in Figure 13.3. More information about the port planning is explained in Section 13.3 (Port planning).

13.2.1 Information flows & systems

The information flows and systems, presented in the short-term berth planning, are shown below in charts. Figure 13.4 shows the information flows between the involved actors in this phase. Table 13.1 gives more detailed information about these information flows.

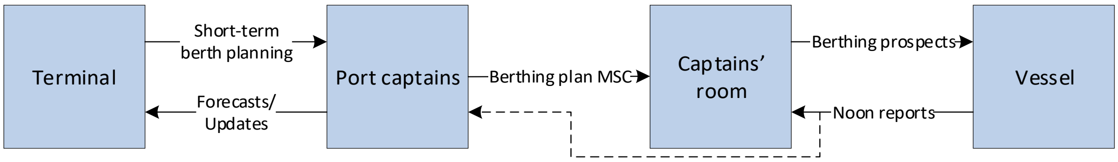

Figure 13.4: Information flows in short-term berth planning phase. Source: own figure.

In short, the short-term berth planning is made by the terminal. The terminal uses the information it obtains from the port captains to update the berth planning. By using its own information and the berth planning of the terminal, port captains make and update the berthing plan of MSC. This is a planning of all vessels which are coming to the Port of Rotterdam. The captains' room, which communicates with the vessel, sends updates to the captain about the time it is expected to arrive at the pilot boarding place (berthing prospects). The vessel, in turn, sends noon reports to provide information about their location.

Table 13.1: Information flows in short-term berth planning phase. Source: own table.

Item	Included timestamps	Timestamps PCO Taskforce/JIT	Data sender	Data receiver	Data file	Data sharing method	Frequency
Short-term berth planning	ETA berth ETD berth	RTA berth ETC cargo services	Terminal	Agent (Port captain MSC)	Excel / PDF	E-mail / PortXchange	1 or 2x / day
Forecasts/ Updates	ETA berth ETD berth	ETA berth ETD berth	Agent - Port captain MSC	Terminal	-	E-mail / Phone	Dependent on updates
Berthing plan MSC	ETA Pilot ETB ETS	ETA PBP, ETA berth (PTA berth) RTC cargo services	Agent - Port captain MSC	Agent - Captains' room MSC	Excel	Intranet MSC	2x / day around 12:00 and 17:00 hrs
Berthing prospects	ET Pilot on board ETA berth ETD berth	ETA PBP ETA berth (PTA berth) ETD berth	Agent - Captains' room MSC	Vessel	-	E-mail	2x / day around 12:00 and 17:00 hrs for vessels expected within 48-72 hours.
Noon reports	ETA ETD	ETA berth ETD berth	Vessel	Agent - MSC Port captain & Captains' room	-	E-mail	-72, -48, -24, -12 hrs before arrival

As explained, Table 13.1 gives a more detailed overview of the information flows. Additional explanation per item is given below. Appendix G.2 shows examples of the information which is shared between actors. Table 13.1 also includes information about the shared timestamps which are essential in this research. Each item in this table is discussed below.

However, the used timestamps do not meet the definitions of PCO Taskforce. Therefore, an extra column is added to the table in order to specify which timestamps an actor should use according to PCO Taskforce (Appendix B). It is important that the information flows satisfy the requirements of PCO Taskforce, since it is considered to be a pre-requisite of Just-In-Time arrivals and services by the IMO (IMO GIA, 2019b).

***Short-term berth planning* |** Appendix G.2 shows examples of the short-term berth planning made by ECT Delta, APMT-R and APMT-MVII. Terminals use different layouts, but the idea is the same. A berth planning shows the expected vessels along the berth for a certain timeframe. There are, however, differences in the frequency information is exchanged. ECT sends a berth planning each day at 13:00 hours. APMT-MVII sends it twice a day at 9:00 and 15:00 hours.

The berth plans also provide information about ETA and ETD berth of each vessel. These timestamps do, however, not correspond to the definitions of PCO Taskforce as explained in Appendix B. For example, an ETA berth is the estimated time of arrival at berth provided by a captain (via agent) arriving ship to a berth operator – also visible in Figure 4.2. A terminal reacts on the proposed timestamp with an RTA berth – requested time of arrival berth. If both berth operator and vessel (or agent) reach an agreement about a specific time, the timestamp is changed to PTA berth – planned time of arrival berth.

It should be noted that some terminals also share the short-term berth planning on PortXchange. ECT Delta terminal shows the planning on their website. PortXchange uses this information to provide planning details. The planning systems of APMT-R and APMT-MVII are linked to PortXchange. If the planning is adapted in its own system, it is also visible in PortXchange. The planning systems of APMT-MVII and APMT-R automatically send updates each 15 minutes respectively to PortXchange. However, it is essential that the planning in the terminal system is up-to-date. Otherwise, PortXchange does not show updated information.

This is also one of the reasons why actors not always trust information of PortXchange. Planning from websites or planning systems are not always up-to-date. In addition, port captains receive the short-term berth planning by email and phone. Therefore, port captains do rarely use PortXchange. It validates information by phone and email.

***Forecasts / updates* |** Updates to the berthing plans are usually given by phone. Port captains frequently communicate by phone with employees of the ECT DDN. Communication with employees of the other terminals takes usually place by email. As explained, port captains also obtain information from other port captains. It uses the berthing plans, but it also communicates via port call references. Each Monday, Wednesday and Friday the port captains of a specific region have a call together and inform each other about the status in 'their' port.

***Berthing plan MSC* |** The MSC berthing plan is uploaded twice a day on the intranet of MSC. Appendix G.2 (Figure G.6) shows an example of the MSC berthing plan Rotterdam. It is again visible that the used timestamps do not correspond with the timestamps of PCO Taskforce.

***Berthing prospects* |** The berthing prospects are also sent twice a day to vessels which are expected in the Port of Rotterdam within 2 à 3 days. In case of any updates, the berthing prospects are sent more than twice a day. The berthing prospects are based on the information of the berthing plan of MSC and the updates of planning information visible in PortXchange. Appendix G.2 (Figure G.7) shows an example of an e-mail which is sent to the captain. In this message, it is also clear that not all timestamps match with the defined timestamps of PCO Taskforce. Different timestamps are used for the same definition. For example, port captains use 'ETA Pilot' and captains' room use 'ET Pilot on board'. The defined PCO taskforce stamp for this particular situation is ETA PBP – estimated time of arrival pilot boarding place.

***Noon reports* |** The captain confirms whether it is able to arrive at the right place and time according to the berthing prospects. In addition, it sends noon reports 72, 48, 24 and 12 hrs before arrival. It is a standardized message which is filled in by the captain. An example is visible in Appendix G.2 (Figure G.8). Experiences of MSC employees reveal that the information of noon reports is not always used by the captains' room. Most information is meant to update MSC Geneva. However, the noon reports also contain estimate of arrival and departure times. The used timestamps are ETA and ETD which refer to ETA berth and ETD berth respectively. These timestamps do, thus, not correspond to the timestamps of the PCO Taskforce.

13.2.2 Findings in relation to Just-In-Time arrivals and services

As mentioned, port calls need to be optimized to implement the Just-In-Time initiative. PCO Taskforce plays an important role in this. In the short-term berth planning, several things are notified which are related to the PCO Taskforce standards and the Just-In-Time initiative.

It is visible that several timestamps are used with the same definition. This may cause unclarity in the processes. PCO Taskforce has developed a port call business process to establish correct standards. Just-In-Time arrivals and services needs these standards and requires exchange of timestamps (IMO GIA, 2019b). The port call business process map (Figure 4.2) states which exact timestamps must be used. Years of industry experience and scientific knowledge have contributed to design this map. Today actors use different timestamps, although the actors usually try to indicate the same. Table 13.1 clarifies the different timestamps used by actors and the related timestamps of PCO Taskforce in the short-term berth planning phase.

For example, several timestamps are used to indicate ETA PBP by MSC. In the berthing plan it is specified by ETA Pilot. Subsequently, the berthing prospects, which are sent to the captain, use ET Pilot on Board. In addition, the captain only sends an ETA as timestamp without specifying a location. This may be confusing for several actors. It is important that all actors use the same definition. There must be no confusion about the same thing.

Another interesting point relates to the frequency that information is exchanged between actors. In general, vessels only receive a berthing prospect two times a day around 12:00 and 17:00 hrs. The planning can obviously change in 19 hours. In order to update the captain more often, the captains' room must also obtain information more often. The Just-In-Time initiative requires that the captain is frequently updated so that it can adapt speed to arrive just-in-time.

Improvements are already made by PortXchange. By using only information of the MSC berthing plan, the captains' room only updates the vessel twice a day since the berthing plan is also uploaded twice a day. However, if the captains' room notifies updates in the terminal planning visible in PortXchange, it sends an extra berthing prospect to the captain. It is, however, interesting to see that the captains' room uses PortXchange and the port captains do not really use the information displayed by PortXchange.

As explained above, it is essential that the captain obtains planning information in an early stage so that it can adapt the vessel's speed. The berthing prospects are only sent to vessels within 2 à 3 days sailing distance of the Port of Rotterdam. This procedure does not change for longer or shorter trips to Rotterdam. For instance, the procedure does not differ for vessels coming from Algeciras (Spain) or Bremerhaven (Germany). If more 'bunker savings' want to be achieved, vessels should get notified in an earlier stage about the ETA PBP in the next port. This is especially for vessels with a relatively longer sailing distance to the Port of Rotterdam.

If MSC, however, wants to update the planning and vessel more frequently, the terminals must also send more planning updates. Terminals only send its short-term berthing plan once or twice a day to MSC. The Just-In-Time initiative requires more frequent data exchange.

PortXchange has already improved this, since terminal systems of APMT-R and APMT-MVII are linked to PortXchange. However, it is still important that the planning is updated in its own system. Otherwise, PortXchange does not receive the information. If other actors do not obtain planning updates, it cannot align the planning. Furthermore, vessels do not adapt speed if it is not notified with planning changes. In addition, if data is not updated frequently, other actors may not trust the data. Consequently, these actors may not use the data anymore. More details about terminal updates follow in vessel and cargo service planning (Section 13.4).

13.3 PORT PLANNING ARRIVAL

When it is known what time the vessel must be present at the berth, a planning can be made of the vessel through the port area. Several actors are involved in the port planning such as the nautical service providers and the harbour master. The port planning is, in fact, the next step after the berth planning. Since both the notification of vessels takes place in an earlier stage and the berth planning may still change shortly before expected arrival, there may be some overlap in the short-term berth planning and port planning in terms of time. Due to the complexity of the cross-functional flowcharts, it is chosen to map and explain both separately.

Figure 13.5 shows the port planning processes of MSC container shipping in the Port of Rotterdam. Most processes take place relatively short before the vessel arrives. Compared to the berth planning, many actors are involved in the port planning. This also makes the processes complex. Actors must collaborate but do also have different incentives and motives as explained in the actor-stakeholder analysis (Chapter 9 and Appendix C).

The harbour master is mapped as a composed actor in order to increase the clarity of the chart. Both actors also collaborate in the port planning. The relevant divisions of the harbour master are HCC and VTS. The contribution of each actor to the port planning is explained in this section.

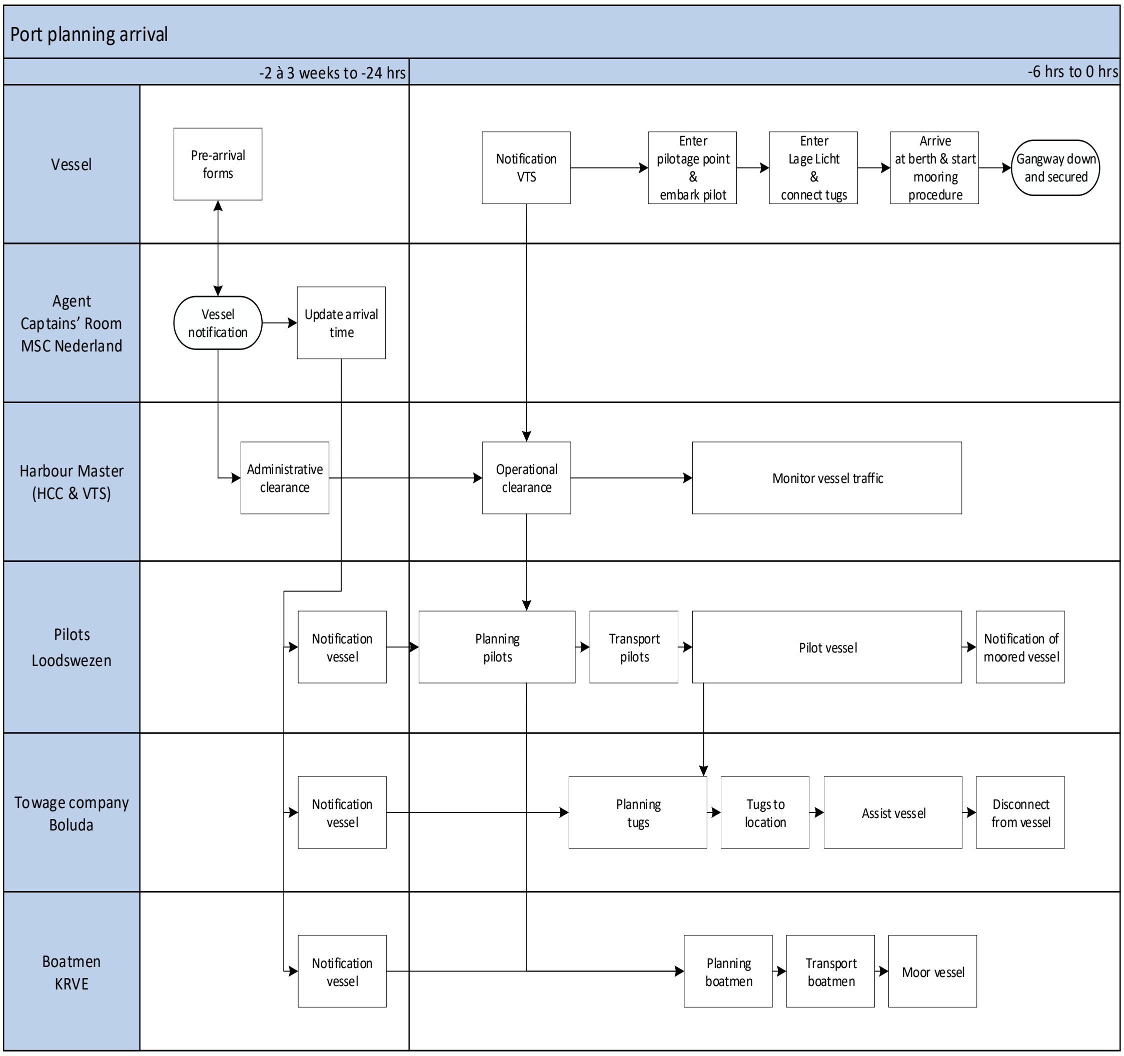

Figure 13.5: Overview of processes involved in port planning arrival. Source: own figure.

***Vessel notification and update arrival time* |** The preparation of the port planning starts when the agent registers the vessel and cargo in Portbase – the Port Community System made for agents (Appendix C.8). Vessels larger than 300 gross tonnage that want to enter the Port of Rotterdam are obliged to notify its future port call in advance. A so-called electronic notification to the harbour master (EKH – Elektronische Kennisgeving Havenmeester) is required. Information is provided about incoming, shifting and outgoing voyages. In this stage, Portbase generates a UCRN (Unique Call Reference Number) for the port call of the vessel.

Incoming vessels are required to send a notification at least 24 hours before arrival in the Port of Rotterdam. Vessels with a draught greater than 17.40 metres need to do this 48 hours before arrival. It is compulsory that changes in arrival times greater than 30 minutes are updated by the agent (Port of Rotterdam, 2020e). According to experiences of [redacted], agents do not always update arrival times frequently enough.

The required submissions in the notification of arrival of MSC operated vessels are submitted by the captains' room of MSC. It provides information about the vessel and cargo on board which is required by the Harbour Master and Customs.

In addition, the captain's room provides information about usage of nautical services. The captains' room indicates if the vessel requires pilot, tugs and boatmen. Nautical services are compulsory for certain type of vessels and circumstances (e.g. weather) in the Port of Rotterdam. The exact requirements are already explained in detail in the 'formal relations' of each stakeholder in the actor-stakeholder analysis (Appendix C). The agent must also submit the number of required tugboats. It has two options for choosing the quantity tugboats:

- It can specify the exact number of tugboats required (e.g. 1, 2, 3).
- It can choose the option L.A.B. (Loods Aantal Boten) which means the responsible pilot determines the required number of tugs in the operation.

MSC nearly always takes the second option, since the responsible pilot on board always takes the final decision. If agents take the first option, the towage companies incorporate this information in their planning. It means that if the agent selects two tugs, the towage company allocates two tugs for that particular vessel. However, if the responsible pilot on board requires an extra tug, this tug may not directly be available since the towage company did not take this into account. This results in delays of the vessel's port call. Therefore, many agents often choose the L.A.B. option. The towage companies then base the planning on information of the responsible pilot. Thus, the responsible pilot decides in both options. The first option let the agent only indicate an estimation. More information about these processes is explained in the nautical service planning. The current order process of tugs causes delays.

The whole processes of submitting the right information as explained above is already done in an early stage by MSC Nederland. It starts planning the vessel's arrival relatively early since it offers regular liner services (Section 12.1). The captains' room uses the berthing plan of MSC to make a notification of the vessel. The berthing plan usually contains information of vessels expected within two weeks. Therefore, the captains' room also makes a notification of vessels two weeks before arrival. At this stage, some information is still missing and arrival times may change. Updates are processed in a later stage. Based on own experiences, arrival times are not continuously adapted when the vessel is further away.

***Pre-arrival forms* |** The captain delivers the required information the agent needs to make an arrival notification in Portbase. The pre-arrival forms (IMO FAL forms) consist of information about the vessel and cargo on board.

***Administrative clearance* |** The harbour master assesses the electric notification submitted by the agent. It reviews if all required information is submitted and if it satisfies the requirements. HCC gives feedback to the agent when the provided information is incomplete or incorrect. For example, if the depth of a vessel is too large in a certain time period, it informs the vessel that it can only enter the port during a tidal window.

***Notification vessel* |** If the administrative clearance is granted, the nautical service providers also receive a notification of the registered vessel. The pilot organisation (Loodswezen), relevant towage company (Boluda, Svitzer or Fairplay) and the boatmen association (KRVE) uses this information to make a planning. Updates about arrival times by agents are also visible for the nautical service providers.

***Notification VTS* |** Besides administrative clearance, a vessel also needs operational clearance before it is allowed to enter the Port of Rotterdam. This process starts when a vessel contacts VTS. When a vessel passes the first calling in point of VTS area Maas Approach (Figure 8.8), it must contact the VTS by using VHF channel 1. This point is approximately 60 km away from the port entrance; it is approximately 2/3 hours sailing before the vessel reaches the port entrance. The vessel provides the required information such as vessel's depth and estimated arrival time. In addition, it communicates which order it has obtained from the agent. A distinction is made between three orders:

- Exchange order – the incoming vessel must exchange with an outgoing vessel at the same berth. The exchange times from PBP to ECT DDN, APMT-R and APMT-MVII are 2, 2.5 and 3 hours respectively.
- First line secured order – the vessel must lay alongside the quay at a specific moment. The vessel does not have to exchange with another vessel, but the terminal can still operate on barges before the vessel arrives.
- No order – the incoming vessel can come as soon as possible. The vessel does not get any specific instruction.

***Operational clearance* |** VTS checks with the captain if previously submitted information by the agent is still up-to-date. It adapts information when it is required. In addition to the information check, HCC checks if the berth and fairway are free at the desired time window. The berth must be free before operational clearance is provided. It means that an incoming container vessel does not get clearance to enter the port when the outgoing container vessel still lays alongside the berth. If the berth is free, the harbour master grants permission to enter the Port of Rotterdam.

After vessels have got operational clearance, the nautical services planning and coordination takes place. VTS sends the time a vessel is estimated at Maascenter – the pilot boarding place. This notification is sent to the nautical service providers for their planning. It means that even if an operational clearance is granted, it can still happen that a vessel cannot enter the Port of Rotterdam due to unavailability of nautical services. If this happens, VTS notifies the vessel thereafter that it cannot enter the port and must wait at anchorage.

The operational clearance falls under the responsibility of HCC. However, one employee of Loodswezen is also closely involved in the processes. The 'chief pilot' of Loodswezen is always present at the office of HCC in order to have closer connections between nautical service providers and HCC. If a vessel contacts the harbour master, the chief pilot also assesses the situation.

This is especially important in case the agent has chosen the option L.A.B. for the number of required tugs. In this case, the agent does not specify the number of required tugs. The chief pilot, then, gives an indication to the towage company about the required number of tugs. The decision is usually based on historic data about the vessel, current weather conditions and regulations (Appendix F). It is important to note that the chief pilot makes an estimation. The final decision follows when the responsible pilot arrives on board.

***Planning pilots – transport pilots* |** At the moment of granting operational clearance, pilots have already started the planning. When the vessel obtains operational clearance, it is only one hour away from the pilot boarding place. If pilots start planning at this point, it can almost never have pilots on board on time. Planners of Loodswezen look ahead at least four hours.

It uses the earlier information sent after the administrative clearance. Since the obtained arrival time of agents is usually not up-to-date, the pre-announced vessels are going to be found on a live vessel traffic map ('Havenmeester Havenkaart'). If a vessel is found, the vessel's position is checked and an estimation is made of arrival time at pilot boarding place.

The planners also consider the pilot availability and certain pilot specializations. If the right pilot is available, it must be called from home and transported to the vessel. A pilot has 1.5 hour to be present at the office. Since it must also be brought to the vessel by tenders, pilots can guarantee that an incoming vessel is embarked within three hours. If Loodswezen has capacity problems, the chief pilot communicates it to HCC. HCC proposes a new arrival time to the vessel then.

***Pilot vessel* |** Details about the execution of a vessel's voyage entering the Port of Rotterdam is explained in Section 8.4.2. This is not discussed again in detail in this chapter. However, part of nautical service planning is determined in this stage.

The responsible pilot on board decides the number of required tugs. If the pilot comes on board, it first checks if everything works in order to safely guide the vessel. It discusses with the vessel's captain how many tugs it needs. Note that the pilot will not guide the vessel into the port when it thinks it is not safe. The pilot primarily decides the number of tugs required. If the number of tugs is determined, the pilot communicates it to the towage company. The responsible pilot also estimates at which time the vessel is expected to be at Lage Licht.

***Planning tugs – tugs to location* |** The planners of Boluda look approximately two hours ahead. It also uses the live vessel traffic map ('Havenmeester Havenkaart') to assess when the pre-announced vessels are in the Port of Rotterdam. This is mainly since it does not get any information about the estimated time at the Lage Licht in advance. This is the location where Boluda's vessels get connected to the vessel (Section 8.4.2). By using the live map Boluda checks the vessel's position and makes an estimation about the arrival time at Lage Licht. In order to allocate tugs for a vessel, it also considers the minimum bollard pool which may be required in certain cases.

The planning for incoming vessels is very dependent on the agent's option for choosing the tug quantity. If the vessel requires a specific number of tugs, it can already make the planning a longer period in advance. If the agent chooses the L.A.B. option, Boluda must wait until the pilot is on board and makes the final decision about the required number of tugs and estimated arrival time at Lage Licht. This is, however, only 20 to 45 minutes in advance which makes it difficult for Boluda to make a proper planning. If Boluda has capacity problems, it communicates this to HCC. A new arrival time is then proposed to the vessel. It must be noted that the number of tugs is often dependent on specific conditions of the vessel and weather conditions. Since most vessels come often in the Port of Rotterdam, a right estimation could often be determined earlier in advance.

***Planning boatmen – transport boatmen* |** The planners of KRVE look approximately 1 à 1.5 hours forward. The planning of boatmen depends on length vessel, material vessel (type of ropes), destination vessel and weather forecasts. It takes the obtained estimated arrival time berth into account for the planning. However, KRVE usually focuses on own perceptions since it does not always trust the obtained information. It uses the Havenmeester Havenkaart to follow the expected vessels. The planners of KRVE determine when boatmen must be at location based on the vessel's current location and destination. The order time of boatmen is around 30-45 minutes; boatmen can provide services at the desired location if it is communicated 30-45 minutes in advance. There are no procedures in case of capacity problems of KRVE since KRVE is always on time to perform the tasks according to many experts working in the Port of Rotterdam.

***Operational execution of inbound voyage* |** A short explanation about the operational execution of an incoming vessel's voyage is given in this part. An extensive description of these processes is already given in Section 8.4.2.

After having obtained operational clearance, the vessel continues its way to the pilot boarding place. The pilot embarks at the pilot boarding place and navigates the vessel into the port. It communicates multiple times with VTS. VTS monitors the vessel traffic in the Port of Rotterdam area. When the vessel reaches the Lage Licht, the tugs connect to the vessel. The tugs assist the vessel in manoeuvring through the port. Once arrived at the berth, the boatmen assist the vessel in the mooring procedure. When the vessel is moored properly, the pilot notifies that the vessel is moored to VTS. The tugs and boatmen have also finished their job then.

***Gangway down and secured* |** The final point in the port planning is the gangway down and secured part. The pilot can then leave the vessel. Moreover, cargo operations can start after this point. More information about this procedure will be given in the vessel and cargo service planning (Section 13.4).

13.3.1 Information flows & systems

The information flows and systems involved in the port planning arrival phase are shown below in charts. Figure 13.6 gives information about the information flows between involved actors in this phase. The information systems used by each actor are also included. Subsequently, more details are provided about the information flows in Table 13.2.

In short, the agent sends a vessel notification a few days/weeks in advance. The harbour master assesses the notification. If the submitted information is correct, it provides administrative clearance. Nautical service providers also receive the vessel information then. When the vessel enters the VTS area in Rotterdam, it contacts VTS. The harbour master checks if earlier obtained information is still correct and assesses if the vessel is allowed to continue its way to the Port of Rotterdam (operational clearance). If the berth is available, the vessel gets informed that it can continue its trip. Subsequently, the nautical service providers get informed about the incoming vessel. The pilots have, however, already started planning. Together with the pilots and boatmen, it communicates in GIDS to align the planning. If nautical service providers deal with capacity issues, the harbour master gets informed.

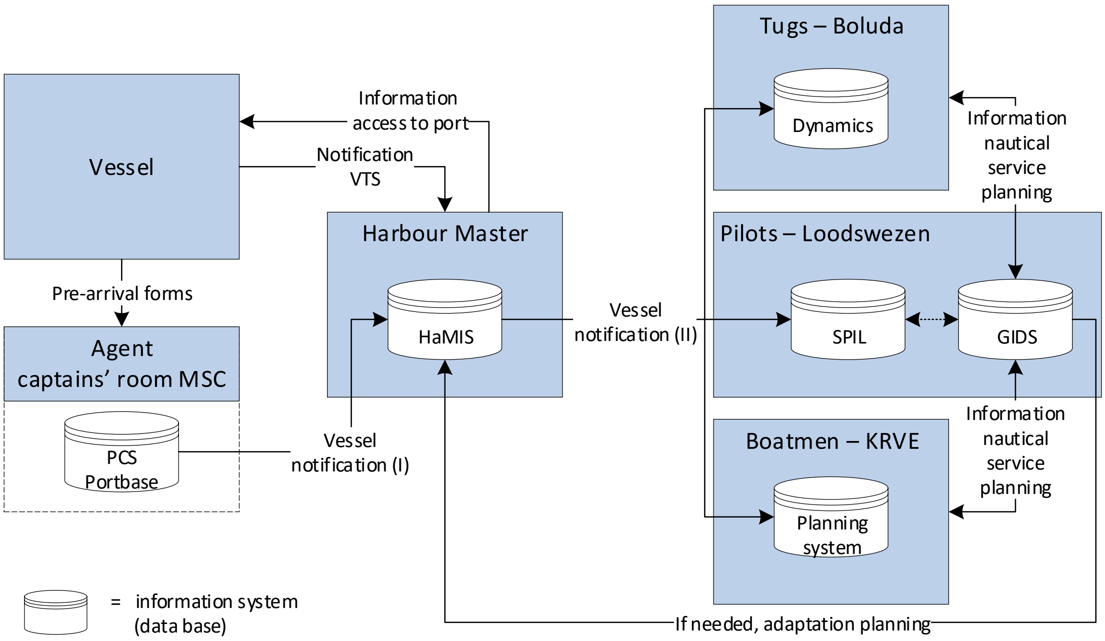

Figure 13.6: Information flows and systems involved in port planning arrival phase. Source: own figure.

Figure 13.6 shows that many information systems are involved in the port planning arrival phase. Moreover, most systems are connected to each other. If arrows start and end in an information system, it means that the systems are directly connected to each other. If an arrow starts or ends at an actor, it means that the actor processes information manually in the information system. Each system is shortly explained to get a deeper understanding of the processes in a current port call.

***PCS – Portbase* |** The Port Community System (PCS) is a central system which is used in the Port of Rotterdam. It is primarily designed with the aim of providing a platform for agents to exchange easily information with other actors. PCS is developed by Portbase which is a non-profit organisation, as explained in the actor-stakeholder analysis (Section C.8). PCS enables that information is electronically exchanged between the right actors. Agents provide information about the vessel's visit and cargo. Via PCS this information is sent to the right parties such as the Harbour Master and Customs (Portbase, 2020).

***HaMIS – Harbour Master* |** HaMIS – Harbour Master Information System – is used by the harbour master in the Port of Rotterdam and Amsterdam. The information system is used in monitoring and planning of vessel traffic as well as processing administrative issues such as clearances. Both HCC and VTS uses HaMIS to perform the activities. It receives information of the agent via Portbase. In addition, the information in HaMIS is also used by the nautical service providers to make their planning. Note that the nautical service providers only use the information in HaMIS. It cannot make changes within the system. The harbour master processes information in HaMIS.

***Planning systems nautical service providers* |** Each nautical service provider has an own information system for the planning. Loodswezen and Boluda use SPIL and Dynamics respectively. KRVE also plans in an own system. All systems are directly connected to HaMIS. The information of the harbour master is read out by own planning systems of nautical service providers. Based on obtained information, it makes a planning with the available capacity.

***GIDS – Loodswezen* |** In order to optimize the available capacity of the nautical services, the nautical service providers exchange data in an information system of Loodswezen. In 2018, Loodswezen developed GIDS – Gezamenlijk Interactief Dienstverleners Systeem – for the Rotterdam-Rijnmond region. It aims to improve the communication and information flows between the nautical service providers. Via GIDS the pilots, towage companies and boatmen inform each other about the capacity and continuation of an incoming and outgoing vessel. GIDS is directly connected with HaMIS. In case of capacity issues, information is sent from GIDS to HaMIS.

Table 13.2: Information flows in the port planning phase. Source: own table.

Item	Included relevant timestamps	Timestamps PCO Taskforce/JIT	Data sender	Data receiver	Data sharing method / information system	Frequency
Vessel notification (I)	ETA PBP ETA berth	ETA PBP ETA berth	Agent - Captains' room MSC	Harbour Master	Portbase	Updates from 1 à 2 weeks before arrival
Pre-arrival forms (IMO FAL forms)	Time of arrival	ETA berth or ETA PBP	Vessel	Agent - Captains' room MSC	E-mail (word file)	Once a few days (3-7 days) before arrival
Notification VTS	ETA PBP ETA berth	ETA PBP ETA berth	Vessel	Harbour Master	VHF	Once at first calling in point VTS area, updates may follow later
Information access to port	ETA PBP	RTA PBP	Harbour Master	Vessel	VHF	Once after first calling in point VTS area, updates may follow later
Vessel notification (II)	ETA PBP ETA berth	ETA PBP ETA berth	Harbour Master	Nautical service providers	HaMIS	Once after administrative clearance, updates may follow later
Information nautical service planning	ETA PBP, ETA Lage Licht ETA berth	-*	Nautical service providers	Nautical service providers	GIDS	Chief pilot makes estimation when vessel is at first calling in point VTS area, updates follow later
Adaptation planning	ETA PBP ETA Lage Licht ETA berth	-*	Nautical service providers	Harbour Master	Phone and GIDS	Dependent on updates about capacity issues nautical service providers.

* The PCO Taskforce does not have defined timestamps related to the nautical service planning.

Since the involved information systems are now explained, a deeper understanding can be obtained about the information flows in the current port call processes. Table 13.2 gives a more detailed overview of the information flows in the port planning phase as shown in Figure 13.6.

***Vessel notification (I)* |** The electronic notification of a vessel's port call is submitted in Portbase by the agent. MSC captains' room usually works 1 à 2 weeks ahead. By checking the MSC berthing plan, the captains' room knows which vessels are expected in the upcoming 1 à 2 weeks.

All mandatory notifications of the vessel are submitted in Portbase which sends the information to the right actor such as the harbour master and customs. It includes visit information, security information (ISPS), crew and passengers, waste et cetera. The relevant part for this thesis is the visit information. The captains' room of MSC must submit information about vessel's previous ports, arrival location, ETA berth, ETA PBP, vessel's draft, cargo and number of crew. The harbour master receives this information in HaMIS from Portbase.

It is compulsory that changes in arrival times greater than 30 minutes are updated. Based on own experiences and experiences of many actors in the chain, arrival times are not adapted frequently by agents. Loodswezen states that the majority of agents only states updates within two hours of arrival at pilot boarding place [redacted]. It does even happen that a pre-announced vessel is still in another port at the time it is expected in Rotterdam according to information in Portbase.

Since MSC submits information relatively early in the process, this information is usually not complete. More information is submitted in Portbase if additional information is obtained from the captain. All required information is usually submitted a few days in advance. If the harbour master has assessed the information obtained in HaMIS, it decides if it gives administrative clearance to the vessel.

***Pre-arrival forms* |** The pre-arrival forms (IMO FAL forms) are sent by the captain to the captains' room by email. Information is delivered about the vessel and cargo on board. It also provides information about the arrival time. However, it is not clear if this is about ETA berth or ETA PBP. The information is usually sent by the captain when the vessel leaves the previous port. The captains' room submits this information in Portbase. The harbour master receives this information via Portbase in their information system (HaMIS).

***Notification VTS & Information access to port* |** The vessel contacts VTS by using its marine VHF radio. Information is exchanged about ETA PBP, ETA berth, vessel's depth and arrival order. VTS submits this information in HaMIS. Based on this information, HCC checks if it can give an operational clearance. If access is granted, VTS communicates via VHF radio at which time the vessel is expected at the pilot boarding place (Maascenter). It also submits the information in HaMIS.

It can happen that VTS must exchange more information with the vessel. VTS updates the vessel with new orders if nautical services are not available at the desired time. It also communicates a new ETA PBP (Maascenter) then. According to the PCO Taskforce standards, VTS should communicate the RTA PBP – requested time of arrival pilot boarding place, if this is the desired time a vessel must arrive at this location.

***Vessel notification (II)* |** All abovementioned information that is visible in HaMIS is also available for the nautical service providers. HaMIS is connected to the planning systems of the nautical service providers. The nautical service providers first receive the information that the agent submits in Portbase via HaMIS. It later receives updates when the harbour master updates the arrival information of a vessel.

***Information nautical service planning* |** The nautical service providers communicate with each other in GIDS. If the agent has chosen the option L.A.B., the chief pilot gives an estimation about the number of tugs needed. This is communicated in GIDS. The final decision is made by the responsible pilot on board. When the pilot is on board, it communicates the exact number of tugs needed and ETA Lage Licht, ETA berth and ATA PBP in GIDS. Boluda and KRVE uses this information for the planning. The nautical service providers give updates about the availability in GIDS. In this system, KRVE is always listed as available since it is always on time and never causes delays.

***Adaptation planning* |** If Loodswezen or Boluda does have capacity problems, HCC or the chief pilot is contacted by phone. A new time slot is proposed at which enough capacity is available. HCC and the chief pilot assess the situation then and find out what the best option is for incoming vessel traffic. The updates are usually given at short notice before the vessel enters the Port of Rotterdam.

13.3.2 Findings in relation to Just-In-Time arrivals and services

In the port planning phase, several things are notified which need to be improved in order to implement Just-In-Time arrivals and services. The PCO Taskforce business process also plays a role in this. This sub-section clarifies the shortcomings of the current port planning phase.

The port planning phase starts with a vessel notification by the agent. As explained, this includes arrival times of the vessel. According to experiences of [redacted] and [redacted] many agents do not update the arrival times frequently. Most updates take place within two hours of arrival at pilot boarding place.

If the port planning must be improved, actors must obtain reliable and updated information in advance. This is especially important if Just-In-Time arrivals and services must be implemented. In this case, information exchange must take place in an earlier stage so that the vessel can adapt speed based on the port planning. It also works the other way around. If nautical service providers obtain earlier reliable arrival times, it can optimize and align their planning.

Another interesting point is related to the processes involved in the operational clearance and contact moment VTS for incoming vessels. According to the PCO Taskforce business process map, ETA PBP is used by the port authority to give the RTA PBP. In simple words, the port authority grants access to the port and gives the vessel an order to be at the pilot boarding place at a specific time. The port authority should base this decision on size and depth restrictions of vessels, specific vessel constraints, berth availability, fairway availability, nautical service providers availability and clearances (Appendix B – PCO Taskforce port call map explanation).

In the Port of Rotterdam, the harbour master has the role of the port authority. It provides information to the vessel about the time it is expected at pilot boarding place. Today, this decision is not based on the availability of nautical service providers. As explained, it may still happen that a vessel has obtained operational clearance but cannot enter the port due to last-minute unavailability of nautical service providers. In this case, the vessel, that still expects to enter the port at a specific time, is contacted again by VTS that it must wait at anchorage.

It is obvious that Just-In-Time arrivals and services requires earlier information exchange. A vessel must be informed earlier in case of unavailability nautical service providers. Moreover, this is essential if the new winds farms are built in the North Sea. Vessels may reroute to anchorage locations further away. In that case, it is crucial that a vessel earlier obtains information about whether it can enter the port or not.

In addition to abovementioned problem, safety may also be increased if the port planning is improved. According to experiences of [redacted], it occasionally happens that vessels get operational clearance but that the fairway is not free due to a priority vessel (LNG vessel or deep-sea vessel). If vessels arrive at the same time of priority vessels, the vessels may experience delays. This, in turn, causes unexpected delays for terminals since these vessels may arrive later at the berth. Therefore, it is important that the harbour master grants access to the port if the fairway and nautical services are available.

The way the nautical service planning currently operates is also interesting. Most service providers use different ways to collect the required information. Since most information is often not reliable, the nautical service providers primarily focus on own experiences. Moreover, the planning is mainly short-term. In case of Just-In-Time arrivals and services, it is important that the vessel gets clearance to enter a port at a specific time in an earlier stage. The vessel must then also know if it can enter the port regarding to the availability of nautical service providers.

Let's start with the pilots of Loodswezen. Loodswezen receives an ETA PBP from the agent and thereafter from VTS. However, it is very difficult to make a proper planning based on this information. As explained, the ETA PBP from the agent is often not up-to-date or updated in a late stage. The ETA PBP from VTS is often reliable. However, this information is only sent approximately one hour before the vessel enters Maascenter (pilot boarding place). Since Loodswezen must transport vessels from home to the vessel, it must know the information at least three hours in advance. Loodswezen tackles this problem by looking four hours ahead by using the 'Havenmeester Havenkaart'. Only problem is that it may happen that a pre-registered container vessel has changed rotation for example. Loodswezen follows the vessel and allocates a pilot. It then becomes clear that the vessel first sails to Bremerhaven for instance. Loodswezen receives this information often too late.

Boluda also uses information obtained from Portbase (via HaMIS). It needs to know ETA Lage Licht of a vessel. This information is obtained via GIDS when the responsible pilot is on board. This is often 20-45 minutes in advance which is also relatively late to make a proper planning. To overcome this problem, Boluda looks two hours ahead via 'Havenmeester Havenkaart'. In this case it estimates when the vessel is at Lage Licht.

In addition, the towage companies encounter another problem in incoming vessels. The L.A.B. option, which is often used by agents, may cause delays in a port call. The 'chief pilot' first makes an estimation about the required number of tugs. Boluda receives this information via GIDS. However, Boluda argues it is difficult to make an appropriate planning with this information since the responsible pilot can still make changes on the number of tugs. Boluda must still wait until the pilot comes on board. This is often 20-45 minutes in advance. At this moment, the responsible pilot communicates the final number of tugs needed.

These planning procedures are very short-term. Boluda would obtain the information earlier, so that it can optimize the planning. It must also be noted that there are, as far as known, no extra compensation is in case of the L.A.B. option. Boluda bears the risk that it causes delays but does not obtain extra benefits for it.

In case of Just-In-Time arrivals and services, the nautical service providers receive the information earlier and can then make their planning earlier. It does not mean that the planning does not change anymore. The involved actors (e.g. vessel, terminals) must still update each other frequently so that changes in the planning can be captured better.

13.4 VESSEL AND CARGO SERVICE PLANNING

Once the vessel arrives at the berth, vessel and cargo services can start. The vessel and cargo service planning is the next step after the port planning. Service providers such as terminals and bunker suppliers are involved in the vessel and cargo service planning. In general, the vessel is planned for a certain time window that cargo operations take place. Other (critical) services are planned in the timespan of the cargo operations. In reality, it may happen that cargo operations are finished before other service providers have completed the job. More information about these issues is discussed in this section.

Figure 13.7 shows the vessel and cargo service planning of MSC container shipping in the Port of Rotterdam. The time span may vary per vessel. Some vessels need up to 10 hours, others need more than 36 hours for vessel and cargo services.

The critical service providers are the type of services that need to be performed before the vessel's departure. This section also discusses the role of a few critical service providers (e.g. bunker barges). Note that terminals are also critical service providers. Since the terminals play a relatively large role in this research, it is chosen to discuss terminals separately. Note that the port planning departure already starts during cargo operations. Therefore, the end point of the chart below is earlier than completion cargo operations.

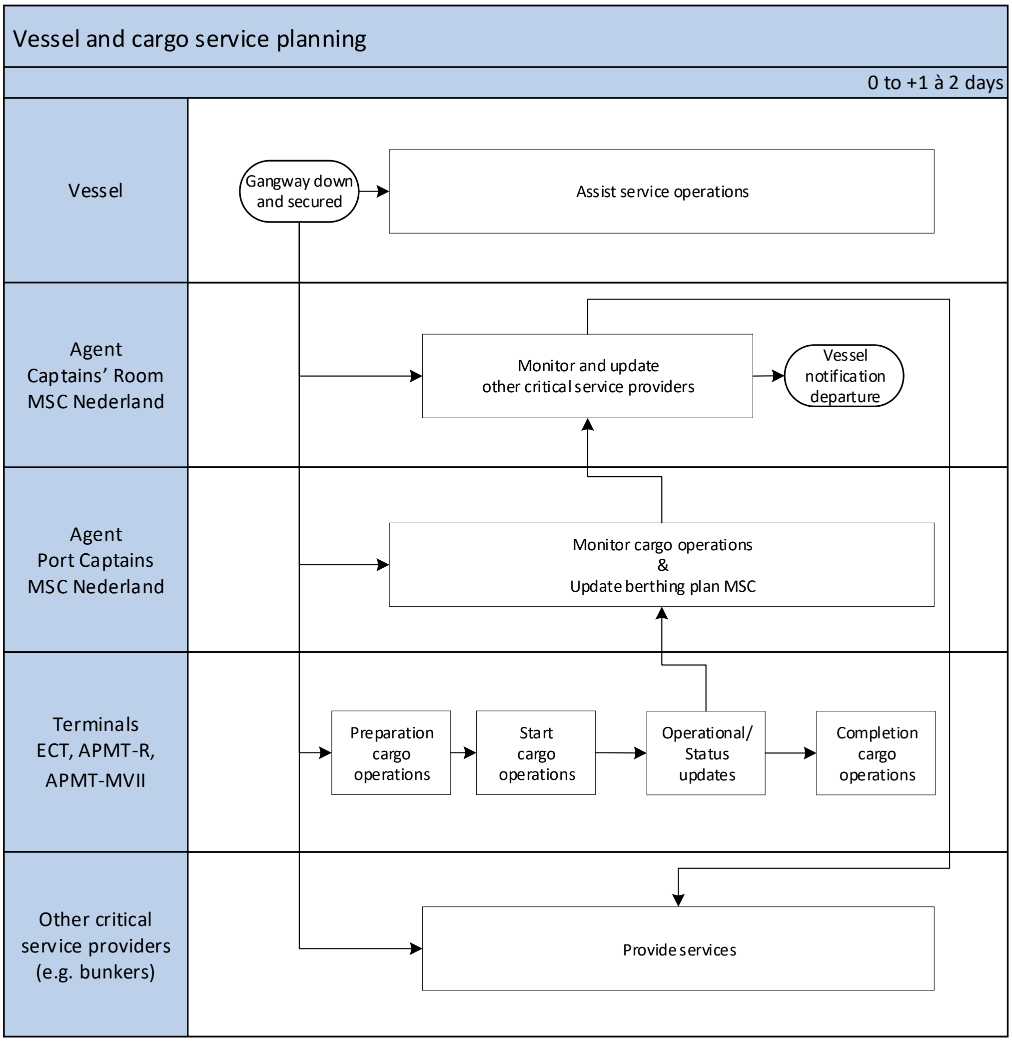

Figure 13.7: Overview of processes involved in vessel and cargo service planning. Source: own figure.

***Gangway down and secured* |** In container transport, cargo operations can only start after the gangway is down and secured. It is the 'start sign' that preparations for cargo operations can begin. Workers of lashing companies can now go on board to perform the activities. The crane operators can also start to bring down the boom of the bridge crane above the ship.

***Preparation cargo operations* |** If the gangway is down and secured, the container terminals get ready for cargo operations. Containers above the hatch covers must be lashed and secured. This is usually performed by external specified parties. Since 2020, new regulation came into force that lashing must be performed by certified dock workers instead of ship's crew for vessels larger than 170 metres (International Transport Workers' Federation, 2020). Terminals usually have agreements with a company to perform lashing and securing services on vessels at the terminal. As explained above, crane operators also get ready to start operations by bringing down the boom of the crane.

***Cargo operations* |** If all preparations are finished, the terminal can start (un)loading containers. The berth and crane productivity (e.g. X moves / hours) are often used to make an estimation when the cargo operations are expected to finish. However, many incidents, which are usually not expected and not planned, can change the expected berth productivity. The Ishakawa diagram (Figure 13.8) shows that there are many causes for a delay in cargo operations. Note that this diagram does not even include all possible causes. It only contains the most common causes, caused by involved actors in the chain. When a delay of cargo operations take place, it is important that involved actors are updated with the required information. A change in completion time of cargo operations must be communicated. This is especially important close to cargo completion since nautical services must then be ordered.

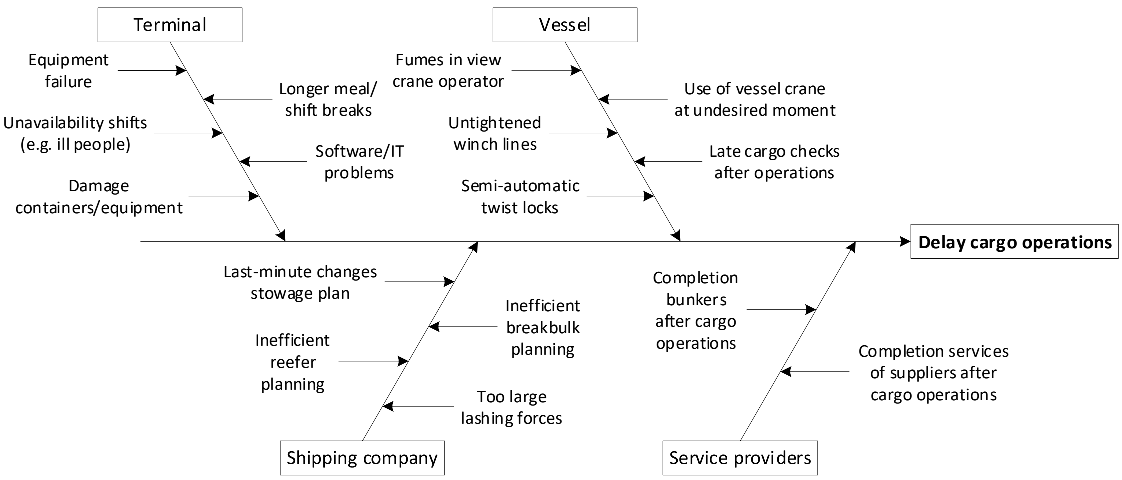

Figure 13.8: Ishakawa diagram that shows causes of delays in cargo operations. Source: own figure.

***Operational/Status updates* |** During cargo operations, terminals update agents about the status of cargo operations. Information about the number of containers that still need to be (un)loaded is given, as well as an estimated time that cargo operations end. In addition to these updates, actors can view the status of terminal operations in PortXchange.

***Monitor cargo operations & update berthing plan MSC* |** The port captains have, among others, the task to optimize the berth capacity. It puts pressure on the terminal to optimize terminal efficiency for MSC operated vessels. This is one of the reasons why the port captains work from an office at the terminal. It checks if enough cranes are operating on vessels, if cranes do not stop operating during work times, if MSC vessels do not get less cranes compared to other vessels et cetera. The port captains try to prevent delays in cargo operations.

It, therefore, uses the operational/status updates to assess if cargo operations are still on schedule. In case of changes (delays or accelerations), it adapts the MSC berthing plan as explained in the short-term berth planning (Section 13.2).

***Monitor and update other critical service providers* |** The captains' room is responsible for vessel services. This includes monitoring bunker barges, ships' stores deliveries, crew changes, waste collection, doctor visits et cetera. Many MSC operated vessels bunker in the Port of Rotterdam. This is mainly due to the bunker prices in the Netherlands. Rotterdam belongs to the top 10 bunkering ports in the world (Maritime Fairtrade, 2019).

Bunker barges are ordered by MEDLOG – the logistic division of MSC Group. The captains' room obtains the information about the bunker barge planning from MEDLOG. The captains' room monitors if the bunker barges and other suppliers provide services within the timespan of cargo operations. The captains' room also updates the suppliers about the timespan a vessel is expected to stay in the Port of Rotterdam. It is important that the captains' room makes sure that all services are provided on time so that possible delays are prevented.

***Provide services* |** Based on the obtained information of MEDLOG and the captains' room, the critical service providers try to provide services within the required timespan. Bunker barges deliver the required bunkers. It occasionally happens that more bunker barges must deliver different types of fuel to the vessel. In addition to bunkers, waste is collected, provisions and other supplies are taken on board, sludge is collected et cetera.

According to employees involved in the terminal operations, it still happens that a vessel has finished cargo operations but cannot leave the terminal quay since bunker barges or other suppliers did not finish their services.

***Assist service operations* |** The vessel is involved in all service operations. Most service providers have agreements with the shipping company. It is important that the vessel contributes to smooth operations in the port. The Ishakawa diagram (Figure 13.9) shows that the vessel can also cause unexpected delays in cargo operations. For example, it is important that winch lines are tightened during the operations. Otherwise, the vessel moves more during cargo operations which makes it more difficult for crane operators to (un)load containers.

***Completion cargo operations – vessel notification departure* |** When the vessel almost completes cargo operations, preparations are made for the vessel's trip to the next port. This is the moment that the port planning departure starts. The port planning departure starts when the agent makes a vessel notification of departure. This is, however, relatively short-term since the estimated time of completion cargo services varies a lot during operations. More information about the effects of variations in cargo completion times is given in the next section (Section 13.5).

13.4.1 Information flows & systems

The information flows and systems, presented in the vessel and cargo service planning phase, are shown below in charts. Figure 13.9 gives information about the information flows between involved actors in this phase. Addition details are thereafter provided in Table 13.3.

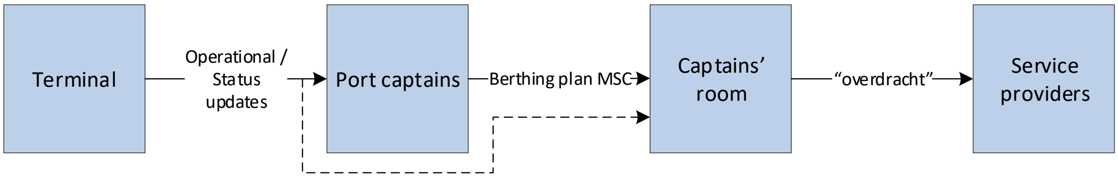

Figure 13.9: Information flows in vessel and cargo service planning phase. Source: own figure.

In short, terminals give updates about the status of cargo operations. The port captains use this information to update their planning (MSC berthing plan). As explained in the short-term berth planning, the captains' room uses the information of the berthing plan. It updates the service providers about the timespan a vessel is at the berth. The service providers are requested to provide services in this timespan in order to avoid vessel delays.

Table 13.3: Information flows in vessel and cargo service planning phase. Source: own table.

Item	Included timestamps	Timestamps PCO Taskforce/JIT	Data sender	Data receiver	Data file	Data sharing method	Frequency
Operational / Status updates	All fast Start Ops Agreed/current /expected ETD	- ATS cargo services PTC cargo services	Terminal	Agent (Port captains & Captains' room MSC)	PDF	E-mail / PortXchange	1 or 2x / shift
Berthing plan MSC	ETA Pilot ETB ETS	ETA PBP, ETA berth (PTA berth) ETC cargo services	Agent - Port captain MSC	Agent - Captains' room MSC	Excel	Intranet MSC	2x / day around 12:00 and 17:00 hrs
"Overdracht" – update service providers	ETA PS ETB ETD	ETA PBP ETA berth (PTA berth) ETD berth	Agent - Captains' room MSC	Service providers	-	E-mail	1x / shift

The information flows discussed in Table 13.3 are discussed per item below. Appendix G.3 shows examples of the shared information between actors. In addition, Table 13.3 includes information about the shared timestamps which play an important role in this research.

***Operational/Status updates* |** During the terminal operations, terminals send updates to the agent about the current status of operations. Each terminal has different formats for sending the information. Examples of operational/status updates are shown in Figure G.9 - Figure G.11 (Appendix G.3). The updates contain information about the number of containers that are already and must still be (un)loaded. It also gives an indication about the estimated time completion of cargo services. This is important for the agent of the next vessel since it must know when the berth is free.

The timestamps used in the operational/status updates do not satisfy the PCO Taskforce requirements. Many actors in the chain use the ETD berth. According to the PCO Taskforce standards, the agent is data owner of this timestamp. The terminal is responsible for a reliable and up-to-date ETC and PTC cargo services.

It is also worth noting that the frequency of data exchange is not the same for each terminal operator. ECT Delta usually sends the operational update twice per shift (once in 4 hours). However, APMT-R and APMT-MVII only sends these updates once per shift (once in 8 hours).

In this phase, PortXchange may also have advantages. The updates of the terminal planning are also shown in PortXchange. In this way, agents can obtain more often updates from APMT-R and APMT-MVII since the planning systems are linked to PortXchange. ECT Delta does only share planning information derived from the own website with PortXchange.

***Berthing plan MSC* |** The berthing plan of MSC is uploaded twice a day on the intranet of MSC. The information in the berthing plan is already discussed in detail in the short-term berth planning phase (13.2). It is, therefore, not explained again in this section.

***Overdracht – update service providers* |** The captains' room has the responsibility that all service providers are completed on time before cargo operations are finished. It sends an email to the service providers ('overdracht') which includes information about required services and the timespan a vessel lays along the terminal quay. The service providers are updated once per shift (once in 8 hours). Figure G.12 (Appendix G.3) shows an example of the shared information. Note that only the larger suppliers receive the 'overdracht'. Other suppliers just receive the berthing plan MSC from the captains' room.

Table 13.3 and Appendix G.3 show that the used timestamps are not similar as the PCO Taskforce timestamps. Especially ETA PS is notable since this is not the same timestamp as used in the berthing plan of MSC. The berthing plan of MSC is often used by the captains' room.

13.4.2 Findings in relation to Just-In-Time arrivals and services

Several things are notified in the vessel and cargo service planning phase. Terminal operations can be delayed by several causes (Figure 13.8). It is obvious that these delays must be avoided. However, it is even more crucial that these changes in cargo completion times are communicated on time to involved actors. Today this type of information is not always exchanged on time. The information is usually available but not shared with involved actors.

APMT-R and APMT-MVII only send operational updates each eight hours. In these eight hours, the estimated time of completion (ETC) terminal can obviously change. Terminal operators must frequently communicate delays to the agent. In case of a delay, it is important that MSC obtains the information on time so that it can adapt the planning. If the next MSC vessel is planned on the same quay as its predecessor, it can slow down speed if the predecessor experiences a delay.

The same applies to the agent which has the task to update the service providers frequently. The captains' room sends updates to the service providers only each eight hours. It is also important that the service providers are informed about changes in ETC terminal. For instance, a service provider must know if cargo services are earlier ready than expected. If it does not obtain this information, it may cause a delay since it must still provide services.

The benefits of an application as PortXchange are already visible. Some terminal operators have connected the planning systems to PortXchange. In this way, agents can more often obtain updates and adapt their planning. If service providers also use PortXchange, it can also receive more updates. It must, however, be noted that the accuracy and reliability of shared information in PortXchange is essential. Terminals must frequently update their own planning systems, so that significant delays do not come out of nowhere.

Another interesting point is related to the pro-activeness of involved actors. In order to give the next vessel accurate information about the arrival time, it is important that the departure time of the previous vessel gets more reliable. It must, therefore, give more often updates about the current status of cargo operations. However, a terminal cannot plan delays caused by other actors. According to many actors in the chain, it occasionally happens that cargo operations are completed but that the vessel cannot leave the port due to other critical services (e.g. bunkers, packages). It is crucial that the agent makes sure that service providers finish services on time. It must, therefore, communicate frequently with these service providers. If the agent then still experiences delays with e.g. bunker barges, it can update the other involved actors in advance because it knows that a delay will take place. Today, the delays are often identified when it already takes place. At this point, it is not possible for other actors to change the planning since these actors did not get the information in advance.

In relation to abovementioned points, the same applies for the ship's crew. As visible in the Ishakawa diagram (Figure 13.8), the vessel may also cause delays in cargo operations. The shipping company must make sure that its crew works in a way that it avoids delays. If delays are still expected, it must be communicated in advance. Note that not all delays caused by the ship are caused by the crew. For example, crane operators are hindered by fumes from the vessel. This is something that may be improved by a different vessel design.

In addition, it is important that actors understand the exchanged information. Misunderstandings about shared timestamps must be avoided. It is, therefore, important that all actors use the same timestamps. Table 13.3 shows that several actors use different timestamps to indicate the same thing. As already explained, PCO Taskforce has developed a port call business process to establish correct standards. Abovementioned problem must be solved by using these standards. The port call business process map (Figure 4.2) states which exact timestamps must be used in each situation. The work of PCO Taskforce is based on years of industry experience and scientific research.

It is also worth noting that the berthing plan of MSC is already discussed in detail in the short-term berth planning (sub-section 13.2.2). Recommendations related to the berthing plan of MSC are, therefore, not discussed again in this section.

13.5 PORT PLANNING DEPARTURE

When the final part of cargo operations is reached, the agent starts planning the vessel's departure. The port planning departure is, in fact, the next step after the vessel and cargo service planning. Since the vessel notification of departure takes place in an early stage during cargo operations, there may be some overlap in the cargo and service planning phase and port planning departure phase. Due to the complexity of the cross-functional flowcharts, it is chosen to map and explain both phases separately.

The port planning departure shows similarities with the port planning arrival (Section 13.3). However, there are differences visible in the port planning of outbound voyage compared to inbound voyage. The main difference is related to the order process of nautical services.

Figure 13.10 shows the port planning departure processes of MSC container shipping in the Port of Rotterdam. Most processes take place relatively short before cargo operations finish. Many actors are involved in the port planning departure such as nautical service providers and harbour master. The contribution of each actor is explained in this section. It must be noted that the terminal is only involved in these processes since it notifies the agent that it can order nautical services. Other operations of terminals are already explained in the previous sections.

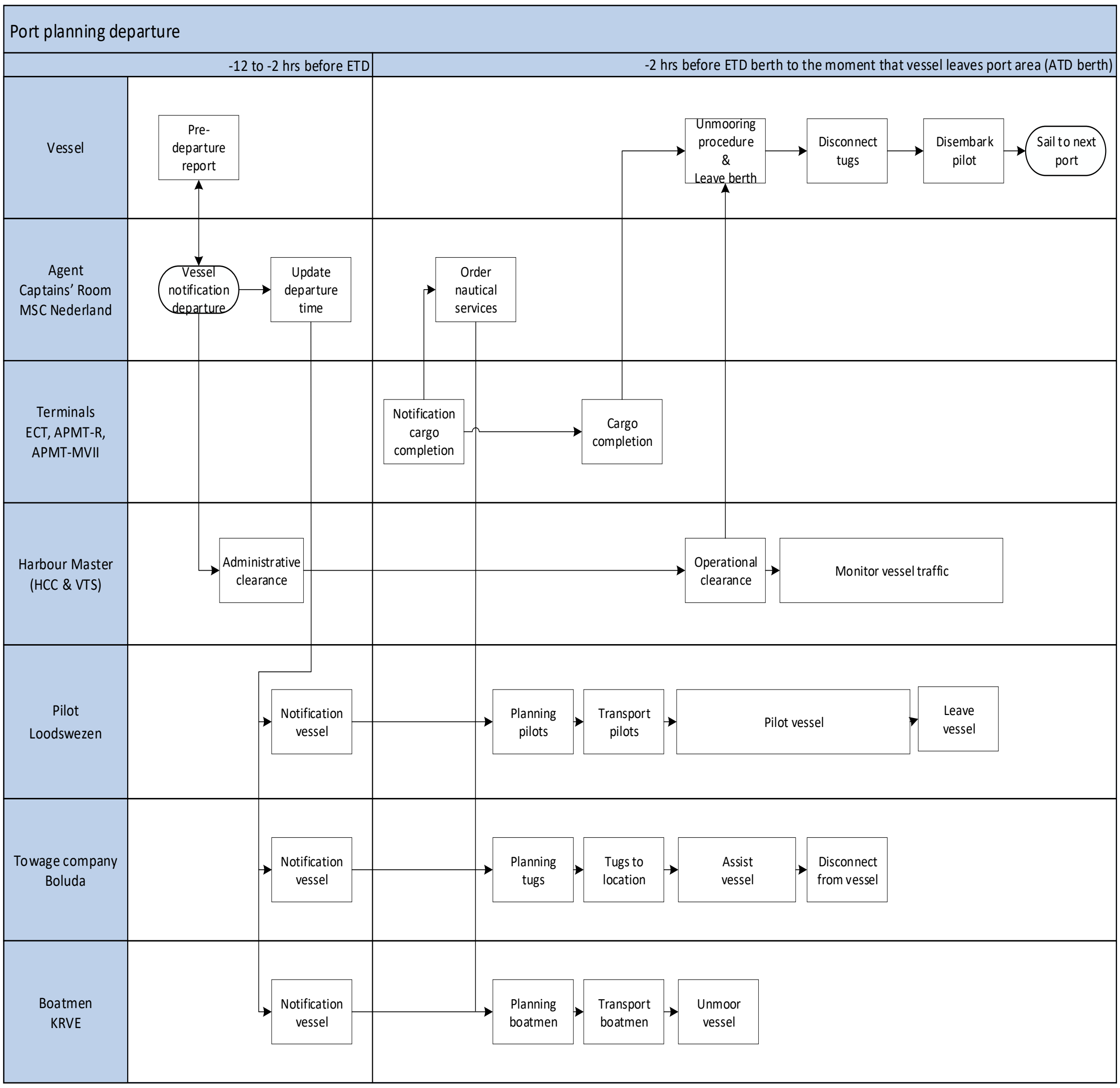

Figure 13.10: Overview of processes involved in port planning departure. Source: own figure.

***Vessel notification departure and update departure time* |** The port planning departure starts when the agent registers the vessel departure information. The agent specifies the estimated time of departure, but also indicates if the vessel requires pilots, tugs and boatmen. Most information is already registered when the vessel entered the Port of Rotterdam.

Agents must submit the notification of departure at least 6 hours before departure. If a vessel needs assistance of pilots or tugs, it must provide the information 12 hours before departure. It is compulsory that changes in departure times greater than 30 minutes are updated by the agent (Port of Rotterdam, 2020e).

The required information in the notification of departure for MSC operated vessels are submitted by the captains' room of MSC. Most MSC operated vessels need assistance of the nautical service providers. In the Port of Rotterdam, the agent must also submit the required number of tugboats. The same options are available as for incoming vessels:

- Specification of the exact number of tugboats required (e.g. 1, 2, 3).
- L.A.B. (Loods Aantal Boten) option which means the responsible pilot determines the required number of tugs in the operation.

In contrast to incoming vessels, the captains' room of MSC usually submits the exact number of required tugboats. The estimation of the captain is often similar to the requirements of the pilot for outbound voyages. Therefore, the captains' room uses the knowledge of the captain to determine the required number of tugboats.

***Pre-departure report* |** The captain delivers the required information that the agent needs to make the departure notification in Portbase. The captains' room has the responsibility to obtain this information on time.

***Administrative clearance* |** The harbour master assesses the departure notification submitted by the agent. Feedback is given to the agent when the provided information is incomplete or incorrect.

***Notification vessel* |** The vessel's notification of departure is also sent to the nautical service providers. When the agent updates the departure times, this is also visible for the nautical service providers. The nautical service providers can use this information to make a pre-planning.

***Notification cargo completion* |** The terminal communicates the estimated time cargo completion to the agent at least 2 hours before departure. The agent uses this information to order nautical services.

***Order nautical services* |** In the Port of Rotterdam, a distinction is made between a notification and order. As explained, the agent makes a vessel notification 12 hours before departure. The next step is, shortly before cargo completion, that the nautical service providers are officially 'ordered'. It means that the agent orders nautical services for a specific departure time. After this point, contractual agreements come into force with the nautical service providers.

The agent must order nautical services at least 2 hours before departure. Subsequently, the nautical service providers must make clear if enough capacity is available to assist the vessel at the required time. This must be done at least 1.5 hours before the vessel's departure.

The agent has the possibility to communicate a new departure time or to cancel the nautical services free of charge. However, this procedure only applies when it is communicated at least

1.5 hours before departure. If the agent makes changes to the order within 1.5 hours of departure, it must pay waiting or cancellation costs.

It is important to note that there is a relatively large difference in the amount of waiting and cancellation costs. The fixed cancellation costs are, especially for shorter waiting times, larger than the variable waiting costs. Both types of costs differ per nautical service provider.

Cancellation costs of Loodswezen are €340 and €186 for incoming and outgoing voyages respectively. Waiting costs are shown in Appendix E.1. The first half an hour, that a pilot must wait, is free of charge. The next hour costs €50, and after this each extra hour of delay costs approximately €100 extra.

Boluda has different contracts per client. The standard contracts are already discussed and shown in Appendix E.2. It is visible that the first half an hour, that tugs are waiting, are free of charge. After this moment, a certain tariff applies dependent on the size of the vessel.

The waiting and cancellation costs for KRVE are given in Appendix E.3. The first 30 minutes waiting time is free of charge. Each additional waiting hour costs the same as the cancellation costs.

Although the waiting and cancellation costs are different per vessel size and contract, it is visible that, especially for larger vessels, waiting costs do not outweigh the cancellation costs. The first half an hour of waiting time is for all providers free of charge. For shorter waiting times (<2 hours), it is usually cheaper to pay waiting costs than cancellation costs. Consequently, agents may prefer waiting costs to cancellation costs. It means that if it is known that the terminal has a delay of one hour, the agent may not update the departure time due to abovementioned financial reasons.

***Planning nautical service providers* |** As explained above, the order processes of nautical services differ for outgoing vessels compared to incoming vessels. The main difference is the 'official' order moment that the nautical service providers receive from the agent. This is important for the nautical service providers since this order moment is a contractual agreement between the nautical service providers and agent.

The nautical service providers receive the departure time of a vessel at least 2 hours in advance. It makes the planning and confirms or rejects the departure time of the vessel. If it has not enough capacity, it proposes a new time that it is available.

The pilots of Loodswezen already determine in advance which pilot specialisation is required for the particular vessel. This also applies for the boatmen of KRVE. Boluda knows which bollard pull is required for a certain vessel. However, if the agent chooses the L.A.B. option, it is not directly clear how many tugs are required for the operation.

As explained, this is a bottleneck in the inbound voyage of vessels (Section 13.3). According to experiences of Boluda employees, the outbound voyage is generally not an issue. In case of the L.A.B. option, the chief pilot makes an estimation about the required number of tugs. This estimation is nearly always reliable, since the number of tugs is often the same for the inbound and outbound voyage. Therefore, Boluda generally does not experience planning problems caused by the L.A.B. options in outbound voyages.

***Transport nautical service providers* |** The transport of the nautical service providers is different for each provider. Loodswezen, Boluda and KRVE takes the transport of the employees and equipment into account when planning. An interesting note is that KRVE is responsible of the transport of pilots for outgoing vessels. Pilots are transported from home by taxi. Since KRVE is responsible for their transport, it can make a tight planning since it knows exactly when the pilot would arrive at the vessel.

Cargo completion **|** When the vessel has (un)loaded the containers, and lashing and securing has finished, the vessel is ready to leave the port. As already noted, lashing and securing is usually performed by an external company that has an agreement with the terminal operator.

Operational clearance **|** When the pilot is on board of the vessel, it comes in contact with the harbour master. The harbour master checks if the fairway is available. If everything is all right, the vessel gets operational clearance to leave the port.

Operational execution of outbound voyage **|** A short explanation about the operational execution of an outbound voyage is given in this part. An extensive description of these processes is already given in Section 8.4.3.

After having obtained operational clearance, the vessel can start the unmooring procedure with assistance of the boatmen. The pilot manoeuvres the vessel through the port by using the assistance of the tugs. The tugs disconnect from the vessel when the vessel reaches the point that it does not longer need tug assistance. The pilot communicates multiple times with VTS during the outbound voyage. VTS monitors the vessel traffic in the Port of Rotterdam area. If the vessel reaches the pilot boarding place, the pilot is disembarked. Subsequently, the vessel continues its way to the next port.

Sail to next port **|** The port call of the vessel is finished. The vessel sails to the next port and prepares itself for the next port call.

13.5.1 Information flows & systems

The information flows and systems involved in the port planning departure phase are given below in charts. Figure 13.11 gives information about the information flows between involved actors in this phase. The information systems used by each actor are also included. Subsequently, more details about the information flows is provided in Table 13.4. In order to get a better understanding of the provided information, this section starts with a short introduction in which the information is summarized.

The port planning departure starts when the captains' room submits the required departure information in Portbase at least 12 hours in advance. The harbour master assesses the obtained information of HaMIS. If it is correct, the information is also sent to the nautical service providers. The captains' room updates the departure information by using PortXchange which shows the estimated completion time of cargo operations.

Close before cargo completion, the terminal informs the agent that it can order nautical services. The captains' room of MSC then contacts the vessel to obtain the required information such as number of needed tugboats. Subsequently, the captains' room orders the nautical services in Portbase. This must be performed at least 2 hours before vessel's departure. The information in Portbase flows via the information system of the harbour master (HaMIS) to the planning systems of the nautical service providers. The nautical service providers communicate in GIDS to align their planning. It confirms or rejects the proposed order time in GIDS. This information goes back to the agent via HaMIS in Portbase. If cargo operations are finished and the vessel is ready to depart, the pilot communicates via VHF with the harbour master. If the fairway is available, the harbour master gives permission to depart.

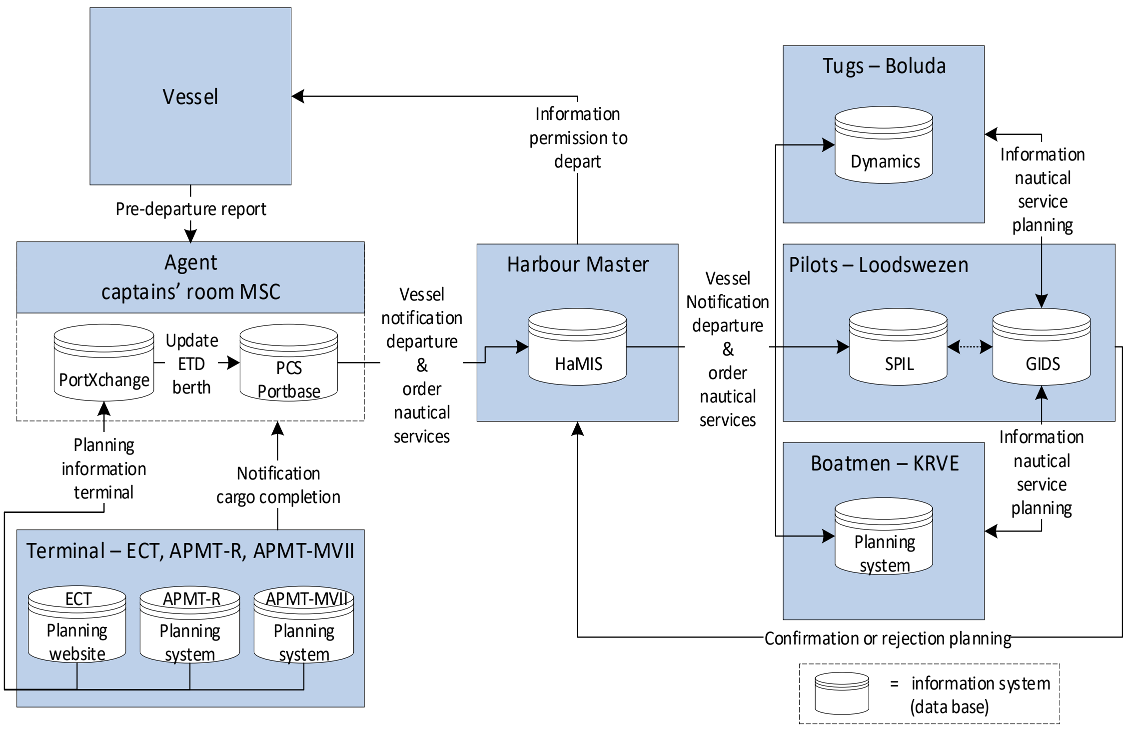

Figure 13.11: Information flows and systems involved in port planning departure phase. Source: own figure.

Figure 13.11 shows similarities with the port planning arrival phase (Figure 13.6). However, it is visible that even more systems are involved in the port planning departure phase. Most systems are connected to each other. If arrows start and end in an information system, it means that the systems are directly connected. If an arrow starts or ends at an actor, it means that the actor processes information manually in the information system.

Most information systems are already clarified in the section about the port planning arrival (Section 13.3). Therefore, this section only introduces the systems which are not yet discussed. Note also that the information flows between agent and terminal only show items involved in the port planning departure phase. As explained in previous section, both actors exchange more information during cargo operations.

***PortXchange* |** PortXchange is a shared digital platform in which actors exchange information related to port calls. The aim of the application is to improve event data in a port. It consists of a common platform provided for shipping companies and their agents, service providers (terminals, bunkers, pilots etc.) and the port authority. It can be used to enhance the planning and coordination of port call activities (Portstrategy, 2019). The involved actors can give updates in PortXchange about the status of the activities. PortXchange displays the information in a time schedule for each vessel and berth.

***Planning systems terminals* |** Each terminal uses its own system to make a planning. Examples of berth plans are discussed in Section 13.2 and are shown in Appendix G.2. It is important to note that some terminals have connected the planning systems to PortXchange. This means that if a vessel planner adapts the planning in the terminal planning system, the changes are also shown in PortXchange. APMT-R and APMT-MVII have such a link with PortXchange. In PortXchange, this data is refreshed each 15 minutes. ECT Delta terminal does not have a direct link between their planning system and PortXchange. PortXchange can only scrape planning information from the ECT website.

Table 13.4: Information flows in the port planning departure phase. Source: own table.

Item	Included relevant timestamps	Timestamps PCO Taskforce/JIT	Data sender	Data receiver	Data sharing method / information system	Frequency
Vessel notification departure	ETD berth	ETD berth	Agent - MSC captains' room	Nautical service providers (via harbour master)	Portbase & HaMIS	Once after administrative clearance, updates may follow later
Planning information terminal	ETC cargo	ETC cargo services	Terminal - ECT, APMT-R, APMT-MVII	PortXchange users – MSC captains' room	PortXchange	ECT – depends on updates website APM – update each 15 min
Pre-departure report	-	-	Vessel	Agent - MSC captains' room	Phone	Once or a few times before cargo completion
Notification cargo completion	ETD berth	ETC cargo services	Terminal - ECT, APMT-R, APMT-MVII	Agent – MSC captains' room	Phone	Once – at least 2 hours before completion cargo operations
Order nautical services	ETD berth	ETD berth	Agent - MSC captains' room	Nautical service providers (via harbour master)	Portbase & HaMIS	Once – at least 2 hours before completion cargo operation terminal
Update ETD berth	ETD berth	ETD berth	Agent - MSC captains' room	Nautical service providers & harbour master	PortXchange, Portbase, HaMIS	Dependent on updates and pro-activeness agent and terminal
Information nautical service planning	ETD berth,	-*	Nautical service providers	Nautical service providers	GIDS	Dependent on updates about capacity issues nautical service providers
Confirmation / rejection planning	ETD berth	-*	Nautical service providers	Harbour master	Phone and GIDS	Once – feedback must be given at least 1.5 hours before vessel's departure
Information permission to depart	-	RTD berth	Harbour master	Vessel	VHF	Once – when the vessel is ready to leave from the berth

* The PCO Taskforce does not have defined timestamps related to the nautical service planning.

By using the knowledge of the information systems, a deeper understanding can now be obtained from the information flows in the port planning departure phase. Table 13.4 gives a more detailed overview of the information flows in this phase.

***Vessel notification departure* |** The notification of a vessel's departure is submitted in Portbase by the agent at least 12 hours before vessel's departure. Most relevant information is already submitted in the port planning arrival phase. For the vessel's departure, it is required that information is submitted such as vessel's draft, number of crew, ETD berth, nautical services. Changes in ETD berth greater than 30 minutes must be adapted by the agent. Portbase is connected to HaMIS. In this way, the harbour master can assess the information provided by the agent in Portbase.

***Planning information terminal* |** The way the terminals share their planning is already discussed in both the short-term berth planning (Section 13.2) and vessel and cargo service planning (Section 13.4). However, it must be noted that the captains' room uses this information to determine and update the ETD berth. Terminal planning information is visible in PortXchange. Since PortXchange is linked to Portbase, the systems give a notification if the cargo completion time in PortXchange is not the same as the departure time in Portbase. In case of changes, the captains' room checks if the information in PortXchange is reliable. It occasionally happens that information in PortXchange is not updated. If the information is considered to be correct, the captains' room updates the departure time in the systems.

***Pre-departure report* |** The captains' room often contacts the vessel to obtain the required information for the vessel's departure notification in Portbase. The captain informs the captains' room about the number of tugs needed. Information is shared by phone.

***Notification cargo completion* |** At least 2 hours before vessel's departure, the terminal communicates the estimated time of completion to the captains' room by phone. The terminal informs the agent that it can order nautical services for a specific time. In fact, the terminal often uses ETD berth as timestamp in the communication. However, the vessel or agent is data owner of ETD berth according to the PCO Taskforce port call map. To avoid miscommunication between actors, the terminal should use ETC cargo services instead of ETD berth.

***Order nautical services and update ETD berth* |** After the agent has received the call from the terminal, it orders the nautical service providers in Portbase. The most important timestamp is the ETD berth. This information is sent via Portbase to HaMIS. Subsequently, the nautical service providers receive the information in their planning systems. If the agent updates the ETD berth, the information is again received by the nautical service providers via HaMIS.

***Information nautical service planning* |** The nautical service providers communicate with each other in GIDS. If the agent has chosen the option L.A.B., the chief pilot gives an estimation about number of tugs needed. This is also communicated in GIDS. Boluda uses this information to align the planning. The nautical service providers give updates about the availability in GIDS. In GIDS, KRVE is always listed as available since it is always on time and never causes delays.

***Confirmation / rejection planning* |** In contrast to the inbound voyage, nautical service providers can give feedback to the agent electronically. It confirms or rejects the ETD berth proposed by the agent. Nautical service providers enter this information in GIDS. The agent receives the information via HaMIS in Portbase.

***Information permission to depart* |** The harbour master informs the pilot on board if it gets permission to leave the berth. The information is exchanged by VHF radio.

13.5.2 Findings in relation to Just-In-Time arrivals and services

In the port planning departure phase, several things are notified which have a relation to the Just-In-Time arrivals and services initiative and PCO Taskforce. In order to implement Just-In-Time arrivals and services, certain processes need to be changed.

As explained in the last section, the estimated time completion cargo services is essential for the planning of other actors. Agents use the information to determine vessel's departure time. It can also inform the next incoming vessel about the berthing prospects. In addition, the departure time is of great importance for the planning of nautical services. Agents are required to update changes in departure times greater than 30 minutes. It is, therefore, important that the ETC cargo services is frequently updated. Terminals must provide real-time information so that other actors can align the planning to the terminal's completion time of cargo. Thus, terminals must share this information and agents must be pro-active to obtain the information.

Based on the ETC cargo services, the agent decides when a vessel can depart. Most important timestamp for nautical services is ETD berth which is the order time. Contractual agreements related to waiting and cancellation costs are based on ETD berth. It is obviously clear that it is important that the terminal frequently informs the agent. However, even if the agent has been informed, it may choose to not update ETD berth in Portbase due to financial consequences.

This is mainly caused by the amount of waiting and cancellation costs of nautical service providers. Today the agent orders nautical services at least 2 hours before vessel's departure. It can update the departure time free of charge until 1.5 hours before vessel's departure. After this moment, the agent cannot give new updates in Portbase. It is only possible to change the ETD berth when the 'current order' is cancelled and a 'new order' is made. However, agents are subject to relatively high cancellation costs.

The captains' room, therefore, does not often cancel the nautical services order because waiting costs are often lower than cancellation costs. For shorter waiting times (<2 hours), it is generally cheaper to pay waiting costs than cancellation costs.

Let's illustrate this with an example. The captains' room has ordered nautical services for 14:00 hrs. At 13:00 hrs, it obtains information from the terminal that the cargo completion time has changed to 15:00 hrs. It means that the vessel's departure time is delayed from 14:00 to 15:00 hrs. Since the captains' room has obtained this information only one hour before the vessel was planned to depart, it cannot adapt the ETD berth in Portbase without paying cancellation costs. Waiting time costs of nautical services are lower for one hour than cancellation costs. Therefore, the captains' room does not cancel the order in Portbase.

Consequently, the pilots, tugs and boatmen are present at 14:00 hrs. These persons are not aware of the delay and expect to start assisting the vessel at 14:00. However, a delay is experienced of one hour. This also effects the activities that comes next. Due to the uncommunicated delay of one hour, Boluda cannot be on time for the next job. A next incoming vessel was expected at 15:00 hrs. This vessel also experiences delays since Boluda must deal with delays of the outgoing vessel. It cannot be on time to assist the incoming vessel.

Abovementioned situation is just an example of a situation that may be caused by financial procedures. However, it is also important to realize that a port call consists of a chain of several actors. If one experiences delays, this has consequences for the next actors in the chain. Most important in this case is that delays are communicated in advance. Otherwise, a snowball effect can exist. If one actor does not update the 'next' actor in the chain, accumulating delays may take place. If the terminal causes a delay and does not communicate this, nautical services cannot adapt the planning. In this way, Boluda may be too late for the incoming vessel. This vessel then also experiences delays and arrives later than expected. As a next step, the terminal also experiences delays since the incoming vessel arrives later than planned.

It is obviously difficult to avoid delays. However, if everyone communicates this information on time, each actor may adapt the planning. In this way, Boluda could be still on time for the incoming vessel which is then also on time at the destination.

In addition, it is also important that no miscommunication exists due to the use of the 'same' timestamp. It is, therefore, advised to apply the timestamps of PCO Taskforce. Years of industry experience and scientific research has contributed to the design of the PCO Taskforce port call map including its standards. These standards are considered as pre-requisite for the Just-In-Time arrivals and services initiative by IMO GIA (IMO GIA, 2019b).

Today the terminal often communicates the ETD berth. However, as shown in Figure 4.2, the terminal is not data owner of this timestamp. It should use ETC cargo services since it is responsible for cargo operations and not for the vessel's departure of the berth. It is crucial that each actor shares the right information according to PCO Taskforce standards. If actors use the same timestamp, it means the information is not owned by one party. Each party must be responsible for their own services and must, therefore, use their own timestamp so that confusion and miscommunication about the same timestamp does not occur.

14 QUANTITATIVE ANALYSIS

The knowledge obtained in the qualitative analysis is used to interpret the quantitative analysis. Without knowledge of the port call processes (Chapter 12 and 13) it is nearly impossible to understand the data. In addition, the quantitative research is primarily based on the qualitative analysis. Research is conducted to confirm or reject several findings of the qualitative analysis. This chapter elaborates on the quantitative research. Figure 14.1 displays an overview of the sections.

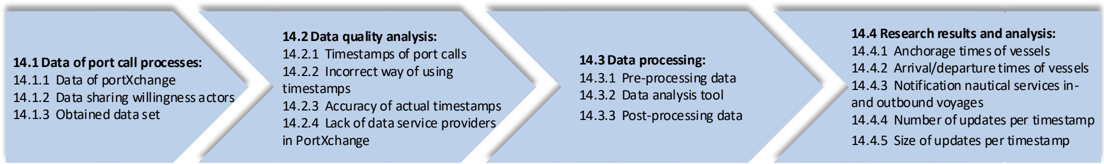

Figure 14.1: Overview of the sections in the quantitative analysis. Source: own figure.

The quantitative research starts with collecting port call data. After approval is obtained of several actors, a large data set is received from the PortXchange application. The data set includes data from the information systems of involved actors. Details about the obtained data and the willingness of actors to share data is discussed in Section 14.1.

In order to check if the data is reliable enough for drawing conclusions about the port calls, a data quality analysis is first conducted (Section 14.2). This part is an important step in the quantitative research because the current business process of port calls is researched by means of the obtained data.

Subsequently, the data is processed so that the data becomes information. In this stage, the timestamps in the data set are converted into valuable port call information. Section 14.3 shows the details of the data processing.

This section also includes information about the developed data analysis tool which consists of several (performance) indicators. The indicators are used to assess the current port call business process and to conduct measurements on the information systems. The planning of actors can also be researched. In addition, the results of the indicators can be used as input for the new business process – Just-In-Time arrivals and services. As last, the potential of the new business process can be determined by the indicators.

The research results of the indicators are widely discussed and analysed in the last section of this chapter (Section 14.4). The results are separately discussed for each indicator in order to get a clear overview of the obtained information.

14.1 Data of port call processes

The first step in this research part is collecting relevant data. It is chosen to perform the quantitative research by using data from PortXchange (Section 14.1.1). In order to use this data for research, approval was required of the involved actors (Section 14.1.2). After having obtained approval, a large data set is obtained. Details about this data follow in Section 14.1.3.

14.1.1 Data of PortXchange

The quantitative research started with obtaining relevant data. This research is performed by data of the PortXchange application, which is set up as part of the Pronto project of PCO Taskforce. The PortXchange application contains a lot of data about timestamps used in port calls. In addition, it captures data of MSC and other actors in the chain. Several information systems of other actors, such as HaMIS, GIDS and Portbase, are connected to PortXchange.

Moreover, PortXchange is a platform that wants to enable Just-In-Time arrivals and services. The shared digital platform originates from PCO Taskforce standards. By doing quantitative research with data from PortXchange, it will become clear if PortXchange still follows these standards. It can be found to what extent the application is ready for the Just-In-Time initiative.

In addition, the actor's view on data sharing can be captured by doing research with PortXchange data. Just-In-Time arrivals and services requires frequent data exchange between involved actors in a port call. Today, data sharing is still an issue in the industry. Most actors in container shipping in the Port of Rotterdam share data with PortXchange. However, not all actors were willing to share this data with MSC for this research.

As explained, PortXchange obtains data from many actors in the chain. In order to use this data for this research, approval was asked of the involved stakeholders during the interviews. In fact, this can also be considered as part of the research. It is important to find out whether involved actors are willing to share data or not. Note that most incentives of actors are already discussed in the actor-stakeholder analysis (Appendix C).

14.1.2 Data sharing willingness actors

Data of PortXchange is used to perform the quantitative analysis. PortXchange is a shared platform in which actors share data with each other. Table 14.1 shows which actors are involved in PortXchange. In addition, it presents which actors were willing to share data via PortXchange with MSC for this research.

Table 14.1: Involved actors in PortXchange. Source: own table.

Actors	Share data with PortXchange	Information system linked to PortXchange	Make use of PortXchange	Share data via PortXchange for this research
MSC Nederland	Yes	Portbase	Yes	Yes
ECT (DDN)	Yes	ECT website	Yes / <u>No</u>	Yes
APMT-R	Yes	Navis - planning system	Yes	<u>No</u>
APMT-MVII	Yes	Navis - planning system	Yes	<u>No</u>
Loodswezen	Yes	GIDS	<u>No</u>	Yes
Boluda	<u>No</u>	-	<u>No</u>	-
KRVE	Yes	GIDS	<u>No</u>	Yes
Harbour Master	Yes	HaMIS	<u>No</u>	Yes

In the Port of Rotterdam, most actors involved in container shipping of MSC deliver data to PortXchange. The following actors share data with the application: 80-90% of container deep-sea carriers, all deep-sea container terminals, agents, pilots, boatmen and harbour master.

Boluda does not share data. Data sharing is considered as a sensitive topic since towage companies do not have a monopolistic position. In addition, towage companies do not see the added value for them. It only obtains benefits if most parties are involved in PortXchange. The container sector is not enough since it must consider all clients in the planning.

Although most actors share data with PortXchange, it is visible in Table 14.1 that these actors do not always use PortXchange. As explained in the actor-stakeholder analysis (Chapter 10 and Appendix C), nautical service providers and the harbour master do not (yet) see the benefits of the application since it must consider all shipping sectors in the planning. Shipping companies in other sectors as dry and liquid bulk are also clients of the nautical service providers. If these sectors do not share data earlier in advance, the nautical service providers cannot guarantee earlier to container vessels that it has enough capacity at the desired time slot.

For this research, approval is asked to get data of MSC operated vessels, which is already shared with PortXchange. Loodswezen, KRVE and the harbour master approved that PortXchange shares data with MSC for this research. Terminal data is only approved by ECT Delta terminal. Due to the partnership of ECT and MSC, ECT was willing to provide data about MSC operated vessels to MSC. Conversely, APM Terminals is the only stakeholder that was not willing to share any data to MSC. Since more than 80% of MSC operated vessels (un)load cargo at the ECT Delta in the Port of Rotterdam, the research can still give very reasonable outcomes.

14.1.3 Obtained data set

After having obtained approval of the involved actors, PortXchange was willing to deliver a data set to MSC for this research. Available data is obtained about MSC operated vessels in the Port of Rotterdam within the time period of 2017-2020. Data of the year 2020 continues until the beginning of July 2020. In total, 236 309 events are included in the data set.

As shown in Table 14.1, data is obtained via PortXchange from Portbase, ECT website, GIDS and HaMIS. In addition, PortXchange is able to deliver AIS data since it collects this data in its application. It is, however, worth noting that AIS data is relatively less useful for this research. AIS data only contains data about actual timestamps. Data from Portbase, ECT website, GIDS and HaMIS often contains data about both estimated and actual timestamps. A timestamp is a combination of a time and location event such as ETA PBP and ATD berth (Section 4.1).

The data contains a lot of information per event. Each event includes, among others, information about UCRN, source, event type, event time, location name. Table 14.2 includes a description and examples of the most important information labels. An overview of all event types in the data set is shown in Appendix H. It shows that a large number of timestamps from several sources is obtained. It is, therefore, essential that the most accurate timestamps are used in the analysis. Section 14.2 elaborates on the data quality analysis of the obtained data.

Table 14.2: Most important information labels of an event. Source: own table.

Event label	Description	Examples
UCRN	Unique call reference number for the port call of a vessel	NLRTM19517269
Source	The source of the event	Portbase, HaMIS, GIDS, ECT Terminal, AIS
Event type	The timestamp of an event including its owner	ETA berth agent
Event time	The time that an event takes place (or will take place)	04-12-2018 12:03:33
Record time	The time that event information is shared	04-12-2018 12:03:33
Location name	The location at which the event takes place	Maascenter, ECT DDN etc.
Location type	The type of the event's location	berth, pilot boarding place

14.2 DATA QUALITY ANALYSIS

Before the data analysis is conducted, the quality of the obtained data set is researched. A data quality analysis is required to investigate if the data is reliable to draw conclusions from in the data analysis. The data quality analysis is an important step in the quantitative research since the current business processes of a port call are researched by means of the data set.

This section elaborates on the quality of the obtained data set. It starts with information about the required timestamps in a port call (Section 14.2.1). Subsequently, it elaborates on the shortcomings in the data set (Section 14.2.2 - 14.2.4).

14.2.1 Timestamps of port calls

As explained in Chapter 4, the use of specific timestamps is essential to enable Just-In-Time arrivals and services. Table 14.3 gives an overview of the required timestamps in a port call. The required timestamps are compared with the timestamps in the obtained data set of PortXchange. This data set contains timestamps which are currently used by actors. By comparing these timestamps with the required timestamps (Table 14.3) conclusions can be drawn about the use of timestamps by actors:

- Actors do not use all required timestamps and, therefore, use a number of timestamps incorrectly (Section 14.2.2).
- Some actual timestamps are more accurate from other sources (Section 14.2.3).
- Some actors do not share timestamps about their activities (Section 14.2.4).

Table 14.3: Required timestamps in a port call process according to PCO Taskforce. Source: own table.

Planning phase	Event type	Event location	Event owner
Berth planning	ETA	Berth	Captain (via agent)
	RTA	Berth	Berth operator (terminal)
	PTA	Berth	Captain (via agent)
	ATA	Berth	Captain (via agent)
Port planning arrival	ETA	PBP	Captain (via agent)
	RTA	PBP	Port authority
	PTA	PBP	Captain (via agent)
	ATA	PBP	Captain (via agent)
Vessel and cargo service planning	ETS	Service	Service provider (e.g. terminal, bunkers)
	RTS	Service	Captain (via agent)
	PTS	Service	Service provider (e.g. terminal, suppliers)
	ATS	Service	Service provider (e.g. terminal, suppliers)
	ETC	Service	Service provider (e.g. terminal, suppliers)
	RTC	Service	Captain (via agent)
	PTC	Service	Service provider (e.g. terminal, suppliers)
	ATC	Service	Service provider (e.g. terminal, suppliers)
Port planning departure	ETD	Berth	Captain (via agent)
	RTD	Berth	Port authority
	PTD	Berth	Captain (via agent)
	ATD	Berth	Captain (via agent)

14.2.2 Incorrect way of using timestamps

Planning of an event usually consists of four stamps: estimated, requested, planned and actual timestamp (Section 4.1). For example, party A delivers an estimated time slot to party B. Party B accepts or changes the estimated time based on their planning. It sends back a requested time slot to party A. If party A and B have an agreement about a time slot, a planned time is determined. Last minute changes can, however, cause deviations. Therefore, the actual time is not always the same as the planned time. To conclude, three stamps are related to the planning of events and one stamp for the execution.

Today, actors do not use the four stamps. Only two stamps are usually used: estimated and actual time. The requested and planned stamps are not (yet) shared among actors. Actors usually use estimated stamps in the planning. For example, MSC delivers an estimated time slot of arrival (ETA berth). The terminal accepts or changes the estimated time and sends back the requested time. However, it does not use RTA berth as timestamp. The terminal sends back another ETA berth to MSC. After the agreement, ETA berth is used as the planned timestamp.

PortXchange tries to overcome this problem by connecting the right timestamp to the obtained data of actors. If PortXchange receives an estimated stamp (e.g. ETA PBP) of the port authority, it changes this stamp because it knows the port authority is not data owner of an estimated stamp (Table 14.3). Therefore, PortXchange displays another timestamp in its application. Own research reveals that PortXchange does not always replace the timestamps in the right way. For example, PortXchange shows the obtained ETA PBP as PTA PBP. However, Table 14.3 shows the port authority is not data owner of a planned time. In fact, PortXchange should change this timestamp to RTA PBP. The same situation applies for timestamps of the terminal. PortXchange shows PTA and PTD berth instead of RTA berth and ETC cargo services.

To overcome abovementioned problem during the data analysis, information gained in the qualitative analysis is used to understand the data set. By considering the source of a timestamp, it is possible to distinguish the different timestamps from each other.

14.2.3 Accuracy of actual timestamps

The obtained data set of PortXchange does not contain ATA PBP, ATA Berth and ATD Berth with captain/agent as event owner (Table 14.3). These timestamps are only available from other sources. The harbour master registers actual arrival and departure times after being notified by the pilot on board. However, the actual timestamps are not always accurate.

It may happen that the harbour master does not register on time when the vessel arrives at the pilot boarding place. It may also happen that a pilot does not communicate that a vessel is arrived/departed to the harbour master. In addition, the definitions of PCO Taskforce for arrival and departure times may not always be understood. As discussed in Appendix B, a vessel is considered as arrived if the first line is secured. It is considered as departed if the last line is released. It may happen that the harbour master or pilot assumes, for example, that a vessel is arrived if all lines are fast.

Therefore, other timestamps are used which are considered to be more reliable (Table 14.4). The timestamps are obtained by GIDS and delivered by Loodswezen and KRVE. A pilot registers in GIDS when it arrives on board. The boatmen registers when it has secured and released the first as well as the last line of a vessel.

Table 14.4: Used actual timestamps in data analysis. Source: own table.

Required timestamps port call			Used timestamps in data analysis			
Event type	**Event location**	**Event owner**	**Event type**	**Event location**	**Event owner**	**Event source**
ATA	PBP	Captain (via agent)	AT Pilot On Board	PBP	Pilots	GIDS
ATA	Berth	Captain (via agent)	AT First Line Secured	Berth	Boatmen	GIDS
ATD	Berth	Captain (via agent)	AT Last Line Released	Berth	Boatmen	GIDS

14.2.4 Lack of data service providers in PortXchange

During the data quality analysis, it became also clear that PortXchange does not (yet) receive data from a few critical service providers. Since no data is available in PortXchange from most service providers, the quantitative research cannot consider the performances of service providers (except terminals).

The unwillingness of sharing data by multiple critical service providers, such as many bunker barges and slops, can be considered as a shortcoming in the current port call situation in the Port of Rotterdam. The service providers have an agreement with the company to provide services. In most cases, these service providers follow the vessel and makes their own planning. It does not share data on a platform as PortXchange. However, many actors such as terminals would like to receive this data for their planning. For example, if it knows in advance that a bunker barge finishes operations at 14:00 hours, the terminal can reschedule some cranes to another vessel if it expects to be ready earlier than 14:00 hours on this particular vessel. Today, terminals do not receive these data of service providers.

PortXchange is only able to show the actual times of start and completion services by means of AIS data. It is essential that estimated times of start and completion services are also given by the service providers. Just-In-Time arrivals and services requires that critical service providers frequently update estimated start and completion times of services.

Note that during cargo operations, many processes of service providers are ongoing at the same time. It means that if a bunker barge delays, it does not always necessarily mean that the vessel delays. If the bunker barge is still ready before the ETC cargo services, the vessel will not delay. However, it is important that the terminal has been informed about the delayed bunker barge so that it does not speed up terminal operations.

It is also worth noting that the quay space of terminals is a constraint in the Port of Rotterdam. This is especially the case on the ECT DDN quay, at which 80-85% of MSC vessels (un)load cargo in Rotterdam. ECT DDN terminal has a quay length of circa 1000 metres (Section C.2). In most cases, the berth is continuously planned with vessels (Figure G.3). It means no place is available for vessels to wait along the quay before another vessel is ready with cargo operations. If its predecessor(s) do not have finished cargo operations, the vessel must wait outside the port. Therefore, it is essential that critical services are aligned to the planning of cargo operations.

14.3 DATA PROCESSING

Data processing is an essential part in the quantitative research since the obtained data set only contains specific time events. Therefore, the obtained data is processed in order to get information about the data. In this way, the timestamps can be converted into valuable information about port call processes. This section discusses the way the data is processed.

Section 14.3.1 gives details about pre-processing the data. Subsequently, the developed data analysis tool is discussed in Section 14.3.2. This section gives insight in the indicators used to analyse the port calls. As last, the data is post-processed so that conclusions can be drawn from the obtained data (Section 14.3.3).

14.3.1 Pre-processing data

The large amount of obtained data must first be pre-processed in order to analyse it. The data set of PortXchange is obtained by a Microsoft Excel Comma Separated Values File (.csv file). Figure 14.2 gives insight in the way the data set looks. Pre-processing the data is required.

	A
1	uuid,event_type,event_time,record_time,ship_imo,ship_name,location_name,location_type,bollard_fore,bollard_aft,orientation
2	535e8ec9-87f3-3c63-8404-b183b59fa130,tugsFromBerth.reportnumber.agent,,2020-06-23 14:21:37+00,8913447,,EUROPAH ECT DDN,berth,,,
3	bc1f45ea-ed55-30ff-a4ad-93400a85e37a,berth.eta.agent,2020-07-06 10:00:00+00,2020-06-23 14:21:38+00,8913447,,EUROPAH ECT DDN,berth,,,
4	d8abc0b9-b80f-49fd-8459-c571c49af4c6,pilotBoardingPlace.etd.predictor,2020-07-07 21:15:00+00,2020-06-23 14:22:14.724+00,8913447,MSC ATLANTIC,Maascenter,pilotBoardingPlace,,,
5	34d7c2d7-cff7-43a4-8a6c-23586e1d493b,pilotBoardingPlace.etd.predictor,2020-07-07 21:16:00+00,2020-06-23 14:22:07.465+00,8913447,MSC ATLANTIC,Maascenter,pilotBoardingPlace,,,

Figure 14.2: Example of a few events in the Excel data sheet obtained by PortXchange.

Pre-processing data, as well as the data analysis and post-processing data, is performed in Power BI. Power BI is a business analytics service developed by Microsoft. MSC uses this system internally for data analyses. Since MSC would like to use parts of this research in the future, it requested to conduct also this research by using Power BI. Research on internet and consultation of MSCs Power BI consultants is used to understand Power BI.

The first step in Power BI is importing the data set from Microsoft Excel. Power BI can read in the data of the obtained data set. After importing the data a few steps are required to start the data analysis. The imported data must be sorted so that the right information is visible in the right columns. In addition, the data type must be corrected for each column. For example, the UCRN code must be read as text and the event time as date-time by Power BI. It is important that Power BI correctly reads the data to avoid errors in calculations and analyses.

After properly structuring the data, the event type is split into separate columns. The event type contains information about the timestamp and event owner (e.g. ETA berth agent). However, data is also visible about 'ETD berth port authority' and 'ATA berth terminal' for example. In order to get a better overview of the different possibilities in used timestamps and to make filtering of specific timestamps easier in the model, the event type is split into three columns which specify the type (e.g. ETA), location (e.g. berth) and data owner (e.g. agent).

The data set of PortXchange contained a few duplicates. It means that all columns were exactly the same for a few events. This may be the reason of small system errors in Portbase, ECT website, GIDS, HaMIS or PortXchange itself. The duplicates in the data set are removed so that the data analysis is performed with correct data.

14.3.2 Data analysis tool

Since the data set only contains specific time events, a data analysis tool is developed to gain information from the data. The data analysis tool consists of several defined (performance) indicators. The indicators are used to assess the current port call business process and to conduct measurements on the information systems. In this way, the planning of some actors can be researched. Subsequently, the gained information is used as input for the new business process to enable Just-In-Time arrivals and services. The indicators show if the current business process must be improved and if the information systems give enough support to the business process. As last, the indicators are used to show the potential of the new business process.

This section elaborates on the way the indicators of the data analysis tool works. The following (performance) indicators are included in the data analysis tool:

- Anchorage times of vessels
- Arrival and departure times of vessels
- Notification of nautical services for in- and outbound voyages
- Number of updates within 12 hours of execution from timestamps
- Size of updates within 12 hours of execution from timestamps

Due to the large amount of data it is essential to know what timestamps must exactly be used in the calculation of the indicators. In the data quality analysis, it became clear that the same timestamps can occasionally be obtained from several sources. It is important to determine which source(s) must be used to get the most accurate research results. Therefore, the information is used from the data quality analysis about the accuracy of timestamps.

In order to let the data analysis tool calculate the indicators per vessel within a certain time period, scripts including formulas are made in Power BI. For each indicator a different script is made to obtain the desired information. The next sub-sections show more details about the data analysis tool per indicator. Appendix I shows the scripts of each sub-section.

Anchorage times of vessels

The data analysis tool first calculates the anchorage times of MSC operated vessels in the Port of Rotterdam. The anchorage times illustrate the size of waiting times of vessels at anchorage. Just-In-Time arrivals and services aims to decrease the unscheduled ad hoc waiting times of vessels at anchorage. Equation 14.1 is applied in order to determine the anchorage times. Table 14.5 indicates the used timestamps to calculate the anchorage times.

$$Anchorage\ times = ATD\ Anchor\ Area - ATA\ Anchor\ Area \qquad [14.1]$$

Data related to anchorage times of vessels is available from HaMIS. A vessel is obliged to give a notification to the harbour master when it is on anchor. Therefore, the captain notifies the harbour master (VTS) when the vessel is on anchor. Subsequently, the VTS operator registers the arrival time at anchorage (ATA Anchor Area) in their information system HaMIS. If the vessel departs from the anchor area, the captain is also obliged to notify the harbour master. In this case, the VTS operator registers the vessel's departure time (ATD Anchor Area) in HaMIS.

Both timestamps from HaMIS are used to calculate the anchorage times. In order to determine the anchorage times per vessel, a few additional steps are required in the data analysis tool. For instance, indexes are added to let the tool calculate the anchorage times of each vessel. The different port calls of vessels can be distinguished by a unique call reference number (UCRN). Appendix I gives more details about the used formulas in the Power BI script.

Table 14.5: Used timestamps in the calculation of anchorage times. Source: own table.

Indicator	Event type	Event location	Event owner	Event source	Event/Record time
Anchorage time	ATA	Anchor Area	Port Authority	HaMIS	Event time
	ATD	Anchor Area	Port Authority	HaMIS	Event time

Arrival and departure times of vessels

In order to check if a shipping company as MSC also plays a role in delays of nautical services, the arrival and departure times are analysed. If MSC wants to sail Just-In-Time, it must also consider the capacity of nautical service providers. If MSC usually arrives/departures during 'peak' times, it may cause delays in port calls. More details about this topic follow in the results and analysis of this indicator (Section 14.4.2).

The indicator to get insight in arrival/departure times of vessels is relatively easily obtainable compared to the other indicators. The right data must be filtered from the data set. In order to determine the arrival/departure times, data is used from the boatmen. The boatmen register in GIDS when the first and last line of a vessel is secured and released. As explained in the data quality analysis (Section 14.2.3), these stamps are more accurate than the ATA and ATD berth. Table 14.6 shows details of the used timestamps.

Table 14.6: Used timestamps to determine the arrival and departure times of vessels. Source: own table.

Indicator	Event type	Event location	Event owner	Event source	Event/Record time
Arrival time	AT First Line Secured	Berth	Boatmen	GIDS	Event time
Departure time	AT Last Line Released	Berth	Boatmen	GIDS	Event time

Notification of nautical services for in- and outbound voyages

The notification of nautical services for in- and outbound voyages is also considered in the data analysis. Both situations are related to the order period of nautical services. Since data is available about these processes, the information in the qualitative analysis can be validated.

***Inbound voyages* |** In the qualitative analysis, it became clear that the port authority notifies the nautical services in a late stage (1-1.5 hours before execution). Loodswezen argues that it cannot plan based on this data. The data analysis is performed to confirm or reject the issue of the pilots. In case of Just-In-Time arrivals and services, nautical service providers must know a longer period in advance which vessels require nautical services at a specific moment. In this way, it can earlier give feedback to the vessels about the requested time. In case of capacity problems, the vessel could adapt its speed based on the new proposed time.

Data is available about the time the harbour master notifies the nautical services. VTS registers in HaMIS at which time the vessel is expected at the pilot boarding place. Loodswezen receives this information in SPIL. In addition, data is available about the time of execution which is the time the pilot steps on board. Equation 14.2 is used to calculate the notification period of nautical services. Table 14.7 shows details about the used timestamps in the calculation.

$$Notification\ period = RTA\ PBP_{record\ time} - AT\ Pilot\ On\ Board_{event\ time} \quad [14.2]$$

Table 14.7: Used timestamps in the calculation of the notification period of nautical services for inbound voyages. Source: own table.

Indicator	Event type	Event location	Event owner	Event source	Event/Record time
Notification period nautical services inbound voyage	RTA	PBP	Port authority	HaMIS	Record time
	AT Pilot On Board	PBP	Pilots	GIDS	Event time

***Outbound voyages* |** For outgoing vessels, an official order moment for nautical services is used in the Port of Rotterdam. As explained in Section 13.5, agents must order nautical services at least 2 hours before the vessel's departure. The agent registers the ETD berth in Portbase. The nautical services receive this timestamp in their planning systems via HaMIS.

Today, this stamp is not used in the right way by other actors. An ETD berth means that a vessel is estimated to depart from the berth at a specific time; it is an estimation at which time the last line is released. In the current order process, the nautical service providers consider this stamp as the time at which it must be present to provide services. However, the unmooring procedure must still start then. If the first line is released at the order time (ETD berth), it means that the last line is definitely released in a later stage than the order time. To conclude, ATD berth is in most cases later than ETD berth. More details to the relation with the Just-In-Time initiative will follow in the research results and analysis (Section 14.4.3).

A quantitative analysis on this topic is performed to check if abovementioned situation is the case in the Port of Rotterdam. The delta is calculated between the order time of the agent (ETD berth) and actual time of departure berth (AT Last Line Released). Equation 14.3 is used to find the delta between both timestamps. Table 14.8 indicates the details of the used timestamps.

$$\Delta(ETD\ and\ ATD\ berth) = ETD\ berth - AT\ Last\ Line\ Released \qquad [14.3]$$

Table 14.8: Used timestamps in the calculations related to ordering nautical services for outbound voyages. Source: own table.

Indicator	Event type	Event location	Event owner	Event source	Event/Record time
Notification nautical services outbound voyage	ETD	Berth	Agent	Portbase	Event time
	AT Last Line Released	Berth	Boatmen	GIDS	Event time

Number and size of updates within 12 hours of execution from timestamps

Just-In-Time arrivals and services requires that actors frequently communicate with each other about the status of operations. Therefore, the number and size of updates from timestamps is also considered in the quantitative analysis. Note that in this report the 'size of updates' refers to difference in time between two sequential event times. For example, if the agent first submits that the vessel's ETA PBP is 18:00 hours and later submits that the vessel's ETA PBP is 20:00 hours, then the size of the update is equal to two hours.

The obtained data set shows that some actors already give many updates a few months in advance in container shipping. This is mainly due the fact the long-term berth planning is already made a few months in advance.

In order to research the size and number of updates a shorter period before execution from timestamps, the analysis is performed over a time range within 12 hours of execution. This time period is chosen since the IMO GIA proposes a 12-hour notice for Just-In-Time arrivals and services (Section 3.2.1). Table 14.9 shows the timestamps of which the number and size of updates are calculated.

Table 14.9: The timestamps of which the number and size of updates are calculated. Source: own table.

Indicator	Event type	Event location	Event owner	Event source	Event/Record time
Number and size of updates	ETA	PBP	Agent	Portbase	Event time
	ETA	Berth	Agent	Portbase	Event time
	RTA	Berth	Terminal	ECT website	Event time
	ETD	Berth	Agent	Portbase	Event time
	RTD	Berth	Terminal	ECT website	Event time

It is worth noting that the actual timestamp is different for each estimated or requested timestamp. An estimated or requested time is given in advance. The actual time is considered as the execution time. As discussed in the data quality analysis, the accuracy of actual timestamps as ATA PBP, ATA berth and ATD berth is considered to be lower than data from pilots and boatmen. Hence, actual times are used from the pilots and boatmen (Table 14.10).

Table 14.10: Execution timestamps. Source: own table.

Relevant timestamps (Y)	Actual/Execution timestamp (Z)
ETA PBP (agent)	AT Pilot On Board (pilot)
ETA berth (agent)	AT First Line Secured (boatmen)
RTA berth (terminal)	AT First Line Secured (boatmen)
ETD berth (agent)	AT Last Line Released (boatmen)
RTD berth (terminal)	AT Last Line Released (boatmen)

In order to calculate the size and number of updates that an actor submits within 12 hours of execution per vessel, the data analysis tool must only consider events within these 12 hours. Only events must be considered in which the difference is smaller than 12 hours between the record time of a relevant timestamp (Y) and the event time of an actual/execution timestamp (Z). Equation 14.4 gives details about the constraint in the tool. Note that 'k' stands for a specific event of a timestamp, and 'n' for the total number of events of a relevant timestamp.

$$\Delta\{Z_{event\ time} - Y_{record\ time,k}\} < 12 \quad with \quad k = \{1,2,\dots,n\} \qquad [14.4]$$

By adding the constraint in the data analysis tool, the remaining events are the events within a time range of 12 hours of execution. Subsequently, the size of events can be determined by applying equation 14.5. Note that equation 14.4 and 14.5 are applied for all five timestamps to obtain the size of updates of these timestamps.

$$(\Delta Y)_k = \left|Y_{event\ time,k} - Y_{event\ time,k-1}\right| \qquad [14.5]$$

14.3.3 Post-processing data

In order to obtain the desired charts from the data analysis tool, the data must also be post-processed. Post-processing is necessary to identify the most important aspects of the data. Depending on the chart the following is performed to obtain the desired results:

- Highly extreme outliers are manually cross-checked to validate the correctness of these outliers. Eventual errors in the data set have been removed.
- Subsequently, outliers in the data set are removed because of the misleading behaviour and extra-ordinary characteristics. Very high or low values are removed by means of the 1.5 rule (Pani, Vanelslander, Fancello, & Cannas, 2015):

$$X < Q_1 - 1.5 \cdot |Q_3 - Q_1| \qquad [14.6]$$

$$or$$

$$X > Q_3 + 1.5 \cdot |Q_3 - Q_1| \qquad [14.7]$$

Where:

- X is the calculated indicator (e.g. number of updates).
- Q_1 and Q_3 are the first and third quartile of the data respectively.

14.4 Research results and analysis

The results obtained by the data analysis tool are visualized and analysed to draw conclusions. This section shows the research results and analysis of the developed indicators discussed in Section 14.3.2. The indicators are extensively analysed in separate sub-sections.

14.4.1 Anchorage times of vessels

The times of MSC operated vessels at anchorage are analysed to assess the current business process. In addition, the anchorage times can be used as input to determine the potential of the new business process – Just-In-Time arrivals and services.

The anchorage times illustrate the size of waiting times of vessels at anchorage. Figure 14.3 and Table 14.11 give insight in the anchorage durations of MSC operated vessels in the Port of Rotterdam. The anchorage durations are obtained by notifications of the VTS in HaMIS.

***Assessment current business process* |** Anchorage was required in [redacted] out of [redacted] port calls [redacted] The average duration on anchor is equal to [redacted] hours. Although, the standard deviation is relatively high, it still shows that the waiting time at anchorage is generally high. The waiting times are often larger than only one or two hours.

In addition, only data was available about the anchor activities. If a vessel is manoeuvring at low speeds in the port area, VTS does not make a notification in HaMIS. This can also be derived from Figure 14.3. The number of vessels with an anchorage duration in a range of [redacted] hours is larger compared to [redacted] hours. Since anchoring can be considered as a complex and time-consuming process, vessels which expect to enter the port in a short period may choose to manoeuvre at low speeds in the port area instead of anchoring. This means that more than 380 MSC operated vessels were subject to waiting times outside the port.

It is important to note that no information was available about the cause of anchoring. It means that some vessels in the chart do not wait at anchorage due to unavailability of nautical services, berth or fairway. Since the Port of Rotterdam is known as a transshipment port, it may happen that feeders experience delays because it must wait for cargo of a delayed deep-sea vessel. In addition, no data is available about liner services and the vessel's previous port. Further research is recommended to draw more detailed conclusions on anchorage times.

Table 14.11: Anchorage durations statistics (in hours). Source: own table.

Total vessels	Min	Q_1	Median	Mean	Q_3	Max	σ
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

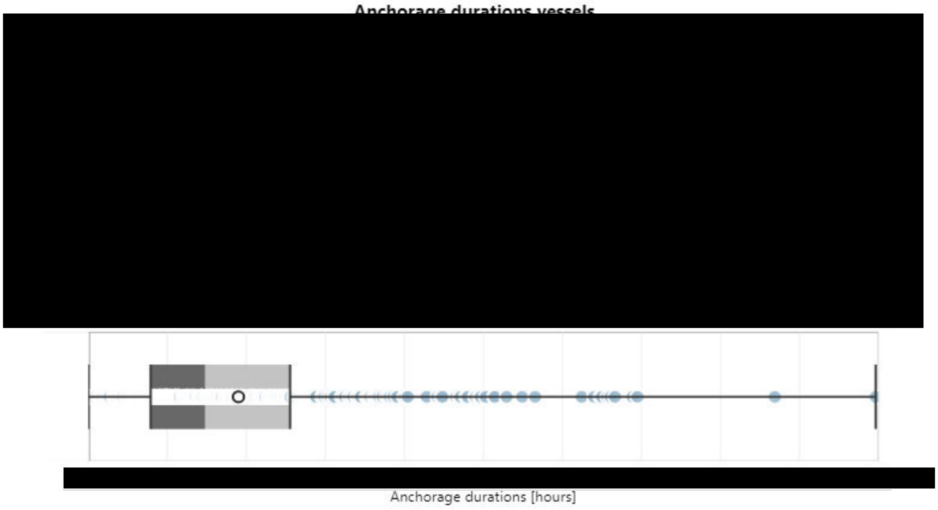

Figure 14.3: Anchorage durations of MSC operated vessels in the Port of Rotterdam area. Source: own figure.

[redacted]

14.4.2 Distribution arrival and departure times

The arrival/departure times of MSC operated vessels in the Port of Rotterdam are analysed in order to assess the current business processes. It is researched if relations can be found in the way actors currently make a planning. In addition, the indicator is used as input for the new business processes.

***Assessment current business process* |** Interesting results are gained from the analysis of departure times of vessels. Figure 14.4 shows the distribution of departure times of vessels over the day. The dashed line represents the average number of vessels that depart in a time span of half an hour.

A relation has been found between the departure times of vessels and the schedules of terminal shifts. Figure 14.4 shows that most vessels depart when the shifts of terminal end. As explained in the actor-stakeholder analysis (Section C.2), container terminals in the Port of Rotterdam generally work with a fixed shift system. A morning, evening and night shift takes place in a time span of respectively 7:00-15:00, 15:00-23:00 and 23:00-7:00 hours. When a shift takes over the other shift, the cranes do not operate for about 30 minutes.

This is also visible in the departure times of vessels. Peaks of departure times are shown, among others, at 7:00-7:30, 15:00-15:30 and 23:00-23:30 hours. It may be caused by shipping companies as MSC that pushes terminals to finish cargo operations before shift change. On the other hand, practical experiences have shown that terminal workers also work towards a shift change. If these workers finish before the shift change, the workers must do another work activity. Therefore, the workers may slow down their operations in order to be finished exactly at the end of a shift.

***Input new business process* |** To conclude, if MSC wants to sail Just-In-Time, it must also take into account the capacity of nautical service providers. If MSC often wants to arrive and depart during 'peak' times, it may cause delays in a port call due to unavailability of nautical services. In case of Just-In-Time arrivals and services, it is important that the planning information is exchanged in an earlier stage between the involved actors. If it is known in advance that nautical services have capacity problems around a specific moment of the day, other actors can adapt and optimize their planning. Today, this information is only exchanged and assessed in a two hours range before departure.

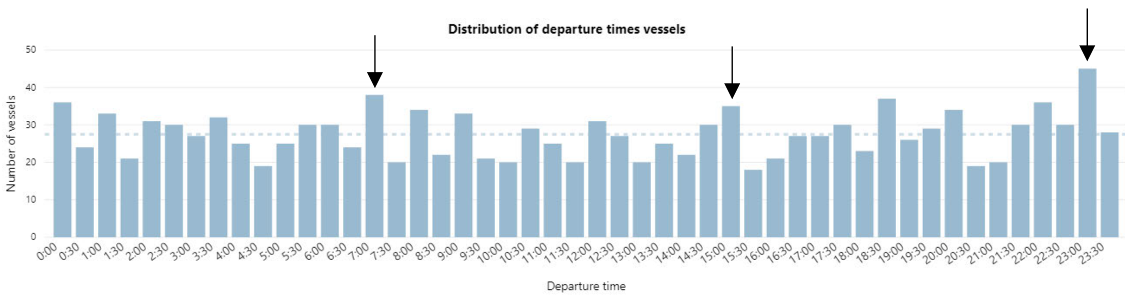

Figure 14.4: Distribution of departure times of MSC operated vessels in the Port of Rotterdam. Source: own figure.

14.4.3 Notification nautical services in- and outbound voyages

The notification of nautical services for in- and outbound voyages is also researched in the quantitative analysis. Both situations are related to the order process of nautical services. The indicators for both the in- and outbound voyage assess the current business process by measurements on information systems. Information about the way actors plan is also found by the indicators. In addition, this information is used as input for the new business process.

14.4.3.1 Inbound voyage

Assessment current business process **|** From the qualitative analysis, it is known that the pilots of Loodswezen cannot base their planning on information from the harbour master. For inbound voyages, the first contact with the vessel is a relatively short period before the vessel arrives at the pilot boarding place (1 à 2 hours). At this time, VTS makes a notification of planned time of arrival at pilot boarding place. However, Loodswezen argues that it cannot plan based on this timestamp. Since the pilots of Loodswezen must come from home and transported to the vessel by tender, it needs a notification period of at least 3 hours in advance.

The quantitative analysis confirms the issue of the pilots. Figure 14.5 shows that the current information flows are not adequate for the business processes. Loodswezen often obtains the information too late. The notification period is smaller than 3 hours for more than 75% of the cases. Note that if the berth, fairway and nautical services are available, the vessel can sail at normal speed further to the pilot boarding place. Then, the vessel arrives even sooner at pilot boarding place, since the sailing distance is only 1 à 2 hours away from the first calling point.

Since the pilots must start planning earlier, it bases their planning on own observations. It checks which vessels are pre-registered in Portbase. The pilots use the 'Havenmeester Havenkaart' to find out which of these vessels are in a 4-hours range of the pilot boarding place. However, Loodswezen also encounters problems with this procedure. If a pre-registered container vessel changes its rotation in liner schedule, it sails further to another port.

Input new business process **|** To conclude, the current business processes for inbound voyages must be changed to implement the Just-In-Time initiative. Nautical service providers must earlier know which vessels require nautical services at a specific moment. In this way, it can earlier give feedback to the vessel about the requested time. A vessel can then base its speed on the time at which it can enter the port.

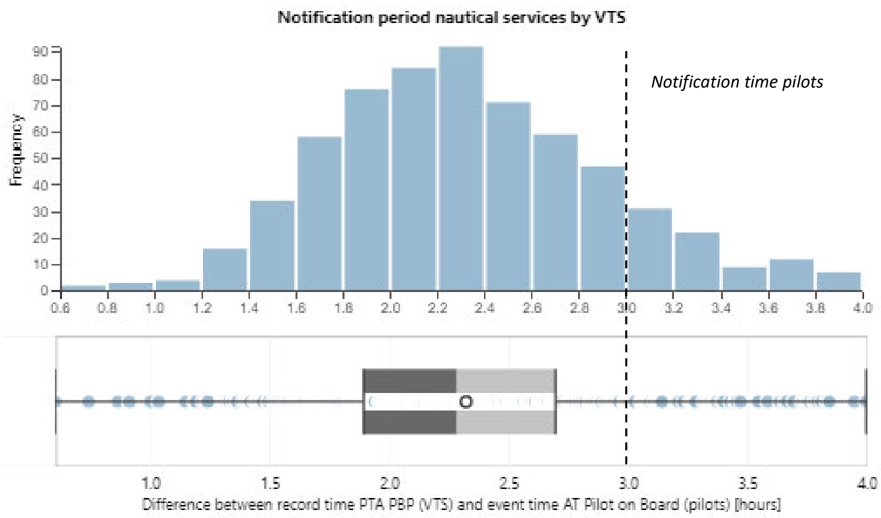

Figure 14.5: Notification period of nautical services by VTS for inbound voyages. Source: own figure.

14.4.3.2 Outbound voyage

Assessment current business process | In contrast to the inbound voyage, an official order moment is used for nautical services in outbound voyages. The agent must register the ETD berth at least 2 hours before the vessel's departure in Portbase. The nautical services have 30 minutes to determine enough capacity is available at the required time. This procedure works better compared to inbound voyages.

However, the electronical order process of nautical services is still not completely correct for outbound voyages. Figure 14.6 shows that the last line released (ATD berth) is often later than the order time of the agent (ETD berth). ATD berth is later than ETD berth in more than 75% of the cases.

Abovementioned is caused by a misunderstanding of the ETD berth definition. ETD berth means that a vessel is estimated to depart from the berth at a specific time; it is an estimation at which time the last line is released (Appendix B). In the current order process, the nautical service providers consider this stamp as the time at which it must be present to provide services. However, the unmooring procedure must still start then. If the first line is released at the order time (ETD berth), it means that the last line is definitely released in a later stage than the order time. To conclude, ATD berth is often later than ETD berth.

Input new business process | In case of Just-In-Time arrivals and services, the next incoming vessel bases its speed on the time at which the berth is free. This depends on the ETD berth of the outgoing vessel (Figure 4.1). If in most cases the predecessor's actual departure time is later than the estimated time of departure, the next incoming vessel will always be too 'early' at the pilot boarding place. Therefore, the current business process must be changed. Nautical services must arrive earlier than ETD berth so that the deviation decreases between the estimated and actual timestamp.

Note that an incoming vessel can still enter the port if more spaces along the quay are available. Since this is not the case at the ECT DDN terminal in the Port of Rotterdam, MSC operated vessels must usually wait outside the port. Both situations are, however, not ideal because the vessel bases its speed on ETD berth of the outgoing vessel.

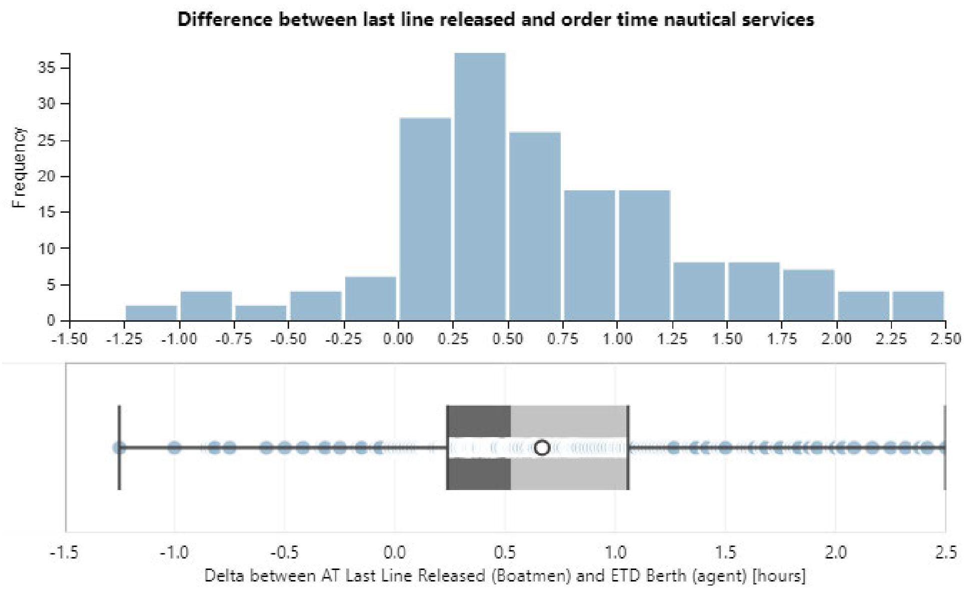

Figure 14.6: Difference between ATD berth and ETD berth (order time agent). Source: own figure.

14.4.4 Number of updates within 12 hours of execution from timestamps

The Just-In-Time initiative requires that actors frequently communicate about the status of operations. Therefore, the frequency of data exchange between actors is also researched. In other words, the current business processes are assessed by measurements on information systems. The obtained information is used as input for the new business processes. In contrast to the previous indicators, more findings are revealed with this indicator. Therefore, the assessment of the current business process and input for the new business process is separately discussed for each finding.

***Assessment current business process* |** Figure 14.7 shows that the agent updates the ETA berth more frequently in the last 12 hours compared to the ETA PBP. This may be the result of the current business processes for inbound voyages. Interviews revealed that agents feel that it is not really involved in the order process. This is because the VTS gives the notification to the nautical service providers about the vessel's ETA PBP.

***Input new business process* |** It is important that the agent updates the ETA PBP with the same frequency as the ETA berth. Based on historic data, it knows the approximate sailing duration from pilot boarding place to berth. For Just-In-Time arrivals and services it must be clear in an earlier stage when the vessel arrives at the pilot boarding place.

In addition, the nautical service providers would like to obtain real-time information about the ETA PBP in an earlier phase. Today, it knows that agents do not update the ETA PBP frequently enough. Therefore, it does not rely on the information provided by the agent.

***Assessment current business process* |** Figure 14.7 also displays that the terminal updates more often the departure time of vessels compared to arrival times in the last 12 hours. This means that vessels in operations are more frequently updated compared to vessels which are still expected. If a vessel is in cargo operations and lays along the quay, it seems logical that the terminal makes more updates about this vessel. It knows the exact quantity of containers that must still be (un)loaded.

***Input new business process* |** It is important that the next incoming vessel receives updates of the vessel's predecessor. If the incoming vessel is not frequently updated with the departure time of its predecessor, it cannot adapt its speed to arrive just-in-time. It is, therefore, essential that the terminal also updates the requested arrival time of the next incoming vessel if it changes the departure time of the vessel along the berth. In container shipping, most incoming vessels must exchange berth with an outgoing vessel. Hence, it is important that the incoming vessel knows the predecessor's ETD berth.

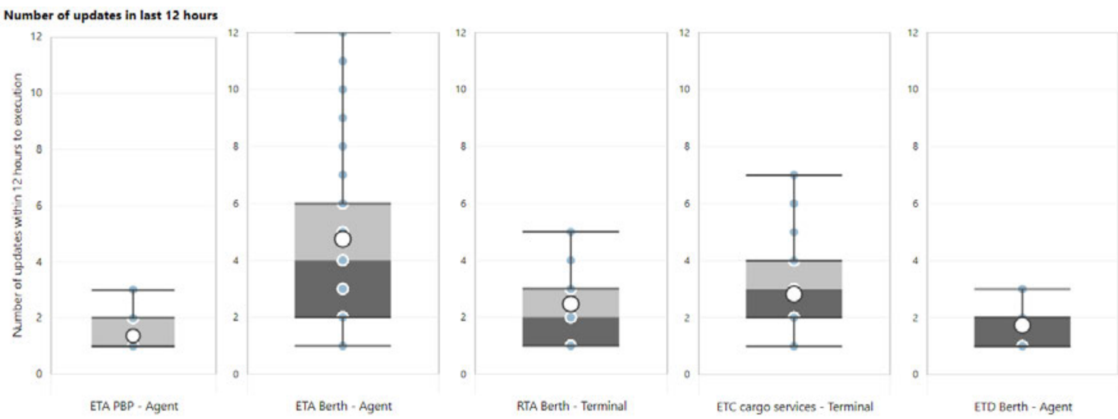

Figure 14.7: Number of updates per timestamp within 12 hours of execution. Source: own figure.

14.4.5 Size of updates within 12 hours of execution from timestamps

In addition, the size of updates communicated by actors is considered in the data analysis. Figure 14.8 shows the size of updates within 12 hours of execution from a few timestamps. Each chart is enlarged depicted in Appendix J. Multiple findings are revealed by the indicator. Therefore, the current and new business processes are separately discussed for each finding.

***Assessment current business process* |** Figure 14.8 shows that updates of ETA PBP have a relatively large size. It can indicate that the timestamp is not updated for a longer time. This corresponds to the information obtained in interviews. The nautical service providers state it cannot base their planning on ETA PBP of the agent because this time is often not up-to-date.

Abovementioned can be confirmed by also considering the size of updates of ETA berth by the agent. The agent knows the approximate sailing duration from pilot boarding place to berth. However, Figure 14.8 shows that ETA berth is updated with smaller sizes than ETA PBP. This is because the frequency of data exchange differs for these timestamps (Section 14.4.4). The agent does not update ETA PBP with the same frequency as ETA berth. Since the ETA PBP and ETA berth have a direct relation, the sizes of updates of ETA PBP may be larger since updates in this timestamp are not that often communicated.

***Input new business process* |** It is important that the agent does update more frequently the ETA PBP in case of Just-In-Time arrivals and services. If vessels sail Just-In-Time, these vessels must know exactly at which time it can enter the port. This means that it must get a confirmation of the availability of nautical services. Nautical service providers can only give this information if it obtains real-time information about the vessel's ETA PBP.

***Assessment current business process* |** Figure 14.8 also shows that the terminal mainly gives updates with a size that is in a range of [0-2] hours. By contrast, the updates of agents do usually have a larger size. As explained above, the size of updates of the agent can become larger if the agent does not update the timestamps with the same frequency as the terminal.

***Input new business process* |** In case of Just-In-Time arrivals and services, it is important that the agent does update the information obtained by the terminal. The relevance of an application as PortXchange should not be overlooked in this situation. If actors trust the information shown in PortXchange, it will not be dependent on the agent's information only. Nautical service providers can already see the planning of the vessels in PortXchange. It can use this information to make a (pre-)planning.

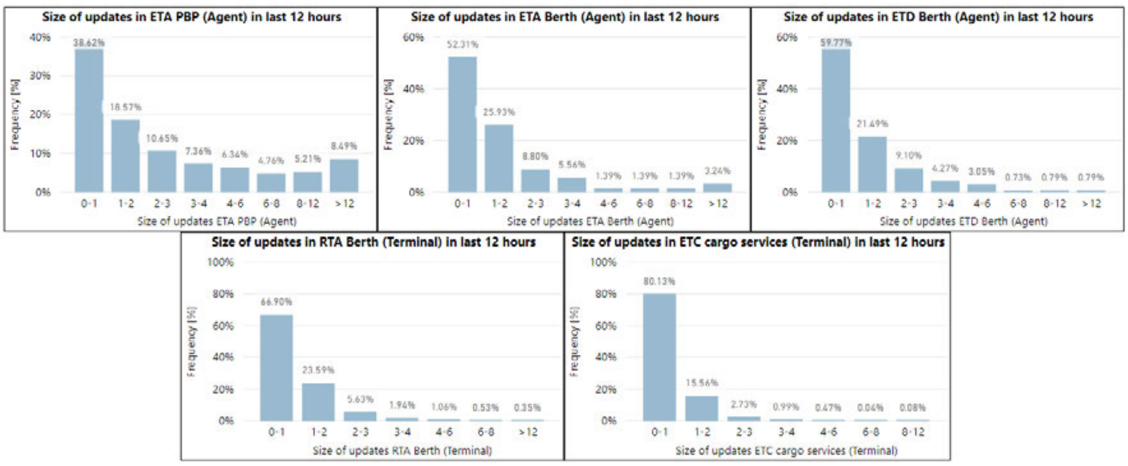

Figure 14.8: Size of updates per timestamp within 12 hours of execution. Source: own figure.

15 CONCLUSION

Both the qualitative and quantitative analysis are explained in Part III. A large amount of information, especially in Chapter 13 and 14, is obtained. This section concludes the qualitative and quantitative analysis which is discussed in Chapter 12 - 14.

15.1 QUALITATIVE ANALYSIS – CONTRACTUAL PHASE

Since it is known that in other shipping sectors (bulk, tanker) contractual barriers can impact the implementation of Just-In-Time arrivals and services, the current contracts in container shipping are also researched. It is concluded that, from a contractual point of view, the container sector is an interesting start point for the implementation of the Just-In-Time initiative.

The container sector is characterized by liner shipping in which vessels sail pre-determined routes and (un)load at fixed ports. Container carriers as MSC make interline agreements with other carriers to share liner services. Carriers agree to either lease part of the slots on board of vessels (SCA) or share vessel capacity in a liner service (VSA). Furthermore, alliances – cooperation agreements between shipping companies – are also well-known in container shipping. The three largest alliances take approximately 80% of the container shipping market. MSC collaborates with Maersk in the 2M-alliance.

Since the container shipping market is relatively consolidated, it may result in a faster adoption of required standards for Just-In-Time arrivals and services. Most container liners already collaborate in terms of SCAs, VSAs and alliances.

In addition, container shipping of MSC is mainly operated by own or time-chartered vessels. This is advantageous in terms of Just-In-Time arrivals and services. Voyage-chartered vessels may cause contractual barriers to reduce speed due to demurrage clauses for instance. In contrast to the bulk and tanker sector, there are no contractual barriers found to reduce speed in container shipping.

Besides, many shipping liners have contracts with terminals operators. In Rotterdam, MSC has a joint venture agreement with the ECT Delta terminal and Maersk Group is owner of APM Terminals. The shipping companies may, therefore, require more frequent real-time data exchange of terminal operators which, in turn, is essential for Just-In-Time arrivals and services. Abovementioned is also confirmed during this research. Due to the partnership of ECT Delta and MSC, ECT Delta was willing to provide data about MSC operated vessels to MSC. Conversely, APM Terminals did not give any data to MSC.

15.2 Qualitative analysis – operational phase

After having obtained knowledge about the contractual relations of MSC container shipping, the operational processes are clarified. The operational port call processes are extensively analysed to determine what must exactly be improved to implement the Just-In-Time initiative in MSC container shipping in the Port of Rotterdam. It is essential to analyse the processes in very detail to find the 'bottlenecks' the current port call processes. In addition, it is crucial that the port call processes are completely understood in order to conduct a quantitative analysis.

As shown in Chapter 13, multiple things need to be improved to implement the Just-In-Time initiative. Current operational barriers are revealed in each phase of a port call. These shortcomings in the current port call processes are extensively elaborated and discussed for each port call phase. A number of conclusions are drawn from this study. The conclusions are explained per port call phase. The conclusions often refer to the standards of PCO Taskforce which is a pre-requisite of Just-In-Time arrivals and services (IMO GIA, 2019b). Years of industry experiences and scientific knowledge have contributed to design the PCO Taskforce standards.

It is already useful to note that in each port call phase actors only exchange estimates and actual timestamps. PCO Taskforce requires information exchange in the form of an estimated, requested, planned and actual timestamp (dynamic planning).

***Short-term berth planning phase* |** The information exchange between actors involved in this phase does not always satisfy PCO Taskforce standards. Several timestamps are used to indicate the same. In addition, information is not often enough exchanged between actors. The Just-In-Time initiative requires more frequent data exchange. Vessels can only adapt its speed to arrive just-in-time if it receives enough updates. Details are already given in Table 13.1.

- Within MSC, the internal stakeholders send different timestamps to express ETA PBP. For example, the port captains use 'ETA Pilot' in the berthing plan. The captains' room uses 'ET Pilot on board' to update the captain, and 'ETA PS' to update service providers.
- The timestamps in the MSC berthing plan do not comply with PCO Taskforce standards.
- The vessel only receives ETA PBP at 12:00 and 17:00 hours if it is within a range of only 2 à 3 sailing days from the Port of Rotterdam.
- Terminals also give limited updates about the short-term berth planning. Information is only exchanged once or twice a day.

***Port planning arrival phase* |** The processes and information exchange between actors involved in this phase are mainly short-term. Just-In-Time arrivals and services requires clarity in an earlier stage about when a vessel can enter the port.

- Today vessels only know a few hours in advance if it can enter the Port of Rotterdam.
- The (operational) clearance, granted by the harbour master, does not always take into account the availability of nautical service providers. It may happen that a vessel obtains operational clearance to enter the port, but that in a later stage the vessel must still reroute to anchorage locations due to unavailability of nautical services.
- Experiences of many actors in the chain reveals that it occasionally happens that the harbour master grants permission to enter the port when the fairway is unavailable. Vessels expect that it can enter the port. However, the vessel cannot enter the port or continue its way in the port due to a priority vessel (LNG or deep-sea vessel).
- The nautical service providers do only get a short period before execution a reliable estimation about which time the vessel is expected at a certain location (Maascenter,

Lage Licht). In case of capacity issues of nautical service providers, it can notify the vessel only one or two hours in advance.

- The L.A.B. option for tugs causes that towage companies get notified relatively late about the exact number of required tugs. If it does not have enough capacity, it can only notify the vessel 30 to 60 minutes in advance.
- Experiences of many actors in the chain reveals that it is difficult for nautical service providers to make a planning a longer period in advance. This is mainly due to the fact agents do not frequently update arrival times.

***Vessel and cargo service planning phase* |** Terminal operations can be delayed by several causes (Figure 13.8). It is, therefore, important that updates about services are more frequently exchanged between actors. The Just-In-Time initiative requires clarity about the vessel and cargo service planning so that other actors (e.g. nautical service providers, next incoming vessel) can align their planning better. In addition, information must be exchanged according to PCO Taskforce standards to avoid miscommunication among actors (Table 13.3).

- Terminals only send operational/status updates once or twice per shift (1x or 2x per 8 hours). APM Terminals only sends it once per shift and ECT Delta twice per shift.
- The captains' room (agent) only sends updates about the vessel's ETD berth once per shift (1x per 8 hours) to service providers. Service providers must obtain more frequent information, especially if a vessel is earlier ready with cargo services than expected.
- Improvements are already made by the PortXchange application. Some terminals give more updates in this platform. However, PortXchange is not used by a few actors and some service providers are not involved in PortXchange (e.g. some bunker barges).
- The agent must make sure that other service providers finishes service before cargo operations are completed. Therefore, it must (more) pro-actively communicate with the service providers.
- The timestamps do not comply with the PCO Taskforce standards. Terminals often communicate an ETD berth. In fact, the terminal is responsible for completion cargo operations (ETC cargo services). The agent determines ETD berth.

***Port planning departure phase* |** As in the port planning arrival phase, the processes and information exchange between actors involved in the departure phase are mainly short-term. Moreover, due to the current processes actors do not communicate frequently with each other as a result of financial consequences. Just-In-Time arrivals and services requires clarity in an earlier stage about when a vessel can enter the port. In container shipping, most incoming vessels must exchange berth with an outgoing vessel. Therefore, it must also be clear in an earlier stage when the incoming vessel's predecessor departs.

- The current order process for nautical services lead to inefficiencies in a port call. Cancellation costs are, especially for shorter waiting times (<2 hours), lower than waiting costs for nautical services. Agents cannot update the vessel's departure time within 1.5 hours before planned execution. Since waiting costs are lower than cancellation costs, agents may not communicate updates in departure time due to financial reasons.
- As explained in the previous phase, the estimated time of completion cargo services must be updated more frequently so that actors can prepare the vessel's departure. Nautical services need the information for their planning. In addition, the next incoming vessel uses the information to adapt its speed to arrive just-in-time.

15.3 Quantitative analysis

A quantitative analysis is conducted by means of the knowledge obtained in the qualitative analysis. Knowledge about the port call processes is required in order to interpret the quantitative analysis. The quantitative analysis is primarily based on the qualitative analysis. Research is performed to confirm or reject several findings of the qualitative analysis.

For the quantitative analysis, data is used from PortXchange. The application captures information from MSC and many other involved actors. In addition, PortXchange originates from PCO Taskforce standards. By doing quantitative research with data from PortXchange, it will become clear if PortXchange still follows these standards. A few conclusions can be drawn which are related to the quality of PortXchange data:

- Some actors were not willing to share data for this research (APM Terminals) since it does not trust other actors with 'their' data.
- Today, actors only share estimated and actual timestamps. Requested and planned events are not shared.
- PortXchange does not always show the right timestamps in its application according to the PCO Taskforce standards. PTA berth and PTD berth must be changed to RTA berth and ETC (or PTC) cargo services.
- Service providers do not share data in the PortXchange application. Other actors involved in PortXchange would like to receive estimates of start and completion times services so that it can adapt their own planning if needed.

In order to draw conclusions from the obtained data, the data is first processed. A data analysis tool is developed to research the port call processes. The following conclusions are found by this study:

- MSC often departs at the time terminal shifts ends. A few 'peak' times are visible in the distribution of departure times. It means the predictability of departure times increases. This type of information can be used by other actors to align the planning. Note that 'peaks' in departure times may cause unavailability of nautical services. However, this also depends on the other shift times of terminal in the Port of Rotterdam. Further research is recommended to take the shift times of other terminals (in other sectors as bulk and tankers) into account.
- For inbound voyages, Loodswezen obtains information about the vessel's ETA PBP too late from the harbour master. In case of Just-In-Time arrivals and services, nautical services must earlier know which vessels require nautical services in order to communicate a requested time of arrival at the pilot boarding place to the vessel.
- For outbound voyages, a time deviation is nearly always found between the ETD berth and ATD berth. It is caused by an 'incorrect' order process for nautical services.
- The agent updates the ETA berth more frequently than the ETA PBP within the last 12 hours of execution. Therefore, the sizes of updates of the ETA PBP are larger compared to the ETA berth.
- The terminal updates the estimated completion times of cargo more frequently than estimated arrival times of vessels. It gives more updates about the status of the vessel along the quay than the next incoming vessel in the last 12 hours before execution.

Part IV:

Proposal adaptation of business process, Conclusions and Recommendations

16 PROPOSAL ADAPTATION OF CURRENT PORT CALL BUSINESS PROCESS TO INVOLVED ACTORS

This research has shown that port call business processes must be adapted in order to implement Just-In-Time arrivals and services in container shipping of MSC in the Port of Rotterdam. Therefore, a proposal of adaptations of the business processes is made to the involved actors. The proposal contains recommendations per actor which are required to enable Just-In-Time arrivals and services.

The emphasis of this proposal is on both the port call business processes and the information systems. As explained in Chapter 13, it is essential that the role of business processes is understood (Kroenke & Boyle, 2016). Since information systems support the business processes, it may often happen that optimizations focus on information systems. However, the information systems do only play a supporting role of the business processes. Root causes of inefficiencies may not be found and solved, if only information systems are adapted and the existing business processes are not adapted.

Note that Just-In-Time arrivals and services require frequent exchange of timestamps between involved actors. Therefore, the narrowing down principle is pointed out a few times in this proposal. The method is based on giving more updates closer to execution. As explained in Section 3.2.1, in a 12-hour window updates are recommended at -12, -8, -4, -2, -1, -0.5 hours prior execution. It is likely that this method is proposed by the IMO since it knows that the planning of the port call processes is subject to many changes. The essence is that information must be shared between actors if planning changes occur.

Just-In-Time arrivals and services requires collaboration of all involved actors in a port call. Port call optimization is not only related to one or two actors in the chain. Therefore, each actor involved in the actor-stakeholder analysis (Chapter 9 and Appendix C) is considered in this section. Each actor is separately discussed in this proposal. The following actions per actor are recommended in order to implement Just-In-Time arrivals and services.

MSC – Shipping company

- Let the internal stakeholders use the same timestamps as determined by PCO Taskforce. It is important that all actors use the same data standards. The berthing plan, berthing prospects and 'overdracht' (update service providers) must, therefore, be adapted to the data standards of PCO Taskforce. Unclarity among internal and external stakeholders about shared information must be avoided.
- Update the vessel more frequently than only at 12:00 and 17:00 hours. Also, if the vessel's previous port has a sailing distance greater than two/three days, it is recommended to send the vessel also berthing prospects longer than two/three days in advance. In this case, the vessel obtains earlier information about the requested time of arrival berth.
- If enough information about ETC cargo services is obtained from terminals, the captains' room should also update the vessel service providers more frequently. The

service providers must be updated more often than only once in eight hours, especially if ETC cargo services is earlier than expected.
- The captains' room should pro-actively communicate with service providers to ensure that these service providers finish vessel services before cargo completion. If the required information is obtained in advance, MSC can align its planning and update other involved parties if service providers experience delays.
- The captains' room should update the ETA PBP with the same frequency as the ETA berth within the last 12 hours before execution. In this way, the port authority and nautical service providers can better prepare the vessel's arrival in an earlier stage. The narrowing down method is recommended in this case.

ECT Delta, APMT-R and AMPT-MVII – Terminals

- Incoming vessels should be updated more frequently about the RTA berth. Today, this information is only sent once or twice a day. Vessels and shipping companies need more frequently information to align the planning and arrive Just-In-Time.
- Operational/status updates should be sent more frequently during cargo operations. This is especially recommended to APM Terminals which only gives updates once in eight hours. The narrowing down method is recommended in this case.
- The terminal should update the requested arrival times of vessels with the same frequency as the estimated completion time cargo services. In this way, the next incoming vessels can use this information to align its speed and arrive Just-In-Time.
- The terminal should use the same timestamps as determined by PCO Taskforce. Today, it often communicates ETD berth. However, terminals are responsible for ETC cargo services. The agent determines ETD berth.
- It is recommended to take next steps in data sharing. In case of Just-In-Time arrivals and services, more information exchange between involved actors is of great importance. It is recommended, especially for ECT Delta, to link their own planning system to PortXchange so that other actors can use this planning information.

Loodswezen – pilots

- In case of the L.A.B. option for tugs, it is recommended to investigate if it is possible to give an estimation about the required number of tugs in an earlier phase before the pilot steps on board. Today, it is difficult for Boluda to give earlier feedback about the availability since it often obtains the information about the number of required tugs in a late stage. This is the moment that the pilot arrives on board.

Boluda – towage company

- In case of the L.A.B. option for tugs, it is recommended to investigate if a relation can be found in historic data of the required number of tugs. The number of tugs depends on, among others, weather and vessel. Most container vessels arrive frequently in the Port of Rotterdam. If a relation is found, Boluda can earlier make an accurate estimation about the required number of tugs.
- Boluda should consider the option to share event data with a platform as PortXchange so that other actors can use the planning information of Boluda. The other nautical service providers (Loodswezen and KRVE) already share event data with PortXchange.

KRVE – boatmen: since KRVE does almost never cause delays in a port call and also share event data with PortXchange, this proposal does not contain any recommendations to KRVE.

Port of Rotterdam Authority

- Adopt the Just-In-Time initiative in the corporate strategy of the port authority. According to the CEO (Castelein, 2020), Just-In-Time arrivals and services can play a key role in optimizing port calls in the Port of Rotterdam. However, this research reveals that the Harbour Master's division of the Port of Rotterdam Authority is not really involved in the Just-In-Time initiative. The harbour master is an important player in a port call process and it is, therefore, essential that this division also believes in Just-In-Time arrivals and services.

Harbour Master – Harbour Coordination Centre (HCC)

- The harbour master should change the order process of nautical services for inbound voyages. The harbour master is responsible for the admission policy of vessels. Today, it gives operational clearance (RTA PBP) based on the berth availability. However, it should also consider fairway availability (e.g. priority vessels) and nautical services availability in this decision. Vessels must know in an earlier phase if it is allowed to enter the port. If it cannot enter the port, it must obtain this information early so that it can adapt its speed. Today, the admission procedures including ordering nautical services are very short-term which also lead to inefficiencies in the planning of nautical services.
  - It is, therefore, crucial that the harbour master changes the order process for nautical services so that it is earlier known which vessels want to enter the port. It is recommended to let agents earlier order nautical services. Another option is that the harbour master comes in contact with the vessels in an earlier stage (e.g. 12 hours before arrival) instead of 2/3 hours before arrival.
- The harbour master should also change the order process of nautical services for outbound voyages. It is the responsible party for giving admission to enter/depart the Port of Rotterdam.
  - The current order process for nautical services lead to inefficiencies in a port call due to contractual issues (cancellations costs > waiting costs). Agents may not communicate updates in departure times as a result of financial considerations. It is, therefore, recommended to let agents update departure times after ordering the nautical services. In this way, the nautical service providers can adapt their planning if delays take places. Further research is recommended to determine if extra payments are needed by agents in case of extra updates within the two hours before departure.
  - In addition, the harbour master must change the timestamp which is currently used as order time in the order process. Today, ETD berth is used as order time by agents. However, the quantitative analysis has shown that nautical service providers consider this stamp as the time at which it must be present. In fact, ETD berth means that the last line is released.

Portbase – Port Community System (PCS)

- It is recommended to get more involved in the Just-In-Time initiative. Frequent data exchange between actors is a pre-requisite of Just-In-Time arrivals and services. However, many parties are afraid of sharing data when it is not clear what happens with 'their' data. Since Portbase is a public organisation, companies may be more willing to share data with Portbase. In addition, Portbase is able to satisfy the actors' requirements by their authorisation models (data governance model).

PortXchange

- PortXchange should use the data standards of PCO Taskforce. For example, the timestamp PTD berth should not be owned by the terminal. PortXchange should show ETC (or PTC) cargo services instead.
- It is also recommended to collaborate with Portbase. Some actors are still against sharing data with PortXchange. By collaborating with Portbase it is able to obtain more data of involved actors, since actors may be willing to share data with PortXchange via Portbase.

PCO Taskforce

- It is recommended to give more information about the data standards of nautical services. As shown in this research (Table 13.2 and Table 13.4), PCO Taskforce has not defined timestamps for the nautical service planning. It has developed a business process map of a port call. Since this map must be applicable for each port call independent on cargo, vessel and port type, the port call map is relatively brief. It is recommended to include standards for the nautical service planning in an appendix. In this way, it is clear for actors what standards must be followed if nautical services are required in a port call.
    - Therefore, a business process map is designed in which the nautical service providers are separately included. Appendix K shows a more detailed overview of a business process of a port call. It also includes the timestamps of nautical service providers.

17 Research conclusion

In this study, research is conducted to identify and improve the current port call processes in order to enable Just-In-Time arrivals and services – a concept proposed by the IMO GIA. A case study is performed on container shipping of MSC in the Port of Rotterdam. Several conclusions are drawn from this study.

This study has shown that the port call business processes are very complex. The complexity is primarily caused by the various actors, the many relations between actors, the different provided services and the high unpredictability of external disruptions. A deep understanding of these processes is essential to analyse it and to propose solutions.

In the port call processes, many actors are involved which differ from each other in terms of incentives, resources and power. The actors primarily act on the basis of its own incentives. In order to enable Just-In-Time arrivals and services, collaboration is required among these involved actors. A holistic approach is needed in which incentives are identified for each involved actor. If actors expect it does not perceive benefits, it will show less motivation to implement the Just-In-Time initiative.

Most actors recognise the advantages of the Just-In-Time initiative. However, in this case study nautical service providers do not obtain the same benefits as other actors. If only the container sector is involved in the Just-In-Time initiative, the nautical service providers cannot optimize their planning. It must consider all clients in the planning.

Although most actors see the advantages of the initiative, actors are generally unwilling to share data about their business processes. Without a clear data governance model, actors are reluctant to give openness of their data.

However, even if data is shared, Just-In-Time arrivals and services cannot directly be implemented. Exchanged data between involved actors does often not meet certain data standards. In addition, the data is not shared often enough among actors. Therefore, port calls must be optimized in order to enable Just-In-Time arrivals and services.

The unwillingness to share data and exchanged data which does not meet standards are not the only reasons port calls must be optimized. Based on a very detailed study, it can be concluded that adaptations are required to the current business processes of a port call in the Port of Rotterdam. The current business process leads to inefficiencies in port calls. This is primarily caused by the business processes defined by the harbour master. Planning information is exchanged in a late stage. In addition, financial considerations cause unexpected delays for nautical service providers.

As last, it became clear that involved actors do not always realise the effects of their own behaviour towards other actors involved in a port call. Actors do not always consider or understand each other’s processes related to a port call. A port call contains a chain of several connected activities and processes. A delay caused by one actor usually results in accumulating delays in which multiple actors are affected (snowball effect). It is not implausible that an actor, that caused the initial delay, also experiences delays in a later stage.

18 RECOMMENDATIONS FOR FURTHER RESEARCH

This section elaborates on suggestions for further research related to port calls of MSC container shipping in the Port of Rotterdam. The recommendations are based on the findings of this research.

In this research, a case study is conducted on container shipping of MSC in the Port of Rotterdam. Besides focusing on the container industry, it is recommended to focus also on other shipping sectors such as dry and liquid bulk in further research. This is particularly important for the nautical service providers since it must consider clients from all type of shipping sectors in their planning.

It must be noted that different barriers could be encountered in the implementation of Just-In-Time arrivals and services in other shipping sectors. Contractual barriers related to voyage-chartered vessels can make the Just-In-Time initiative less attractive for shipping companies. In addition, expert consultation revealed that certain information systems, used by shipping companies in the bulk sector, must first be improved before data can be exchanged with other actors.

In addition, further research is recommended to the arrival and departure times of other shipping companies at different terminals. In this case study, a relation is determined between the shift times of terminals and the vessel's departure times. If similar relations can be revealed in other sectors at different terminals, the predictability increases of vessel's arrival and departure times. Peaks in arrival and departure times can impact the availability of nautical services and the fairway.

It is also recommended to conduct more research on the cause of vessels on anchor. In this research, no information was available about the cause of anchoring. If this type of information is available, a more accurate estimation can be made of the anchorage times due to unavailability of fairway, nautical services and berth.

As a next step of this research, a simulation of the port call processes is recommended in order to quantify the benefits of other involved actors in case of Just-In-Time arrivals and services. Since a large amount of information is obtained in this report to understand and get insights in the port call processes, it is recommended to use the information in this research as building blocks for further research in this field.

As last, more research is recommended to determine if extra payments are required by agents in the new proposed business process. If agents are allowed to give extra updates within two hours of departure when ordering nautical services for outbound voyages, it must be researched at which price an agent is willing to give extra updates to the nautical service providers. The price must be at least lower than the current waiting costs of nautical services in order to avoid that agents do not update ETD berth due to financial consequences. Note that paid updates are likely required in order to avoid that agents misuse this possibility and do not give reliable information to nautical services a longer period in advance.

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Part V: Appendix

A. MARITIME INITIATIVES MEMBERS

MSC is an active member of several global environmental initiatives and platforms to have a positive impact on the environment. It participates in the Global Industry Alliance (GIA) and PCO Taskforce. Leading firms of the industry cooperate with each other to find shipping solutions. To gain a better understanding about which parties are involved in the initiatives, an overview is shown in this appendix.

Appendix A.1 displays the current members of the GIA. The involved parties in the PCO Taskforce are given in Appendix A.2. The PCO Taskforce consists of industry partners and endorsers. PCO Taskforce consists of industry partners and endorsers.

A.1 GLOBAL INDUSTRY ALLIANCE (GIA)

Figure A.1 shows the current members of the Global Industry Alliance. MSC is one of the members. GIA currently consists of 16 companies. It is officially launched on 29 June 2017 at headquarters of the IMO.

Figure A.1: Members of the GIA (IMO GIA, 2018b).

A.2 PCO Taskforce

Members of PCO Taskforce are partners of the industry. Shipping companies (including agents) and ports collaborate to optimize business processes. International associations endorse the standards provided by PCO Taskforce members. Figure A.2 shows the involved parties of the PCO Taskforce initiative.

Figure A.2: Members of the PCO Taskforce (PCO Taskforce, 2020).

B. PORT CALL BUSINESS PROCESS IN GENERAL

Appendix B provides detailed information about the business process map of a port call designed by PCO Taskforce. The port information manual (PCO Taskforce, 2019a) and the business process handbook (PCO Taskforce, 2019c) are often used to obtain the information of this section. The port call business process map is visible in section 4.2. The blocks of this map are clarified in each sub-section below. Titles of the sub-sections are similar to the used block titles in the business process map.

Cargo contracts on subject

The first part of the port call process map refers to the moment a buyer and seller agree on a contract of the sale of goods. The type of cargo can be bulk, but also customer goods (containers). In bulk trade contracts, agreements are made about transport price, cargo tonnage, cargo quality, loading and discharging place and time. In containerized cargo trade, which is approximately 20% of total shipping, most goods are customer goods.

In containerized cargo trade, a contract of carriage is signed between two parties. On the one hand is the carrier of goods or passengers and on the other hand is the consignor, consignee or passenger. Contracts of carriage basically mentions the rights, duties and liabilities of the involved parties. It also points out matters as acts of God or clauses as force majeure. This is in order to eliminate liability and obligation in case of natural hazards / unavoidable events.

The consignor is the exporter of record for a shipment to be delivered, or in simple words it is just the sender. The consignor is usually a manufacturing company, agent or warehouse. The consignee is the importer of record for a shipment to be delivered, also called recipient. It is usually the purchaser of a product or the client of the importer (Freightos, n.d.).

A consignor usually contacts a freight forwarder who takes the responsibility of the goods transport on behalf of the consignor. The freight forwarders do usually have contracts with several carriers which are the actual transporters of the goods. This means a forwarding contract is also signed. The consignor and freight forwarder are the involved parties in a forwarding contract. A contract of carriage is concluded between freight forwarder and carrier.

Contract for hiring ships

Shipping can be divided into two main operation types based on the type of services: liner and tramp shipping. A short explanation about these types is given below.

- Liner shipping consists of shipping that provides services on fixed schedules. Liner ships usually sail pre-determined routes and load/discharge at fixed ports. In general, it transports small amount of goods for several clients. Liner ships are usually equipped with sophisticated and expensive propulsion systems. Quick loading/discharging is a characteristic for liner shipping. The freight rates of liner shipping are in general stable and fixed.
- On the contrary, tramp shipping is not characterized by fixed routing and schedules. These ships usually transport cargo for one or two users. Therefore, the number of port visits per trip is often reduced to a few ports. Tramp carriers are designed to transport large quantities of uniform goods such as bulk. The unit value of the commodities carried is usually lower than in liner shipping. Tramp shipping generally operates on relatively less speed. The freight rates are often not fixed and negotiable (Hanse oil, 2017; Reddy, 2017).

A company can transport the cargo by using own ships or chartered vessels. In case of chartering vessels, a broker can be an intermediary in order to find available and suitable vessels. In general, a charterer makes an agreement with a ship owner or operator to transport the cargo from point A to B. A so-called charter party is thus a contract between both parties (ship owner and charterer) in which the cargo owner pays the charterer freight to transport their cargo. A charterer can be a cargo owner or a representative of the cargo owner (Manaadiar, 2019). A distinction is made between four types of charter parties (Boomsma, 2019; Stopford, 2009). Table B.1 summarizes the cost responsibilities for each charter type.

Table B.1: Cost responsibilities for each charter type (Stopford, 2009).

1. Voyage Charter *Master instructed by:-* Owner	2. Time charter *Master instructed by:-* Owner for ship and charterer for cargo	3. Bare boat *Master appointed by:-* Charterer
Revenue depends on: Quantity of cargo & rate per unit of cargo	*Revenue depends on*: Hire rate, duration and off-hire time	*Revenue depends on*: Hire rate & duration
Costs paid by owner:	**Costs paid by owner:**	**Costs paid by owner:**
1. Capital costs Capital Brokerage	*1. Capital costs* Capital Brokerage	1. *Capital costs* Capital Brokerage
2. Operating costs Wages Provisions Maintenance Repairs Stores & supplies Lube oil Water Insurance Overheads	*2. Operating costs* Wages Provisions Maintenance Repairs Stores & supplies Lube oil Water Insurance Overheads	Operating costs: note that under bare boat these are paid by the charterer
3. Port costs Port charges Stevadoring charges Cleaning holds Cargo claims *4. Bunkers, etc* Canal transit dues Bunker fuel	Voyage costs: note that under time-charter and bare boat contracts these costs are paid by the charterer	
4. Contract of Affreightment (COA): cost profile same as voyage charter		

Voyage charter is an agreement that contains information about the transport of a certain type of cargo from point A to B for a specific price per ton cargo. The contract generally includes loading & discharging port(s), cargo size range and loading and discharging times. In this type of contract, the ship owner has the highest risk since it is subject to the voyage and navigational risk. Responsibility of loading and discharging operations depend on the charter party agreement. Voyage charters are frequently used in bulk trade.

Time charter is an agreement in which the ship, for a specified amount of time, is operationally controlled by the charterer while the ownership and management is still the responsibility of the ship owner. The ship is in fact hired by a charterer. Within agreed conditions, the charterer decides the trading area and the type of transported cargo. The time period of a time charter contract can vary from a single voyage (time charter trip) or a longer period (period charter). The ship owner receives a day rate by the charterer for renting out their ship(s). Voyage related costs, such as demurrage/despatch, stevedoring/lashing, bunkers, are paid by the charterer. Time related costs, such as insurance, maintenance, management services, are still borne by the ship owner.

Bareboat charter is a contract in which a charterer gets full control over the ship. The time related costs are in this case also for the charterer. The charterer is responsible for all voyage and operating costs. The ship owner is in general not involved in the operation of the vessel. The ship owners usually consider the vessel as an investment. A bareboat charter has the advantage for the charterer that a huge investment in a ship is not necessary. At the same time, the investors/ship owners may have tax benefits.

Contract of affreightment (COA) can be considered as a combination of voyage charters. In this contract the ship owner agrees to transport a given quantity over a certain time period for a specified price per ton cargo. The ship owner has the freedom to plan their ships in the most efficient way. Ship names are not named in advance in a contract of affreightment. COAs are often used in trade of dry bulk cargoes.

Each charter party also includes certain clauses. The most important ones will be explained:

1. **Always afloat, safe port, safe berth**: the charterer takes the responsibility that the ship is only ordered to destinations (ports and berths) which are considered to be safe. A widely used legal definition under common law states (PCO Taskforce, 2019c): *"A port will not be safe unless, in the relevant period of time, the particular ship can reach it, use it and return from it without, in the absence of some abnormal occurrence, being exposed to danger which cannot be avoided by good navigation and seamanship."*
   This citation also includes that the port usage is safe which means for example that the berth is available for the vessel at the required time. A charterer needs port information (e.g. depth restrictions, service availability) to determine whether it is safe or not. In fact, this type of port information should be easily obtainable by the charterer. More content of port information is given on the next page.

2. **Delivery of ship**: the ship must be present at the destination at the certain time as agreed with the charterer. In a charter party, agreements are made about laydays and cancelling date. Laydays describes the period a vessel must be present at the agreed location for loading/discharging. The cancelling date refers to the final date a vessel must be presented. If the vessel is not on time and arrives after the cancelling date, the charterer may refuse the contract. Laydays and cancelling date agreements are often combined into laycan. For example, "lay/can 8/11 October" means that laydays begin at 8th of October and the cancelling date is 11th of October. Thus, the vessel must be present between 8 and 11 October. The charterer may cancel the vessel for another vessel if it arrives after 11 October (General Cargo Ships, n.d.).

   If a vessel is ready for loading/discharging operations, it sends a Notice of Readiness (NOR) to the charterer. In case of a virtual arrival scheme, a vessel can submit a NOR if it has not yet arrived. This would enable speed adjustments to arrive on time. A valid NOR means a vessel meets the three criteria: present at the agreed place, physically ready and legally ready (Rabeux, 2017).

3. **Discharging/loading time**: Lay time is a term that quantifies the allowed duration in hours of loading/discharging cargo after NOR. Demurrage costs must be paid by the

charterer to the ship owner if the cargo operations (loading/discharging) time exceeds the agreed duration in the charter party. If the time is below the minimal threshold, despatch costs must be paid by the ship owner to the charterer.

4. **Communication operations**: The vessel is obliged to render arrival updates (e.g. ETA) to the port authority. More updates are required if vessels are closer to the destination.
5. **Clearances for financing of cargo/ship**: Clearances provided by banker/insurer of the vessel or cargo might be required in certain situations. For example, if the trip destination is unsafe due to piracy, clearances might be needed**.**
6. **Speed agreements**: Time charter party might specify minimum or maximum speed of the vessel in certain situations.

Cargo contract final

Besides the cargo contracts as discussed in Table B.1, several contract related documents are also important in shipping transport. An overview of the most important documents is given below:

- Bill of Lading (B/L) – document which is defined as follows (iContainers, n.d.): *"The Bill of Lading acts as evidence of a contract of carriage between the shipper and the shipping line to carry out the transportation of cargo under the terms and conditions agreed upon between the seller and buyer. It proves the existence of a goods transportation contract".*
- Time sheets – quantifies the exact start and completion time of the operations. It also specifies the cargo quantity and the lay time calculation.
- Statement of Facts (SOF) – gives a detailed activity overview, in chronological sequence, of the vessel in a port. It specifies activities such as pilots onboard, tugs, (un)mooring, loading/discharging operations. It further shows the quantity of loaded/discharged cargo and the fuel onboard (Logistics Glossary, 2019).
- Letter of Protest – a way to express a disagreement by a party towards another party. A party claims that the other party is responsible about a certain issue which leads to damaging effects fort the complaining party. The dispute is usually related to cargo.

Contract terminal

A terminal consists of a few berths together to provide operational facilities of certain type of cargos. The carriage contract (container) is related to a terminal contract. Container terminals are involved in activities such as handling, storage, discharging/loading containers to another transport modality. It can be divided into five categories based on the ownership (Ting, 2007; Singh, 2019):

- **Public/state run terminals**: In general, shipping lines are not charged different tariff rates and obtain no priority in berth usage by public terminals. Vessels are usually subject to the 'first come first serve' principle. Container handling is computed at regular tariff rates or at quantity discount rates.
- **Carrier-leased dedicated terminals**: terminals are only used by carriers which made long-term lease agreement with the port authority. Carriers (e.g. large shipping companies) pay the lease amount to obtain priority access of the berths. A distinction can be made between single user and multi-user contracts. Single user contracts are agreements with only one carrier and terminal. Multi-user contracts can be considered

as agreements with a terminal and joint venture between shipping lines in order to share terminal usage.

- **Terminal-operator built and operation terminals**: terminal operator leases or makes investments (e.g. in cranes, berth) in the container terminal. It usually pays a deposit to the port authority. The amount of deposit is contractually agreed and based on the value of the terminal operations.
- **Carrier built and operation terminals**: one or more carriers leases or makes investments (e.g. in cranes, berth) in the container terminal. It usually pays a deposit to the port authority. The amount of deposit is contractually agreed and based on the value of the terminal operations. The carriers can also provide terminal services to other shipping companies in addition to the own fleet.
- **Joint venture of carriers and terminal operators**: this category is a combination of terminal-operator built and operation terminals, and carrier built and operation terminals. Carriers (shipping lines) and terminal operators cooperates in the context of a joint venture. Investments or lease agreements are concluded with the port authority.

The value of the terminal operations, as stated in the contract between the terminal and carrier, mainly depend on:

- Loading/discharging time which is equal to the difference of ETA berth and ETD berth
- Expected berth moves per hour (BMPH)
- Number of containers and container tariff
- Duration of container at the terminal before/after transport to/from the vessel
- Time that stowage list must be present at the terminal. A stowage list is document which gives information about the container locations on board of the container vessel.

Port information

Any place a ship can call stands for a port. This means a place with possibilities to load, discharge, maintenance & repair, and anchor. In order to select the right contract to the right vessel, certain information about a port must be acquired. Port information consists of information from the pilot boarding place to the berth. The pilot boarding place is the point at which the pilot (dis)embarks.

From the pilot boarding place to the berth, a ship navigates through certain port sections. A distinction is made between four sections.

- Fairway: main navigable channel in a river or port that has enough depth for vessels.
- Turning basin: specific enlarged area where vessels can turn.
- Basin: port section used for port operations. It is connected to the sea, another port or other basin. This area is generally enclosed (by quays) in order to safely perform operations.
- Berth pocket: port section at berth or anchor berth which can be used by vessels to make fast for mooring or anchoring.

The availability of port information increases the reputation of a certain port. However, data ownership and data sharing often depends on the power of the port authority. Ports can be governed by:

- Local community or state: focus is not always on shipping by local authorities since the port might be relatively less profitable for the local community.
- National or federal authority: more focus is on shipping since national needs are more important for the national authority. In contrary to local authorities, communication might contain multiple stages between the port and national authority.
- Mix of local community and national authority
- Private parties: ports are generally not controlled by many private parties. Data sharing might be relatively more cumbersome since private parties consider data as sensitive.

Port information must provide information about the port access. Safe accessibility of the port means vessels can safely enter, arrive and lay at the berth. Within a port, the master falls under the control of the authority but the vessel's master remains responsible. The master is positioned above charterers and ship owners in terms of control.

Port information should at least include size and depth restrictions, specific constraints for certain port calls, availability of nautical service providers, and information availability of the vessel arrival at the port.

Size and depth restriction
From the pilot boarding place to the berth, information should be provided about the maximum dimensions. This includes information about restrictions of the vessel's length, beam, draught, air draught, arrival displacement.

Port information should also consist of restrictions at a berth. This must obviously also contain maximum dimensions of the vessels. Berth information should further include restrictions on the maximum displacement and the minimum parallel mid body (PMB) of a vessel alongside the birth. PMB specifies the vessel's length at which the shape and size of the mid ship section remains equal (Wärtsilä, 2019).

The vessel's maximum draught in a port also depends on tide. Hence, the port must provide data about maximum draught in- and excluding tide operations. To make an accurate estimation of the maximum draught, the master needs information about the minimum water depth, tide level, currents, water density, under keel clearance (UKC) allowance per vessel, soil type, load line zone (Summer, Winter, Tropical, Winter North Atlantic, Fresh, Tropical Fresh), time zone. Currently, this type of information is sometimes hard to obtain. Several parties are responsible for different coastal and inland areas. For example, local authority could take care of waterway data and the port authority of port basins.

Specific constraints for certain port calls
Port safety can be different for each vessel and for each period. Restrictions can thus also vary for a specific vessel based on the dimensions, type, destination and waterway of the vessel. The constraints depend amongst others on the sea state (e.g. significant wave height), weather (wind, visibility), tide, current, possible ice state, fairway planning and conditions.

It could also be a combination of vessel and period constraints. For instance, a fully loaded ultra large container vessel (ULCV) reacts differently on wind force eight than a half-loaded container feeder. This also means that restrictions must differ per vessel (group).

Availability of nautical services
Without information about the availability of the nautical services, a master cannot make a tight planning. The nautical service providers are the pilots, tugs and boatmen. Special mooring

equipment is occasionally also needed. The availability is also dependent on the working hours and local holidays. Public nautical services generally disclose more information than private nautical services.

Information availability of the vessel arrival at the port
At time of port arrival, the master must obtain information that can influence the current port call process. The charter party requires a notification system to provide the updates about unsafe events. Information about the ISPS security level must be available. A charter party also requires contingency plans, which are preparations in case of unexpected future events. These are needed to advice the master in case of unsafe situations.

Berth information

Besides port information, berth information is obviously important to select the right contracts for a vessel. A berth is considered to be the quay used by a vessel to anchor or lay alongside. To give more accurate information to the master, a berth can be more specified by a berth position. This is the specific location along the berth (e.g. bollard number) at which the vessel can moor.

Safe berth information is differently considered by the berth operator and port authority. This is because different approaches are used for the vessel's maximum size alongside the berth. The berth operator only cares about possible damages on the quays. The port authority, in turn, also requires that the vessel alongside the berth does not impede the passage of other vessels.

Safe berth information must contain the same elements as safe port information. The only difference is that information availability of the vessel arrival at the port is changed to information availability of berthing ship.

Passage planning

If a vessel departures at port A, it must plan the trip to port B. A passage plan is of great importance for safe navigation from berth to berth. Regulation 34 of IMO SOLAS Chapter V states (Maritime & Coastguard Agency, n.d.):

"Prior to proceeding to sea, the master shall ensure that the intended voyage has been planned using the appropriate nautical charts and nautical publications for the area concerned, taking into account the guidelines and recommendations developed by the organization.
The voyage plan shall identify a route which: takes into account any relevant ship's routeing systems, ensures sufficient sea room for the safe passage of the ship throughout the voyage, anticipates all known navigational hazards and adverse weather conditions, and takes into account the marine environmental protection measures that apply, and avoids, as far as possible, actions and activities which could cause damage to the environment."

Most accidents take place between the pilot boarding place and the berth. A passage plan aims to reduce the incidents and thereby increases the safety on the waterway. In order to make an accurate passage planning, the master needs port and berth information. However, if available data differs per information owner it may be difficult for the master to select the right data. A master usually uses two sources to obtain the required information. It makes use of authorized information (nautical charts and publications) and local information. If both information sources use different standards, misconceptions can exist.

The national hydrographic office of the port is responsible for the nautical charts and publications. The national hydrographic office usually belongs to the national authority, which is in most cases the navy department. The national hydrographic office can choose to enter a contract with the UKHO to use the same charts and publications.

Estimated Time of Arrival berth

The master usually sends the ETA berth to an agent. The agent is the contact person of the vessel for all parties ashore. The number of updates given by the master usually increases when the vessel gets closer to the port/destination. This is also called the narrowing down method.

The contract of carriage specifies which notifications are mandatory to be sent. Port charters require a notification of NOR at the pilot boarding place / anchorage. Berth charters require this at the berth. Port charters are more often used.

Tramp shipping

In tramp shipping, the vessel sends an ETA berth notification to the terminal as agreed in the charter party. If the vessel has more destinations within a port, each terminal receives an ETA berth of the vessel.

Liner shipping

The fixed schedules in liner shipping are not always realised as a result of, for example, tidal restrictions and canal transits. Therefore, the vessel sends an ETA berth notification to each terminal.

Berth planning

The information of the vessel's ETA, berth information and planned time of departure of each vessel is used by the terminals to make a planning. Subsequently, the terminal delivers a requested time of arrival berth to the ship. It requests the vessel to be present at the terminal at a certain time. Terminals use different systems to create a planning. Digital planning systems are not always used to create a planning. Some terminals still use excel, paper cards or phone calls. Information is not always shared digitally.

Tramp shipping

The terminal is usually not part of the charter party. A terminal service contract is mostly used. It specifies agreements such as the price for discharging/loading cargo and demurrage conditions (TPS, n.d.). Since the demurrage agreements can be different per vessel, the terminal might prioritize certain vessels based on the demurrage agreements. Vessels with higher demurrage costs might be prioritized first. This makes the information of terminal planning sensitive. In normal situations, 'first come first serve' is applied at terminals.

Liner shipping

If a customer is the only customer of the terminal, the planning information is usually not considered to be sensitive. This changes if the terminal has more customers, or if it is the owner of the terminal. Specific vessel can be prioritized based on contracts, agreements or relations. This makes this type of information sensitive. However, 'first come first serve' is normally the case.

Planned time of arrival berth

If the RTA berth delivered by the terminal is accepted by the responsible person of the vessel (agent/master), the requested time of arrival berth changes in planned time of arrival (PTA) berth.

Tramp shipping & Liner shipping

If the vessel has more discharging/loading destinations within one port, it also receives several RTAs of the terminals. The arrival sequence of different terminals depends on the customers, availability terminals, stowage plan, port restrictions (e.g. size and depth restrictions) et cetera.

Estimated time of arrival pilot boarding place

By means of the PTA berth information, the agent/master of the vessel sends an ETA pilot boarding place. This time is needed to make a sufficient port planning. This process does not differ in tramp and liner shipping.

Port planning

The ETA pilot boarding place of the vessel is used by the port authority to give the RTA pilot boarding place. The requested time of arrival pilot boarding place depends on:

- Size and depth restrictions vessel
- Specific vessel constraints
- Berth availability
- Fairway availability
- Nautical service providers availability
- Clearances

If the ETA and RTA pilot boarding place do not match, the reason for the deviation (e.g. unavailability nautical services) must be identified. This type of information must be available to determine which party is responsible for the costs of delays.

Nautical service planning

The nautical services need to be requested in advance in order to be available at the right time. The service providers usually need the RTA pilot boarding place of a vessel at least 2 à 3 hours, but sometimes up to 6 hours in advance. This differs per provider and mostly depends on the vessel's destination and station location of pilots, tugs and boatmen.

Clearances

Local authorities are responsible for providing clearances to the ship. The ship needs to get these clearances prior a specific moment. For example, health clearances are required before the vessel has entered the port. It is a proof that health condition of the vessel's crew is fine (Sharda, 2019). Before loading/discharging operations have started, customs clearance must also be given to the vessel. This is a customs formality which is needed to get permission for import/export of certain goods in a country. Since clearances need to be provided prior a certain moment, it must also be taken into account in the port planning.

Planned time of arrival pilot boarding place

If the RTA pilot boarding place delivered by the port authority is accepted by the responsible person of the vessel (agent / master), the requested time of arrival pilot boarding places changes in planned time of arrival pilot boarding place.

Actual time of arrival pilot boarding place

The actual time a vessel is at the location of the pilot boarding place is called the actual time of arrival (ATA) pilot boarding vessel. The ATA PBP is usually noted in a vessel's logbook. AIS information could also provide these data.

Tramp shipping

If the vessel is at the agreed destination, it delivers a NOR to the charterers. This moment depends on the agreements in the charter party. The charter party specifies if the ship must have been arrived at the specific berth, or just within the port. This determines if a vessel delivers a NOR at the berth or in the port. NOR is important in the calculation of the lay time. As the ATA pilot boarding place influences the NOR, it is sensitive information.

Liner shipping

The ATA pilot boarding place is usually considered to be not sensitive in liner shipping. In general, the information of ATA pilot boarding place cannot be used to derive contract agreements.

Actual time of arrival berth

The definition of ATA berth is often a point of discussion. Some consider ATA berth as the moment of fastening the first line of the vessel. While others deliver ATA berth when all the lines are fastened.

The International Regulations for Preventing Collisions at Sea (COLREGs), published by the IMO and aims to prevent collisions at sea, defines that a vessel is underway if it is not aground, at anchor or fastened to the shore. Therefore, the ATA berth must be considered as the moment of fastening the first line.

Vessel and cargo service planning

The service planning is mainly dependent on the critical services. These type of services need to be performed before the vessel's departure. Noncritical services are services which are not urgent at that time. These services can thus also be performed in the next port. The service planning can be slightly more complicated in a few cases. It depends among others on the number of terminal visits within a port and regulations about simultaneous bunker and cargo operations. Furthermore, the contact person for the services influences the service planning. The agent is not always the contact person. Consequently, the service provider might not receive updates about arrival/departure times.

Cargo services – container terminal

A critical factor in the determination of a vessel's completion time is the number of allocated cranes. The number of cranes can even be changed during discharging/loading operations which will have a direct impact on the expected completion time. Terminal services are considered to be completed after the last move, including lashing/securing. It is the time at which all terminal operations, related to the ship, are completed. In certain situations, cranes need to be moved or crane's boom need to be lifted before the vessel is able to depart. The terminal completion time is then the moment that these crane operations are performed.

Vessel services

In a port several services need to be performed on the ship. This includes services such as bunkering, waste collection, bringing provision on board, repair & maintenance, lashing et cetera. The responsible party for ordering the services might be different for each vessel. It is important that the ship's services do not result into a delay at a terminal.

Completion time of bunker service by barges are the moment that the last mooring line is disconnected. In container shipping, completion time of lashing services depends on the service provider. An external party responsible for lashing may deliver a separate service completion time. However, a separate completion time is usually not given if lashing is performed by the ship's crew. It must be linked to terminal operations since lashing/securing is considered to be part terminal operations. Lashing/securing can thus affect the terminal completion time.

Note that since 1 January 2020 the IBF 'dockers clause' has come into force in container shipping. It basically states that lashing/securing must be performed by certified dock workers instead of ship's crew. Exception to this clause are vessels less than 170 metres length overall or vessels not falling under the criteria of the IBF (International Transport Workers' Federation, 2020).

Service planning – start and completion

The planning of the services shows similarities with the planning of the vessel. The service provider initially delivers a notification of estimated time of start (ETS) service. Following this, the vessel answers with a requested time of start (RTS). This is based on aspects such as rest hours of the crew, bunker planning, position of operating cranes. If the service provider agrees on the vessel's RTS, it will become planned time of start (PTS). If the service provider does not agree, the ETS and RTS process starts again. The actual time of start (ATS) should be the same as PTS.

The same applies for the completion time of the vessel's services. The service provider sends an estimated time of completion (ETC) to the vessel. If ETC fits in the schedule of the vessel, it delivers a requested time of completion (RTC). An agreement by the service provider leads to the planned time of completion (PTC). The actual time of completion (ATC) should be the same as PTC.

International Ship and Port Facility Security Code

International Ship and Port Facility Security Code (ISPS) is a safety measure introduced by the IMO after the 9/11 attacks. It consists of preventive measures and security detection methods. The regulation aims to maintain safety for the maritime transport sector (vessels, ports, cargo, crew) (Flexport, n.d.). Vessels above 500 gross tonnage involved in international trade, ports, terminals and service providers must comply with ISPS regulation. It also means that all services need to be identified. ISPS also impacts vessel and cargo service planning.

Maritime Labour Convention

The Maritime Labour Convention (MLC) describes the rights and work conditions of seafarers (Seafarers rights international, n.d.). The vessel's master must comply with these regulations. In the port, the rest hours of the crew are most important. The service planning must be aligned with the work hours of the crew.

Estimated time of departure berth

The vessel must provide an ETD berth. Furthermore, the nautical service providers must again be ordered in advance in order to be available at the right time. The service providers usually need the RTA pilot boarding place of a vessel at least 2 à 3 hours, but sometimes up to 6 hours in advance.

Port planning

The ETD berth is used by the port authority to give the RTD berth. The requested time of departure berth depends on:

- Size and depth restrictions vessel
- Specific vessel constraints
- Fairway availability
- Nautical service providers availability
- Clearances

If the ETD and RTD berth do not match, the reason for the deviation (e.g. unavailability nautical services) must be identified. This type of information must be available to determine which party is responsible for the delays.

Planned time of departure berth

If the RTD berth delivered by the port authority is accepted by the responsible person of the vessel (agent/master), RTD berth changes in planned time of departure (PTD) berth.

Actual time of departure berth

The actual time of departure (ATD) berth is also determined according to the COLREGs regulations. It states that a ship is underway if it is not aground, at anchor or fastened to the shore. Hence, ATD berth is at the point when the last line of the vessel is released.

Actual time of departure pilot boarding place

The actual time a vessel is at the location of the pilot boarding place during the outbound voyage is called the actual time of departure (ATA) pilot boarding vessel. The ATD PBP is usually noted in a vessel's logbook. AIS information could also provide this data.

C. COMPLETE ACTOR-STAKEHOLDER ANALYSIS OF ACTORS INVOLVED IN A PORT CALL

Appendix C includes the complete actor-stakeholder analysis of the actors involved in a port call. In this section the steps of the actor-stakeholder analysis method of Enserink et al. (Enserink, et al., 2010) are applied on the involved actors in a port call. Due to the size of the report, Chapter 9 gives only a short introduction of the involved actors in a port call.

As mentioned in Chapter 9, several actors are involved in a port call process. However, these parties can have different relations, interests and objectives. Moreover, each actor can be different in terms of resources, power and influence on other actors. In this research, it is important to obtain this type of information about each involved party. It is essential to know what the current port call processes drive. Besides, the actors' opinions about the Just-In-Time initiative must be determined.

Therefore, an actor-stakeholder analysis is performed of the involved actors in a port call. The method of Enserink et al. (Enserink, et al., 2010) is a useful method to obtain these insights. The theory behind this actor-stakeholder analysis method is widely discussed in Section 5.1. The method of Enserink et al. (Enserink, et al., 2010) contains the following steps:

1. Problem formulation
2. Inventory of involved actors
3. Map formal relations of actors
4. Determine the interests, objectives and problem perceptions of actors
5. Analyse interdependencies between actors
6. Confront the initial problem formulations with the results

The **problem formulation** (step 1) is related to the fact that Just-In-Time arrivals and services is not yet implemented in MSC container shipping in the Port of Rotterdam. The current port call processes are not optimized in a way that the initiative can be implemented. Insight in the current port call processes is required. The current port call processes must be mapped and analysed in detail. The position and motives of each actor is of great importance in these analysis. The actor-stakeholder analysis must provide these insights. Note that the actors' perceptions about Just-In-Time initiative is also part of the actor-stakeholder analysis.

The **involved actors** (step 2) in this research contains actors that can influence the arrival/departure times of container vessels of MSC in the Port of Rotterdam. This is, however, a very wide definition. For this reason, a list of the involved stakeholder is provided.

The involved stakeholders are: MSC – shipping company, Loodswezen – pilots, Boluda – towage company, KRVE – boatmen, Port of Rotterdam Authority, harbour master, ECT Delta Terminals, APM Terminals Rotterdam, AMP Terminals Maasvlakte II – berth operators.

Two platform enablers in the Port of Rotterdam are PortXchange (Pronto) and Portbase (Port Community System). These parties are considered as stakeholders because both play an important role in the current port call processes. PCO Taskforce is obviously also part of the actor-stakeholder analysis.

The **next steps (3-5)** of the actor-stakeholder model are different for each actor. For this reason, these steps are separately applied for each actor.

C.1 MSC[3]

***MSC* |** MSC is the second largest shipping company in the world. It offers 200 ocean liner service including 500 port calls. It provides services with its fleet of 520 container vessels. MSC transported 21 million of full TEUs in 2019. The headquarters are based in Geneva in Switzerland. MSC is globally presented by its extensive agency network which is spread across 80% of all countries in the world. The operations are supervised by the headquarters of MSC.

Figure C.1: MSCs deep-sea container vessel and logo (MSC, 2020).

***MSC (Nederland) BV* |** MSC Nederland is the local agent of MSC Geneva and is established in 1985. Before this, an independent shipping agency 'Pegasus' was the representative of MSC in the Port of Rotterdam. As already explained, MSCs activities in the Port of Rotterdam has grown enormously. In 2018, MSC was responsible for the transhipment of 11.3% of the total container TEUs in the Port of Rotterdam. The increase of MSCs activities in the Port of Rotterdam also resulted in an increase of employees in MSC Nederland. Today more than 340 people work for MSC Nederland BV. The operations department in MSC (Nederland) BV is responsible for the coordination and guidance of operations of MSC deep-sea vessels in/to/from the Port of Rotterdam. Two divisions play an important role in the operational processes: port captains and captains' room.

***Port captains* |** Port captains of MSC are the eyes and ears of MSC Geneva; it is the link between terminal and MSC global headquarters in Geneva. Each country with a deep-sea port, where MSC vessels sail to, has port captains. Port captain(s) are responsible for their 'own' port. It keeps an eye on terminal services in their responsible port and coordinates MSC vessels from and to their port. Their task is to optimize the berth capacity and communicate with MSC Geneva operations and planning department. It puts pressure on terminals to improve terminal efficiency of vessels. Port captains are allowed to take action when it is required to let vessels depart from the berth. Port captains try to improve terminal services on MSC vessels.

Port captains have close contact with each other about the expected departure time of vessels in the 'previous' port. The previous port is dependent on the schedules and rotations that MSC vessels are expected to sail. Subsequently, the port captains of the 'next' port plans the estimated arrival time of the vessel in 'their' port by considering the quay availability on the terminal at the desired time slot. The port captains also estimate the expected departure time

[3] Most information in this section is obtained by working as an intern in MSC and interviews with employees of MSC such as Special Projects Manager (Den Ouden, personal communication, September 5, 2019), Regional Operations Manager (De Jong, personal communication, February 6, 2020), Port Captain (De Klerk, personal communication, February 14, 2020) and Marine Operations Manager (Jairam, personal communication, February 13, 2020). In addition, literature is used from the website of MSC (MSC, 2020). References are placed when other sources are used.

of the vessel in ‘their’ port. Port captains of the other ports need this information to make a proper planning.

Each port captain communicates this type of information by a so called ‘berthing plan’. This plan shows vessels including expected arrival and departure times in a port. Port captains of each port upload this berthing plan, which is an excel file, twice a day around 12:00 and 17:00 hours on the intranet of MSC. All port captains can download the berthing plans of each port. In addition, port captains of specific regions update each other during conference calls on Monday, Wednesday and Friday at 16:30 hrs.

In order to give accurate predictions about vessels’ departure times, port captains frequently communicate with terminal operators about the planning and execution. In Rotterdam, MSC port captains work from a small office located on the ECT Delta Terminal. In this way, it can monitor if everything progresses as planned at the terminals. For example, if cranes are not operating when an MSC vessel lays along the quay, port captains will immediately react to ensure timely departure of the vessel and improve the efficiency of the terminal berth productivity.

MSC has currently three port captains. There are usually two port captains during office hours. At least one person is present at the office from 7:00 – 19:00 hours. Outside these hours, one port captain is responsible for performing the activities from home. Captains’ room sometimes takes over the role of port captains by night.

***Captains’ room* |** The captains’ room is the communication line for the captain of an MSC vessel. The captains’ room of MSC Nederland is the representative of the captain in the Port of Rotterdam area. The captains’ room is the in-house agent of MSC Nederland. Since November 2019, MSC Nederland terminated the contract with Inchcape, a shipping agency, in Rotterdam.

The captains’ room uses the information of the berthing plans to provide the required information to the captain. It communicates, among others, at which time it is expected to be at the pilot boarding place and terminal and when it is expected to departure. The captains’ room additionally provides the required information to the port authority if a vessel plans to visit the Port of Rotterdam. It is responsible that the Harbour Master Division obtains the required information such as the vessel’s depth, crew list et cetera.

Moreover, the captains’ room is responsible for the vessel services, except terminal services, in a port call. It includes ordering and controlling nautical services, bunker services, ships’ stores deliveries, crew changes, doctor visit et cetera. The captains’ room must strictly monitor the nautical services in order to minimize waiting time and cancelation costs. It also performs the administrative tasks such as charging waiting time costs to service providers.

The captains’ room is operating 24/7. The employees work in a shift system. Since the port captains do not work 24/7, the captains’ room take over their activities in the night. However, there is still a port captain accessible in the night.

***Captain – crew MSC vessels* |** Another important player in a port call process is related to the vessel itself. The vessel is central in a port call process. Without vessels ports would not exist. The captain is the responsible person for the whole crew on a vessel. The captain has the responsibility to sail the vessel safely from point A to B. Even when a pilot is on board, the captain remains responsible.

Most MSC vessels sail according to a predetermined schedule of destinations. The captain obtains this information from the headquarters of MSC. However, the long-term schedules are subject to changes. The captains' room informs the captain about the requested/planned arrival and departure time in the Port of Rotterdam.

MSC Nederland is the representative for the captain when it is in the Port of Rotterdam area. Most communication goes via the agent which is MSC Nederland. Terminal operators usually have contact with MSC Nederland or MSC Geneva. It only communicates directly with the crew of MSC vessels about stowage plans.

C.1.1 Formal relations

Vessels that plans to visit the Port of Rotterdam are required to communicate certain information to the harbour master. The captains' room takes the responsibility to communicate in advance information such as ETD, vessel's depth, details of destination.

The captains' room must also provide information about the nautical service requests. Information about the number of tugs and tug company must be specified. Vessels larger than 75 metres are required to make use of pilotage and boatmen services. In addition, most vessels are also required to use towage services. This is dependent on, among others, destination in the port and weather conditions. More details about the exact requirements of nautical services follow further on in the actor-stakeholder analysis (Sections C.3-C.5).

MSC has specific contracts with the nautical service providers and terminal operators for their services. Pilotage tariffs are not subject to negotiations. Conversely, each vessel operator may have different contracts with towage companies, boatmen and terminal operators. MSC additionally need to pay port fees when their vessel visits the Port of Rotterdam. These tariffs are also non-negotiable. Additional information about contracts with service providers is also provided further on in this stakeholder model.

C.1.2 Interests, objectives and problem perception

MSC is obviously a for-profit company. The commercial oriented company has an interest in making profit. Its direction is to increase profits. MSC obtains revenues by, among others, the transportation of containers with cargo of clients.

MSC's objective is to keep growing in the fields in which it is active. It is already a global leader in container shipping, but it still wants to maintain and improve their position in the market. It means MSC also aims to strengthen their position in the Port of Rotterdam.

In order to growth as a company, MSC wants to increase their efficiency. It is, therefore, important for MSC that a port call of MSC operated vessels are minimized. The port captains, captains' room and crew of MSC vessels must make sure, that the time MSC operated vessels are in the Port of Rotterdam area, are optimized. It cooperates with the other service providers in a port call to achieve this.

MSC will obviously benefit from the Just-In-Time initiative. The main advantage will be fuel consumption which is beneficial in terms of costs and environment. Moreover, it can optimize their planning if it obtains real-time information of other actors in the chain. Another benefit is that MSC is also interested in reducing its carbon footprint since more clients are looking for logistic solutions with less impact on the environment. Today more and more clients also want to make a positive impact on the environment. It expects shipping companies to do the same.

MSC can, therefore, be considered as a supporter of Just-In-Time arrivals and services. The different players of MSC such as port captains and captains' room also see the benefits of the initiative. However, port captains also note that it is still a long way to go in order to achieve the benefits of Just-In-Time arrivals and services. All actors must be involved. Today, data from container terminals is not always up to date which makes it not reliable for the port captains. In addition, many bunker barges do still not share data which makes it more difficult for the captains' room to monitor the bunker services.

C.1.3 Interdependencies between actors

The vessels are central in a port call. Ports and nautical service providers would definitely have a smaller role without vessels. The most important resource for MSC is, therefore, the position in the network. It is because in a port call everything revolves about a vessel. In addition, MSC is a large player in the Port of Rotterdam. It can have a large influence on other involved actors which means it has a so-called power of realisation.

In the case study in this thesis, MSC is a critical actor in a port call. All processes are related to the MSC operated vessels. The vessels are, thus, of great importance in a port call. It is not replaceable in this case study. Both items make the resource dependency of MSC, therefore, high (Table 5.1).

Note that shipping operators as MSC are replaceable. However, a vessel is always central in a port call. It is a critical player in a port call. Since this thesis is narrowed down to container shipping of MSC, MSC operated vessels are also not replaceable in this case.

MSC will obviously be affected by the Just-In-Time initiative. As explained, it also expects benefits of it. MSC has a motivation to exert influence related to Just-In-Time arrivals and services. For this reason, MSC is considered as a dedicated actor. By using the information of Table 5.3, MSC can also be considered as an actor that will probably participate and are potentially strong allies in the Just-In-Time initiative.

C.2 ECT DELTA, APMT-R, APMT-MVII – TERMINALS[4]

***Container terminals* |** Terminal operators lease ground and 'basic infrastructure' of the Port of Rotterdam Authority. Container terminals are the type of terminals involved in a port call process of MSC. Container terminals (un)load containers on and from vessels. It is the place where containers are transhipped from vessels to other vessels or inland carriers (barges, trains, trucks) and vice versa. In addition to (un)loading of containers, terminals play a role in storage and staging (preparing container to leave/enter terminal) of containers.

The terminal operator is obviously an important stakeholder in the analysis. However, MSC vessels (un)load cargo at different terminals in the Port of Rotterdam. All these terminals are considered in this section. It must be noted that terminals may have different motives/incentives since the terminals are owned by different operators and have different operating methods. Each terminal is, therefore, discussed separately. It concerns the ECT Delta Terminal, APM Terminals Rotterdam (APMT-R) and APM Terminals Maasvlakte II (APMT-MVII). Figure 8.4 already showed the terminal locations in the Port of Rotterdam.

***ECT Delta Terminal* |** The ECT (Europe Container Terminals) Delta terminal is operated by Hutchison Ports ECT Rotterdam which is, in turn, a member of Hutchison Ports. Hutchison ports is active in each continent; it operates in 52 terminals in 27 countries. Hutchison Ports ECT Rotterdam operates terminals in the Netherlands, Germany and Belgium.

The ECT Delta terminal was opened in 1985. In 1993, this terminal became the first automated terminal in the world. Today, the terminal operates using automated guided vehicles (AGVs) and automated stacking cranes (ASCs). The quay cranes are still operated manually. According to experts in the field, the equipment on the ECT DDN is relatively often subject to failure.

The ECT Delta terminal has a total area of 272.5 ha and quay length of 4.4 km. The area is divided in three parts (Figure 8.4): DDE – Delta Dedicated East, DBF – Delta Barge Feeder, DDN – Delta Dedicated North. Almost all MSC vessels (un)load containers at the ECT DDN terminal since MSC has a joint venture based on volume commitment with the terminal. The maximum depth along the quay is 17.5 metres. ECT DDN terminal has a quay length of circa 1000 metres with 10 cranes. 5 cranes have a range of 20-22 metres and operate on the larger vessels. The other 5 cranes are smaller. The DDN berth has place for 2 larger deep-sea vessels or 3 smaller vessels. It can also tranship containers from/to barges at the terminal.

HUTCHISONPORTS
ECT ROTTERDAM

Figure C.2: ECT DDN Terminal owned by Hutchison Ports ECT Rotterdam (NOS, 2019; Hutchison, 2020).

[4] Most information in this section is obtained by interviews with Supervisor Quality Planning and Business Consultant Operations of ECT Delta (Willemsen & De Jong, personal communication, March 6, 2020), Supervisor of APMT-R (Terpstra, personal communication, April 2, 2020), Manager Planning of APMT-MVII (Van Strien, personal communication, February 18, 2020). In addition, literature is used from the websites of ECT Delta (Hutchison, 2020) and APM Terminals (APM Terminals, 2020). References are placed when other sources are used.

***APM Terminals Rotterdam* |** Both APM Terminals Rotterdam (APMT-R) and APM Terminals Maasvlakte II (APMT-MVII) are operated by APM Terminals. APM Terminals is one of largest companies in its field. It is globally active in 68 countries with 78 terminals. It is the employer of 22000 people. It became an independent division of Maersk Line in 2001. Today, it is still owned by the same company which is renamed to A.P. Møller – Maersk (Maersk, 2020).

Since 2000, APM Terminals obtained its own terminal on the Maasvlakte I. Around 600 people work for APMT-R. It has a total area of 106 ha and a quay length of 1600 metres. The terminal has access to 13 cranes for sea vessels and 1 crane for barges. 5 cranes have an outreach of 23 rows to handle the larger container vessels. The terminal does not operate using AGVs and ASCs; straddle carriers and stacking cranes are manually operated. It might be the reason why this terminal is still more productive. In 2015, APMT-R was the most productive terminal in Europe for the fourth time in a row (Port of Rotterdam, 2015).

In December 2019, APM Terminals and Hutchison Ports signed a letter of intent for the acquisition of APMT-R to Hutchison Ports. The acquisition must still be approved by several unions and authorities. According to the agreement, APMT-R will continue operating as independent organization and keeps a volume guarantee with Maersk for the coming 5 years (WorldCargoNews, 2020). Since the takeover is not yet approved and APMT-R still operates in same way the coming years, it is assumed in this thesis that its position will not change.

Figure C.3: APM Terminals Rotterdam owned by APM Terminals (APM Terminals, 2020).

***APM Terminals Maasvlakte II* |** In 2015, APM Terminals Maasvlakte II (APMT-MVII) opened a new terminal at the Maasvlake II. It is the first container terminal without emissions both on and off site since it is powered by wind energy. In addition, APMT-MVII is the world's most fully automated terminal; 80% of movements are automated and remaining operations are remotely controlled. It uses AGVs, ASCs and controls the bridge cranes remotely from the office. Moreover, APMT-MVII can handle the very largest container vessels in the world.

APMT-MVII has a deep-sea quay of 1000 metres including 10 Super Quay Cranes (SQC's) to (un)load the world's largest vessels. The barge quay is 500 metres with 3 quay cranes. The terminal has a total area of 86 ha. It is important to note that this terminal concept has separated barge and deep-sea vessel quays.

In contrast to the ECT DDN and APMT-R terminals, APMT-MVII can take less advantage of spaces in the planning. Let's illustrate this with an example. An MSC deep-sea vessel lays along the quay of APMT-MVII. The vessel's cargo completion time of the terminal is expected around 6:00 am. However, at 1:00 am the terminal receives a notification that the bunker barge, which lays along the MSC vessel, will not complete their services before 10:00 am. It means the terminal will complete operations at 6:00 am but must wait at least 4 hours before it can continue operations. This is obviously not planned. However, things like this happen in reality and involved parties must deal with it.

Consultation of experts revealed that terminals that (un)load barges and vessels with the same quay cranes have more possibilities to anticipate these situations. For example, it can choose to decrease the number of cranes performing operations on the deep-sea vessel and use these cranes to operate on barges. Therefore, the cargo completion time of the terminal for the deep-sea vessel can be 'delayed' until the bunker barge completes their services. At the same time, the terminal can still use the resources when it also performs operations on barges.

It is also important to note that APMT-MVII is a relatively new terminal. [redacted]

Lifting Global Trade
APM TERMINALS
APM Terminals Maasvlakte II

Figure C.4: APM Terminals Maasvlakte II owned by APM Terminals (Torn, 2019; APM Terminals, 2020).

***Working hours* |** In general, terminals work with a certain shift system (24/7). The morning shift is from 7:00-15:00 hours, evening shift from 15:00-23:00 hours and the night shift is from 23:00-7:00 hours. During a change of shifts, the crane does not operate for about 30 minutes. The shifts itself are eight hours but does also include meal breaks. Each shift consists of half an hour break. In addition, the workers must also be transported to and from the cranes in case of manually operated cranes. In total, breaks can last 40-55 minutes per shift. Note that these are standard shift systems. Each terminal can make adaptations to these shifts. The terminal must, however, satisfy the contracts of the labour unions.

Terminals use different options to overcome the loss of operation during breaks of workers. Most terminals can move the time window of breaks with an hour in case a vessel arrives outside the 'regular' break windows. Other options are usually related to extra shifts that work during the breaks, or extra people per shifts. The chosen options differ per terminal. For example, ECT occasionally uses an extra person per shift and APMT-R makes use of long and short shifts to overcome the breaks.

A shift size is related to the degree of automation of terminals. APMT-R does not use AGVs and ASCs. Their standard shift consists, therefore, of 5 workers: crane operator, 2 radio operators and 2 carrier drivers. ECT DDN uses shifts of 3 workers since it uses AGVs.

***Planning* |** The planning of the shifts is based on the expected work/volume. Each terminal has a certain amount of own people it can use for their shifts. In addition, terminals use a pool where extra temporarily agency workers can be asked for peak periods. Moreover, it can ask their own workers to work longer shifts in peak periods. In off-peak periods, these people can get extra days off.

Terminals make a distinction between long term and short term in ordering shifts. In general, forecasts are made 7 days in advance about the number of workers which are needed per shift. It is based on the expected amount of volume of containers in this period. This planning is considered as long term. The final decision comes 24 hours in advance on weekdays and 72 hours for weekends. At this moment, the exact amount of people is ordered for each shift.

MSC asks for a certain amount of 'shifts' at the terminals based on the expected vessels. Experience of MSC employees revealed that APM terminals usually have the same number of persons available. Conversely, ECT DDN is sometimes able to scale up the number of persons available for MSC.

C.2.1 Formal relations

Terminal operators have specific contracts with the Port of Rotterdam Authority to lease ground and 'basic' infrastructure. The depth along the quay is maintained by the Port of Rotterdam Authority and is usually part of a contract.

Terminal operators do also have contractual agreements with shipping companies. Terminal operators provide services and obtain, in return, money for these services by shipping companies. This type of contracts usually consists of several components such as:

[redacted]

Delays caused by shipping companies are recovered by terminals and vice versa. In practice, shipping companies are clients of terminal operators. It is more often the case that MSC charges costs to the ECT DDN than the other way around.

Since 2011, MSC and the ECT Delta Terminal have a joint venture cooperation which is based on volume commitment. MSC brings volumes to the terminal and, in turn, the ECT reserves their DDN quay for MSC vessels. Note that MSC is not owner of the quay or part of the terminal. It is an agreement based on volume commitment.

Compared with APM terminals, ECT DDN seems to be more flexible in planning for MSC vessels and cargo. MSC makes often last-minute changes to container quantities for example. ECT DDN is more flexible in adapting to these situations compared to APM terminals. Moreover, MSC's port captains have more control about the berth planning at the ECT DDN since almost all vessels along this quay are MSC operated. [redacted]

In addition to terminal agreements between both APM terminals and MSC, there is also another indirect relation. Since both APM Terminals are owned by Maersk, it also effects MSC. MSC and Maersk operate both in an alliance (2M-alliance) which means vessels share cargo of MSC and Maersk. Thus, MSC vessels visiting these terminals also have cargo on board of Maersk.

C.2.2 Interests, objectives and problem perception

The terminal operators (ECT Delta, APMT-R, APMT-MVII) are for-profit companies. The commercial oriented companies have interests in making profit. It obtains revenues by performing services to shipping companies.

The objective of the involved terminals does also not differ per terminal. All terminal operators want to improve their terminal services and operations to satisfy clients' needs. By providing high-quality services it hopes to attract and maintain clients.

Terminals' perceptions about Just-In-Time arrivals and services differ per terminal. All terminals are profit oriented and are, therefore, not against optimization. However, the involved terminals have different operating procedures which may make the Just-In-Time initiative less beneficial for some operators.

As explained, terminals that (unload) containers from barges and deep-sea vessels are more flexible in changes in the planning. For example, if a vessel will arrive just-in-time at 11 am, but the terminal is earlier ready than expected with terminal operations on the previous ship, it can choose to bridge this time to (un)load container from barges.

However, it is important to note that each terminal can benefit from the initiative. Terminal operators support the initiative. According to the terminal experts, more clarity and accuracy in the arrival time of vessels will definitely improve the terminal planning. Terminal operators can adapt and optimize the planning of resources if it knows vessels arrive at the predetermined time. In the current situation, it is still possible that vessels are later than expected due to unavailability of nautical services for example.

However, terminals realize that the current port call situation is far from the desired situation. Data sharing is still an issue. Besides, it is important that all involved actors take part in the Just-In-Time initiative. This is also not the case right now.

C.2.3 Interdependencies between actors

The most important resource of terminal operators is the position in the network. Shipping companies must collaborate with terminal operators since it needs someone who (un)load their cargo. Terminal operators in general cannot be replaced and are of great importance in a port call. All terminals have a high dependency and are considered as critical actors.

Several terminal operators are operating in the Port of Rotterdam. It might suggest that these terminals are easily replaceable. However, ECT and APM terminals are currently still critical actors for MSC since it has direct and indirect relations with these terminals. MSC has a joint venture commitment with the ECT terminal. In addition, APM terminals are owned by Maersk and MSC is part of the 2M-alliance with Maersk.

Since terminal operators possibly perceives benefits of Just-In-Time arrivals and services, these actors are also considered as dedicated actors. The actors will probably participate and may potentially be strong allies to enable the Just-In-Time initiative.

C.3 Loodswezen – Pilot organisation[5]

***Pilot profession* |** The coastal area of a port is subject to unpredictable changes in terms of currents, wind, visibility et cetera. It might be difficult to manoeuvre a vessel through a port area without up-to-date knowledge about the entire coast and estuaries. Therefore, the navigation is performed by registered maritime pilots which are specialized in a certain region or port. The pilots guide sea-going vessels into and out of seaports. Their aim is to navigate a vessel safely to, through and from a specific port. During this process, pilots communicate and collaborate with other stakeholders such as tugs, boatmen and the harbour master. Note that the captain is still responsible during the port operations. The captain is, however, deemed to listen to the experts (pilots) of the port area.

***Nederlands Loodswezen* |** 'Nederlands Loodswezen' is the organisation responsible for the guidance of vessels subject to compulsory pilotage in and from Dutch and Flemish seaports. It is a private organisation which became independent in 1988. Before this, it fell under the Dutch Minisitry of Defence. Loodswezen consists of two parts: Nederlandse Loodsencorporatie – NLc (Dutch Maritime Pilot's Association) and Nederlands Loodswezen BV – NLBV (Dutch Pilotage Service). It is considered as a public and private body.

NLc is responsible for the education of current and future pilots. It gives professional trainings and lessons to provide pilots with up-to-date knowledge. Its main task is to preserve and improve the quality of pilot services. NLc is an officially recognized educational institution by the Dutch Ministry of Education, Culture and Science. All Dutch registered pilots are members and cooperate in the NLc. The pilots are registered in the pilot registry.

NLBV, often known as Loodswezen, is the organisation responsible for providing support to registered pilots in the execution of their profession. It leads the planning and provides services to transport pilots to and from the vessels. Furthermore, it performs the associated administrative tasks as collecting pilotage fees. The registered pilots are also shareholders of NLBV.

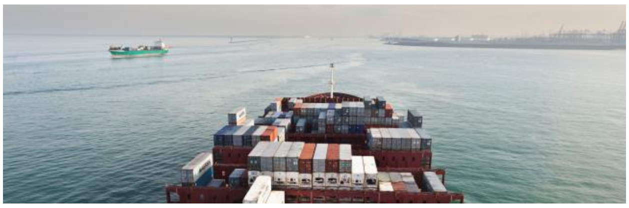


Figure C.5: Pilot's view of Loodswezen guiding container vessel to the Port of Rotterdam (De Ronde, 2019; Loodswezen, 2020b).

***Monopolistic position Netherlands* |** Loodswezen is the only party within the Netherlands which is qualified to provide pilotage services. Since it is the only organisation in this field, the ACM (Authority for Consumers & Markets) strictly monitors Loodswezen. The ACM is an organisation that protects consumers and business. It prevents that Loodswezen can abuse their monopolistic position. In general, Loodswezen estimates a budget which covers costs and investments, and the number of expected pilot trips. This results in the pilot fee. The ACM controls this, so that Loodswezen does not get (large) profits since this could suggest a misuse of their monopolistic position (Prent, 2015).

5 Most information in this section is obtained by an interview with Manager Operations and Marketing & Communication Manager (Oskam & Peekstok, personal communication, February 19, 2020), and literature on the website of the pilot organisation (Loodswezen, 2020b). References are placed when other sources are used.

***Rotterdam-Rijnmond* |** The pilot organisation works in four areas: North, Amsterdam-IJmond, Rotterdam-Rijnmond and Scheldemonden. The registered pilots are usually specialized and active in one region. For the scope of the thesis, we zoom in on the Rotterdam-Rijnmond area. The Rotterdam-Rijnmond area includes a large area such as the Maasvlakte, Europoort, Botlek, and ports up to Moerdijk and Dordrecht. An overview of the Rotterdam-Rijnmond area is shown in Appendix D.5. Pilotage services are performed 24/7 in several weather conditions.

***Pilot specializations* |** Each pilot is specialized to navigate a certain vessel in a specific area. There are divisions in terms of areas, size of vessel, and type of vessel.

A rough distinction can be made in three regions: the Europoort, city area, and Dordrecht-Moerdijk area. Note that a pilot can also be active in more than one region.

After having obtained the pilot degree, a pilot is allowed to navigate vessels up to 100 metres. Each year this will be increased by approximately 25 metres. In general, a pilot will specialize after being pilot for more than 5 years. A generalist is usually allowed to sail vessels up to 200 metres in the city area and Europoort. There are different specializations. For example, a sub-specialization for the Europoort are the gully vessels (channel bounded vessels). Container vessels longer than 350 metres also require a certain specialization.

The vessel type is generally not used as criterion for pilot qualifications. Pilots are usually allowed to navigate cruise ships, bulk carriers, container vessels et cetera. LNG tankers are the only exception due to the somewhat different vessel traffic rules.

***Transport equipment* |** Loodswezen uses a pilot vessel, launches, pilot tenders and helicopters to transport pilots to incoming ships and from outgoing ships in the Rotterdam-Rijnmond area.

The pilot vessel is positioned around the regular pilotage point (Figure 8.8). It functions as a hub on sea. Pilots from outgoing vessels are picked up and transported to the pilot vessel. Subsequently, these pilots prepare the next trip and will be brought to an incoming vessel. Note that the pilot vessels must not be considered as a hotel where pilots sleep. Pilots sleep at home and will be called from home.

Transport from and to the pilot vessel is performed with fast launches or pilot tenders. The fast launches are suspended on the pilot vessel. A small crane on the pilot vessel (davit) is used to bring the launch into and out of the water.

The pilot tenders are used in the (dis)embarkation procedure. For example, the pilots ashore are usually transported to the incoming vessel by a pilot tender. There are currently three pilot tenders in use. This means it is impossible to bring pilots to vessels on sea every 10 minutes. Approximately each hour a tender is available to bring a pilot to a vessel at sea.

It can be impossible or unsafe to reach the vessel during bad weather. In such cases a helicopter is sometimes used for transportation. Pilot are then brought to the incoming vessel or picked up from the outgoing vessel.

Figure C.6: Equipment Loodswezen including pilot vessel, fast launces, tender and helicopter (Loodswezen, 2020a).

If pilotage transport is not possible anymore, 'Shore Based Pilotage' is a solution. A special trained pilot will guide the vessel from a radar station ashore. When the incoming vessel has passed the piers, a pilot is brought to the vessel and guides the vessel to the destination. Outgoing vessels are navigated by a pilot until the piers. After that point, the vessel is guided from the radar station ashore. This option is usually only used for vessels with LOA and depth smaller than 150 metres and 9 metres respectively (Van Waasdijk, 2019).

***Working hours* |** All pilots work according to a schedule one week on and one week off. Approximately 75 persons are available each week. The pilots keep up a list which ranking is based on the last time a pilot was called in. The pilot on top of the list has spent the longest time without work. The pilot on bottom of the list has spent the least time without work. If more pilots are needed, pilots can be asked which are in the one week off schedule. In this way, it can increase the available pilots when needed.

Pilots can be called with a notice of 1.5 hours. The actual trip can be different per pilot. For example, it can get one long pilotage trip or two/three shorter trips. When the pilot has done the job, the person returns at home. The pilot is legally entitled to have eight hours rest. On average, a pilot is called 8 or 9 times a week.

***Planning* |** The planners of Loodswezen look ahead at least 4 hours in advance. It will check if the registered vessels are on time. It also looks at the pilot availability. Some vessels require a certain specialization of the pilot. If a pilot is available, it must be called from home and transported to the vessel. The pilots have 1.5 hour to be present at the office. However, it must also be brought to the vessel by tenders. In case of an incoming vessel, the pilots can guarantee that a vessel is embarked within three hours if pilots are available.

It is important to note that there is always one pilot, called 'chief pilot' at the office of the Harbour Coordination Centre. This is to enhance the planning and communication between the nautical services and the Harbour Coordination Centre.

C.3.1 Formal relations

The Pilotage Act states that a registered pilot's task is to provide pilotage services. Loodswezen is responsible for the safe guidance of vessels subject to compulsory pilotage in and from the Port of Rotterdam. In the Rotterdam-Rijnmond region, ships with length over all (LOA) smaller than 75 metres are not required to have a pilot on board when navigating through the Port of Rotterdam area. An exemption can be requested if the vessel's LOA is less than 95 metres. LNG vessels with a depth larger than 17.4 metre are even required to have two pilots on board when navigating through the port area. This is not applicable for MSC container vessels.

In extreme weather conditions such as fog and fierce storm, the chief pilot and duty officer of the Harbour Coordination Centre (HCC) will discuss about the options for guiding of incoming and outgoing vessels. Shore based pilotage is an often-used method in these situations.

Shipping companies which require pilotage service are subject to a certain tariff structure. The pilotage tariffs are publicly available and determined by the ACM (Loodswezen, 2020a). The tariff structure is fixed, which means vessel operators cannot negotiate these tariffs. The tariffs consist of a starting rate, route-dependent rate and additional charges. The tariffs are dependent on pilot boarding place location, depth, destination of the vessel et cetera. Each shipping company is subject to the same tariff structure. Since the tariff structures are made public, it will not be discussed in further detail.

An exception is made for the most important waiting time tariffs, since these are vital in this research. If a pilot is cancelled or the pilot services are not used, a pilot expense reimbursement must be paid of €340 and €186 for incoming and outgoing voyages respectively. A delay of each hour after the confirmed pilot order time costs €50. Appendix E shows the amount to be paid per delay period. Loodswezen will charge these costs to the vessel operator in case of a delay. If the delay is caused by another party (e.g. terminal), Loodswezen will still charge the delay costs to the vessel operator (e.g. MSC) which is Loodswezen's client.

C.3.2 Interests, objectives and problem perception

The pilots' main interest is continuity of business. It wants to contribute to an efficient and safe handling of vessel traffic. It is important for Loodswezen to provide high-quality services for the right tariffs, since it wants to retain their monopolistic position in the port of Rotterdam.

As part of the nautical chain, Loodswezen also wants to cooperate with the other nautical service providers to improve the nautical services. It is important for them that clients are satisfied and want to come back to the Port of Rotterdam in the future.

According to Loodswezen (Loodswezen, 2020a), the objective of the pilots is: "to *ensure a safe and quick passage of vessels to, through and from the various Dutch and Belgian ports, as well as to safeguard the interests of the environment"*.

The pilots are an important part of a port call and are, therefore, also affected by port call optimization in the form of the Just-In-Time initiative. Loodswezen also tries to optimize their processes. However, it is often dependent on information of other actors. Without sharing real-time information, it may be difficult for Loodswezen to optimize their planning.

Loodswezen is a supporter of port call optimization and the Just-In-Time arrivals and services initiative. In their opinion, optimized process also provides benefits for them. The most important aspect for them is, however, that the order time of pilots must be right and accurate. The pilot order time is decisive for Loodswezen, because this is the contractual agreement between the parties. From this moment, the planning processes will be started. More information about these processes is further explained in Chapter 13.

C.3.3 Interdependencies between actors

Most ships are not allowed to enter the Port of Rotterdam without a pilot. These vessels do not have a choice; a pilot is required to enter the port. According to Enserink et al. (Enserink, et al., 2010), this can be described as formal power. Furthermore, the pilots have a certain knowledge/skill to guide vessels to, through and from the port safely and efficiently. The most important resources of Loodswezen are, thus, the specific knowledge and the formal power.

Pilotage services can only be performed by pilots. Since Loodswezen is also the only organisation in the Port of Rotterdam offering pilotage services, it cannot easily be replaced. There are currently no options to replace the resources. Only pilots of Loodswezen are able to safely guide vessels in the port area. The resources of Loodswezen are, therefore, of great importance in the Port of Rotterdam. It means the resource dependency can be considered high (Table 5.1). In the actor-analysis, Loodswezen's pilots are critical actors in a port call.

Loodswezen is important actor of a port call process. As already mentioned, it supports port call optimization and the Just-In-Time initiative. Since Loodswezen will probably benefit, it is considered as a dedicated actor. According to Table 5.3, Loodswezen will probably participate and are potentially strong allies in port call optimization by Just-In-Time arrivals and services.

C.4 BOLUDA TOWAGE EUROPE – TOWAGE COMPANY[6]

***Towage profession* |** Vessel often need tug(s) assistance when it navigates through the port. A harbour tug is a special type of boat designed to provide towage services. Tugs assist vessels during (un)berthing procedures, manoeuvres in the port area, and shifting of vessels or offshore platforms. By pushing and pulling a vessel, it gives assistance in the navigation. A tug is part of the nautical chain in a port. The tug crew often communicates and collaborates with the other actors such as pilots and boatmen.

***Towage companies Port of Rotterdam* |** There are three companies providing towage services in the Port of Rotterdam: Fairplay, Boluda Towage and Svitzer. In total, these companies operate with approximately 40 tugs. In 2019, Boluda has a market share of 65% in the Port of Rotterdam. Fairplay and Svitzer are responsible for 35% of the market (Daling & Lalkens, 2019). Besides, Boluda currently started cooperating with Svitzer in the Port of Rotterdam.

***Boluda Towage Europe* |** Boluda Towage Europe, called Boluda in this report, is part of the Boluda Group which is established in 1837. The Group consists of three business divisions: Boluda Towage, Boluda Lines and Boluda Tankers. Boluda Towage is one of the largest companies in the towing sector. It provides towage services in main ports in Europe, Africa, Latin America and Indian Ocean. Boluda Towage Europe is part of Boluda Towage.

Boluda Towage Europe is active in the Netherlands, Belgium, Germany and the United Kingdom. It entered the towage market of the Port of Rotterdam in August 2019. At that moment it acquired Kotug Smit Towage. This company was formed after the merger of Kotug (part of Kotug International) and Smit (owned by Boskalis) in 2016.

BOLUDA TOWAGE EUROPE

Figure C.7: Boluda's tugs assisting MSC Gülsün into the Port of Rotterdam (Modeva, 2019; Boluda, 2020).

***Competitive market* |** The acquisition of Boluda Towage Europe was unavoidable in the Port of Rotterdam, according to the management of Kotug, Smit and Boluda. A consolidation of the towage market is required due to intense price competition in the towage sector. The large container shipping companies, which are the most important clients of towage companies, are the instigators of fierce competition. The container shipping companies make severe cuts in costs. Moreover, the co-operations between shipping companies weakened the negotiating position of towage companies. Consequently, towage tariffs have drastically reduced. In some cases, prices have been dropped up to half of original tariffs (Daling & Lalkens, 2019; AD, 2019).

***Equipment* |** Boluda has currently access to 23 tugs in the Port of Rotterdam. 20 of them are owned by Boluda and the other three tugs are rented. The fleet differs, among others, in size and tonnes bollard pull. Bollard pull is a widely used measure for pulling/towing power of a tug. Boluda has tugs varying from 45 to 90 tonnes bollard pull. The heavier tugs, with a larger

[6] Most information in this section is obtained by an interview with Manager Operations of Boluda (De Vries, personal communication, February 20, 2020), and by literature on the website of the towage company (Boluda, 2020). References are placed when other sources are used.

bollard pull, are positioned in the Europoort where larger vessels arrive and depart. The lighter tugs, with a smaller bollard pull, are in the city area where generally smaller vessels sail.

There are currently seven tugs positioned in the city area and the other tugs are in the Europoort. Most tugs are usually in use. There are a few required dockings per year in which some tugs cannot be used. The tugs also need some maintenance from time to time. Boluda does not have any 'spare' boats which could be used in busy periods.

***Working hours* |** Boluda makes use of two types of schedules: block schedules and full continuous schedules. A block schedule consists of 14 hours sailing and 10 hours rest per day which is according to the Maritime Labour Convention (MLC) legislation. The crew stays on board during the week. In a block schedule, the crew works according to a schedule one week on and one week off. The tugs are deployable 14 hours per day. Conversely, the full continuous schedule allows tugs to be deployable 24 hours per day. This schedule consists of two shifts of 12 hours a day. The first shift is on board the first 12 hours, the other shift the next 12 hours.

***Planning* |** The planners look approximately two hours ahead. For incoming vessels, tugs must often wait before a pilot is on board. The pilot gives advice about the number of tugs needed. At that moment the tugs can start planning. Planners must also take into account that some vessel require tugs with a minimum bollard pool. More planning details follow in Chapter 13.

C.4.1 Formal relations

Certain regulations regarding to tug requirements apply in the Port of Rotterdam. Requirements are put on number of involved tugs and minimum bollard pull. Regulations can differ per port area, vessel's length and depth and weather conditions. MSCs deep-sea vessels only operate in a few port areas in the Port of Rotterdam such as Europahaven and Prinses Amaliahaven. The restrictions for each relevant port area are set out in Appendix F.

It must be noted that the tug regulations often specify only a few restrictions. For example, tugs need a minimum bollard pull of 45 tons in the Prinses Amaliahaven when the vessel's length is greater than 325 metres and the wind speed exceeds 10.7 m/s. The requirements seem clear at first sight but do not specify the exact number of tugs required.

The pilot on board, therefore, plays an important role in these processes. Pilots generally take the final decision about number of tugs required when sailing in the port area. If a pilot does not agree with the predetermined number of tugs requested by the shipping operator, the number of tugs will be changed according to the pilot's advice. The towage companies are, thus, dependent on the pilot's advice.

Vessel operators usually have contracts with a towage company. In general, Boluda does not have time-based contracts. Standard tariffs of towage companies are published by the Port of Rotterdam each year. Each vessel operator can, however, have different contractual arrangements with a towage company. Vessel operators can negotiate about the standard towage tariffs. This situation is opposite to the fixed tariffs of Loodswezen.

Appendix E.2 shows the standard tariffs and conditions of Boluda in region Rotterdam. Tariffs depends, among others, on vessel's length and distance to destination. MSC has a contractual agreement with Boluda in the Port of Rotterdam. It gets paid by MSC to provide towage services for MSC vessels. MSC is a large client of Boluda in the Port of Rotterdam.

In case of a delay caused by Boluda, MSC charges costs to Boluda. Conversely, Boluda charges costs to MSC if Boluda's tugs are subject to delays related to MSC vessels. In simple words, MSC requests Boluda to provide towage services at a specific time. If Boluda's tugs are present at agreed time but cannot provide services due to a delay related to the MSC vessel, it charges delay costs to MSC. Besides, Boluda charges cancellation costs if MSC cancels a towage order.

Note that nautical service providers do only charge costs to the client. When another party causes delays in Boluda's operations at MSC vessels, Boluda still charges costs to MSC. Subsequently, MSC charges the costs to the final responsible organisation. For example, Boluda charge costs to MSC and MSC, in turn, to the terminal if the terminal is the cause of delay.

C.4.2 Interests, objectives and problem perception

Boluda is a for-profit organisation which has an interest in making profits. The direction of Boluda is to increase profits. It tries to retain and win clients by providing high-quality and flexible services for the right tariffs. As part of the nautical chain, Boluda also wants to cooperate with the other nautical service providers to improve nautical services. It is important for them that clients are satisfied and want to come back to the Port of Rotterdam in the future.

The objective of Boluda is to provide best possible services to their client. Boluda wants to achieve this by understanding the client's requirements and being involved with the client. It wants to let grow their businesses.

Boluda is also not against Just-In-Time arrivals and services. If it obtains real-time information about progression of activities in the port area, it can adapt to the situation. For example, an outgoing MSC vessel is delayed with 15 minutes. If Boluda obtains this information in advance, it has more time to sail to the location. The tugs can slow down and save fuel. In case of longer delays, Boluda can adapt the planning and change, for example, the allocated tugs for that job.

However, Boluda emphasises it can only work if all parties are involved. It will not work if it obtains information about only 60% of the vessels. It must know in advance which vessels are coming to the Port of Rotterdam. For example, if bulk vessels are not involved in the initiative, Boluda cannot make a proper planning since it must consider all vessels.

C.4.3 Interdependencies between actors

Towage services are mandatory in certain cases. In these situations, a resource of towage companies is formal power. Most important in a port call is, however, the pilot's advice. As explained, the regulations can dictate a minimum number of tugs required. Subsequently, the pilot takes the final decision. Towage companies, thus, have support of other actors in the chain. According to Enserink et al. (Enserink, et al., 2010), this type of resource can be formulated as position in the network. In addition, towage companies have expertise in their field. It is not possible for other companies to deliver this type of services at this moment.

Thus, the resources of towage companies are formal power, position in the network and knowledge/skills. Since, shipping operators have contracts with one of the three towage companies in the Port of Rotterdam. Abovementioned resources also apply to Boluda.

Most MSC vessels need on average two tugs during in- and outbound voyages. The towage companies cannot be ignored in the process and are, therefore, critical actors. Boluda is one of the three towage companies but is still a critical actor in the process. MSC has limited options to replace Boluda. Only two other towage companies operate in the Port of Rotterdam. The resource dependency of Boluda is, thus, considered high (Table 5.1).

As explained, Boluda is a supporter of Just-In-Time arrivals and services since the company can have benefits of it. Boluda is a critical actor in the process and is, therefore, considered as dedicated actor. If Boluda gets benefits of the initiative, it will probably participate (Table 5.3).

C.5 KRVE – BOATMEN ASSOCIATION[7]

***Boatmen profession* |** Mooring and unmooring procedures are not the easiest procedures of a port call. In order to make the operations safer, boatmen assist vessels during berthing, unberthing and shifting. In a mooring procedure, boatmen first sail to the vessel to collect their ropes. Subsequently, it brings these ropes to the boatmen ashore who attach the ropes to the shore bollards. Boatmen make sure vessels are moored properly. In case of unmooring, boatmen let go the ropes from shore bollards. Boatmen frequently communicate and collaborate with other nautical service providers.

Figure C.8: Boatmen of KRVE providing services in the Port of Rotterdam (Montfrooij, 2015; KRVE, 2020).

***KRVE* |** The Royal Dutch Boatmen's Association (KRVE) is the boatmen organisation active in the Port of Rotterdam. It is established 125 years ago. Before this, several small boatmen parties were responsible for the (un)mooring services. The procedures were based on first come first served principles. The boatmen that first arrived at the vessel, could do the job. This did not work well. Most boatmen wanted to provide services to the most 'profitable' ships. And 'cheaper' vessels were not always directly served. In 1895, the harbour master decided to change it. The result was the establishment of KRVE in which the smaller parties started working together in one organisation. In this period, the boatmen used rowboats and were called roeiers (rowers) in Dutch. Nowadays, the organisation has access to a fleet of modern vessels. All boatmen are qualified as skipper and are thus allowed to sail these vessels.

KRVE is available for their clients 24/7. Its main task is to assist in mooring and unmooring of vessels. KRVE also provides services during shifting, which means that a vessel changes location within a port. Boatmen assist in unmooring at location A and mooring at location B. Besides, KRVE is responsible for transport of pilots within the Port of Rotterdam. It also assists in emergency situations in maritime traffic and plays a role in innovation in the Port of Rotterdam. In 2013, it launched ShoreTension which is a product that allows ships to be more securely and safely moored to the quay. KRVE often uses ShoreTension to moor a vessel.

***Monopolistic position* |** KRVE is the only boatmen organisation in the Port of Rotterdam. Therefore, the organisation obliges itself to be always available and on time. It wants to prevent that their clients ask for a competitor in the Port of Rotterdam. What makes KRVE unique as an organisation is the fact that it is an association. The organisation structure is different than a company. The board is chosen by all members. Each member is in this way involved in important decisions. Besides, each member earns approximately the same. The KRVE is not monitored by the ACM since it is an association.

[7] Most information in this section is obtained by an interview with Manager Operations of KRVE (De Graaf, personal communication, February 21, 2020), and by literature on the website of the boatmen organisation (KRVE, 2020) of KRVE. References are placed when other sources are used.

***Equipment* |** KRVE currently has approximately 300 members. Their fleet consists of different vessels: 40 flatboats, 5 RIB's, 2 twin screw-propeller tenders, 3 multipurpose vessels and 3 steal tenders. Besides, KRVE provides mooring and unmooring services by using 32 owned winch trucks. The pulling capacity of the trucks is 1400 kg. The rope of the vessel is attached to a smaller rope with a capacity of only 100 kg. The small rope is connected to the winch truck. If it goes wrong, the small rope will only break, and the winch truck will stay at its position. The location of the mooring equipment is shown in Appendix D.6. The locations are strategically chosen to provide the best possible service to the client in the whole port region.

KRVE also has access to 9 taxis including drivers. The taxis and fast tenders (RIB's) are used to transport the pilots within the Port of Rotterdam. Note that transport of pilots on/from sea is performed by Loodswezen.

***Working hours* |** Boatmen of KRVE work in shifts of 12 hours. The first shift starts at 5:30 am and the second shift at 5:30 pm. During a shift the boatmen are present at the KRVE offices and are sent to several locations to perform their work activities in the Port of Rotterdam. Each shift generally consists of 66 persons. The shift minimum is 55 persons. It means there is a 'slack' of 11 places to be sick, vacation et cetera. Boatmen are divided over three major areas: Waalhaven (9 persons), Botlek (21 persons) and Europoort/Maasvlakte region (36 persons).

Moreover, KRVE makes use of a telephone service. Shipping is accompanied with peaks and downs in supply. In peak periods it can call in extra boatmen from home. KRVE always has employees at home standby who are obliged to be available. All boatmen also live in a radius of half an hour. If extra persons are needed, the boatmen can be at location relatively fast.

***Planning* |** Planners of KRVE look approximately 1.5 hour forward (short term). Planners are highly skilled boatmen. In order to become a planner, it is required to have worked for at least 10 years as boatman. In this way, the planners use their own experiences to make a proper planning. KRVE has two central planners and a few planners per operating area.

Planning of boatmen depends on length vessel, material vessel (type of ropes), destination vessel and weather forecasts. Order time of boatmen is around 30-45 minutes; boatman can provide services at the desired location if it is communicated 30-45 minutes in advance.

C.5.1 Formal relations

It is obliged to moor and unmoor with assistance of boatmen for vessels with a LOA greater than 75 metres. Vessels transporting dangerous liquid chemicals always need boatmen's assistance in mooring and unmooring. These rules are not applicable in a few cases. For example, when a vessel is shifting but remains connected to the quay, boatmen's assistance is not obliged (Gemeente Rotterdam, 2020).

A relation is also visible in the form of an agreement between KRVE and Loodswezen. As explained, KRVE is responsible for transport of pilots of Loodswezen within the harbour of the Port of Rotterdam.

KRVE gets paid by vessel operators to provide their services. The standard tariffs and conditions of boatmen's services are published by the Port of Rotterdam each year (Port of Rotterdam, 2020c). KRVE does not have many contractual agreements with parties. However, vessel operators have the possibility to negotiate about the standard terms of KRVE.

Appendix E.3 gives an overview of the standard tariffs and conditions of KRVE in Rotterdam region for 2020. The tariffs are dependent on, among others, the vessel's LOA and required activities (mooring, unmooring, shifting). MSC has a contractual agreement with KRVE in the Port of Rotterdam. It gets paid by MSC to provide boatman services for MSC vessels.

Since the KRVE is always available and on time, it never causes delays. Therefore, MSC never charges delay costs to KRVE. Conversely, MSC receives cancellation and delay costs of KRVE. As explained in Section C.4.1, nautical service providers do only charge costs to the client. KRVE provides services for MSC which is their client. If the terminal operator causes a delay, the KRVE charges delays costs to MSC. MSC charges these costs to the terminal operator.

C.5.2 Interests, objectives and problem perception

KRVE's main interest is to continue business in the Port of Rotterdam. It wants to provide high-quality services to clients. It is important for KRVE to provide the best possible services for right tariffs to maintain their monopolistic position. KRVE obliges itself to be always available and on time. It wants to prevent that clients ask for competitors in the Port of Rotterdam.

The objective of KRVE is, thus, to provide the best possible services to the client. By improving their services and innovating, it wants to have an important contribution in the Port of Rotterdam. As part of the nautical chain, KRVE also wants to cooperate with the other nautical service providers to improve the nautical services. It is important for them that clients are satisfied and want to come back to the Port of Rotterdam in the future.

KRVE is, like the other nautical service providers, a supporter of Just-In-Time arrivals and services. The organisation wants to be involved in initiatives that optimize the port processes. Nowadays, KRVE is always available and on time to provide services to their client. Nevertheless, KRVE is still looking for optimizations in the processes. A more accurate order time can be useful for KRVE. The order time is the time at which boatmen need to provide services. If real-time information is shared, KRVE can optimize their planning.

C.5.3 Interdependencies between actors

Most ships are not allowed to moor, unmoor or shift without assistance of boatmen. These types of services are provided by KRVE in the Port of Rotterdam. The resource of KRVE can then be described as formal power.

The boatmen are always available and on time to do the jobs. An important resource is the knowledge/skills of KRVE. It offers inhouse trainings to educate boatmen. In four years, candidates obtain qualifications and experiences needed to become a boatman. Boatmen in other ports can also have the skills/knowledge to operate in the Port of Rotterdam. The knowledge/skills of KRVE is still considered as an important resource since KRVE has proven to provide excellent services. It might be difficult for new entrants to provide same quality of services as KRVE. KRVE is considered as a great organisation by multiple parties in the industry.

Boatmen services are only performed by KRVE in the Port of Rotterdam. There are currently no options to replace KRVE. Deep-sea vessels of MSC are obliged to get assistance of boatmen during mooring, unmooring and shifting. The boatmen are part of a port call and cannot be neglected. The resource dependency of KRVE is high. It is a critical actor in a port call.

As explained, KRVE support the Just-In-Time initiative since it can also have advantages for their organisation. It can optimize the planning and resources. KRVE is considered as a dedicated actor (Table 5.3). It will probably participate and are potentially strong allies in the implementation of Just-In-Time arrivals and services in the Port of Rotterdam.

C.6 PORT OF ROTTERDAM AUTHORITY

***Port of Rotterdam Authority* |** The authority of the Port of Rotterdam is an institution which takes responsibility for managing, operating and developing the port and industry area around Rotterdam. Besides, its task is to ensure a safe and smooth handling of vessel traffic in the port area. The port authority wants to enhance the competitive position, both in terms of size and quality, of the Port of Rotterdam (Port of Rotterdam, 2020a).

***Commercial oriented with public interest* |** The Port of Rotterdam Authority is an unlisted public limited company. It is a commercial oriented company, as public influence is only indirectly exerted through the shareholders. The municipality of Rotterdam and Dutch State owns approximately 70% and 30% of the shares respectively. The Port of Rotterdam is a landlord port. The port authority is only owner of 'basic' infrastructure. It leases infrastructure to operators, often on basis of long-term concession. Private companies make investments in terminals which includes buildings, cranes, equipment et cetera (Van Steenderen, 2019).

***Revenue streams* |** The authority of the Port of Rotterdam has a turnover of about €710 million. Its main revenue streams are rental income and port dues. As explained above, it leases port sites to operators. In addition, vessels operators must pay port dues when vessels have been in the Port of Rotterdam. The revenues of the Port of Rotterdam Authority are used to invest in infrastructure (e.g. roads, quay walls) and new port sites.

***Organisational structure* |** The company consists of circa 1200 employees. Its organisational structure is depicted in Figure C.9. The authority of the Port of Rotterdam has departments that are responsible for development and maintenance of the port area. Besides, commercial divisions focus on finding companies that want to operate in the port. Furthermore, public duties (e.g. traffic planning and guidance) are performed by the Harbour Master's Division.

The Harbour Master's Division has a special place in the organisational structure. It is responsible for the public duties assigned by the government and several municipalities in the Rotterdam region (Port of Rotterdam, 2020b).

Since this public side may have different motives/interests than the private side of the Port of Rotterdam Authority, both parts must be considered. In this thesis, the Port of Rotterdam Authority refers to the private side of the company. This section provides information about the private side. The Harbour Master's Division – the public side of the company – is explained in more detail in the next section of the actor-stakeholder analysis model (Section C.7).

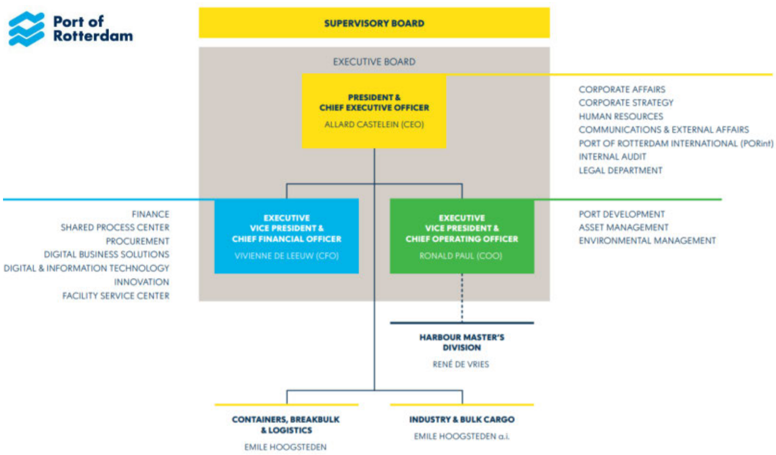


Figure C.9: Organisational structure Port of Rotterdam Authority (Port of Rotterdam, 2020b).

C.6.1 Formal relations

As explained above, vessels need to pay port dues after visiting the Port of Rotterdam. In addition, it receives rent from the operators within the Port of Rotterdam. The ownership of the port area is allocated to the port authority, which in fact leases the land in perpetuity from the municipal government (Van Steenderen, 2019).

C.6.2 Interests, objectives and problem perception

The Port of Rotterdam Authority is a commercial oriented company. The main interest of the company is to obtain profits by keeping in mind its public tasks. It tries to achieve this by satisfying its objective. The objective of the Port of Rotterdam Authority is to enhance the competitive position, both in terms of size and quality, of the Port of Rotterdam (Port of Rotterdam, 2020a).

According to the CEO of the Port of Rotterdam Authority (Castelein, 2020), 30% of shipments is delayed. It means there is a potential to optimize these processes in the Port of Rotterdam. Therefore, the Port of Rotterdam Authority is a supporter of the Just-In-Time arrivals and services initiative. If a port call can be optimized in the form of the Just-In-Time initiative, the Port of Rotterdam Authority can have benefits of it. The competitive position may enhance with the implementation of Just-In-Time operations. It is worth noting that it must be considered as a first-mover advantage. The port is only better than the other port if it is the only one that has implemented the initiative. In the ideal scenario, all ports are connected and have implemented the Just-In-Time initiative. In this case, all ports improve their performances.

C.6.3 Interdependencies between actors

Since the Port of Rotterdam Authority in this thesis is considered as the private side, its most important resource is not formal power but the position in the network. The Port of Rotterdam is a landlord port. It leases the infrastructure to terminal operators. Terminal operators cannot lease land from other actors. It must do business with the Port of Rotterdam Authority.

Since the Harbour Master's division is considered as a separate entity in this thesis, the Port of Rotterdam Authority does not play a large role in the operational processes of a port call. It is, however, still an important player in the implementation of the Just-In-Time initiative. If the Port of Rotterdam Authority decides that it must be implemented, it is the party which can exert influence on other players of a port call. For example, a port authority may mandate to share data on a public platform which is needed to implement the Just-In-Time initiative (IMO GIA, 2019b).

The authority cannot be replaced by another party. Hence, the Port of Rotterdam Authority has a high dependency which makes it a critical actor. It is assumed to be a dedicated actor, since the Port of Rotterdam Authority refers to the profit-oriented company. However, it must be noted that an organization with both public as private interests may have different incentives. Supposing the fact that the Port of Rotterdam may enhance the competitive position by the implementation of Just-In-Time operations, it is assumed that the Port of Rotterdam Authority will probably participate to implement the initiative. This makes it a dedicated actor (Table 5.3).

C.7 Harbour Master – Harbour Coordination Centre[8]

***Harbour Master* |** The harbour master is a special division in the organisation of the Port of Rotterdam Authority. The harbour master aims to ensure a safe and smooth handling of vessels in the Port of Rotterdam, also taking into account sustainability. It cooperates and communicates with other actors in a port such as nautical service providers and vessel operators. The harbour master is responsible for several public-law duties. It enforces the laws and regulations in the Port of Rotterdam. It has been given the power to perform these tasks by the Dutch government (Minister of Infrastructure and Water Management) and municipalities of Rotterdam, Vlaardingen, Schiedam and Dordrecht (Van Steenderen, 2019).

***Harbour Master divisions* |** The tasks of the harbour master can be described as: Harbour Coordination Centre (HCC), Vessel Traffic Service operators (VTS), harbour patrol boats, inspection, port health authority and port security. In this thesis, the most relevant parts are HCC and VTS operators. HCC is responsible for a safe planning and gives permission to enter/leave the port. VTS monitors vessel traffic in the port and keeps in contact with vessels.

VTS is part of a port call but will not play another role in Just-In-Time operations since it is not responsible for vessel planning. Conversely, HCC will be greatly affected by the Just-In-Time initiative. It is involved in planning of vessels and the nautical clearances to enter/depart the Port of Rotterdam. Therefore, the focus of this section is primarily on HCC.

***Harbour Coordination Centre* |** HCC is the responsible department for a safe planning and giving permission to vessels to enter/leave the Port of Rotterdam. Its aim is to ensure a safe and smooth procedure for vessels entering/leaving the port. Vessels planning to visit the Port of Rotterdam need to inform HCC a specific time in advance. HCC cooperates and communicates with other nautical service providers to ensure a safe and smooth planning of all vessels to/from the Port of Rotterdam. Based on the information it obtains, HCC decides if it can give permission for entering/leaving the port. It gives nautical clearances which are required to enter/leave the port. A distinction is made between an administrative and operational clearance. More information about these procedures is explained in Chapter 13.

Figure C.10: Duty officer of HCC (Port of Rotterdam, 2020d).

***Public tasks* |** HCC performs public duties and is, thus, not profit oriented. It cooperates with organisations which have commercial interest such as towage companies. The most important for HCC is to ensure a safe and smooth vessel planning in the port area. It decides if a vessel is allowed to enter and leave the Port of Rotterdam.

***Planning* |** The duty officers of HCC, including assistants, are involved in the vessel planning. There is always a duty officer available at the office. Duty officers work in a shift system of 8 hours. After 8 hours, another duty officer takes over the job for the next 8 hours. According to the duty officers, HCC is not responsible for the planning of nautical service providers. It ensures a safe planning and it tries to anticipate in case of unavailability of nautical service providers. HCC is responsible for the admission policy. It actively communicates with the chief pilot to assess the situations in the port, since the chief pilot is an expert in this field.

[8] Most information in this section is obtained by an interview with Teamleader HCC and duty officer (Maan, personal communication, March 3, 2020), and by literature on the website of the port authority (Port of Rotterdam, 2020d). References are placed when other sources are used.

C.7.1 Formal relations

Vessels larger than 300 gross tonnage are required to communicate certain information to the harbour master, if it wants to enter/leave the Port of Rotterdam (Port of Rotterdam, 2016). For example, incoming vessels must obtain information such as ETA, ETD, name captain, nautical service providers, depth, details of destination. A distinction is made between a notification and order. Most incoming and outgoing vessels are required to send a notification at least 24 and 12 hours in advance respectively. Nautical service providers need to be ordered at least 2 hours in advance. More detailed information about these processes is given in Chapter 13.

By obtaining the right information from the agent and vessel, the Harbour Coordination Centre decides if a vessel gets permission to enter/leave the Port of Rotterdam. Without permission it is not allowed to enter/leave the Port of Rotterdam.

HCC follows the regulations and laws. In the Port of Rotterdam, certain areas can have additional restrictions which are related to vessel's depth, wind, visibility, speed, number of tugs, tugs specifications, passing restrictions et cetera. Appendix F shows the restrictions for several sections in the Port of Rotterdam where MSC deep-sea vessels (un)load cargo.

HCC frequently communicates with nautical service providers. If a vessel requests nautical services, HCC will first obtain this information. It will collaborate with the chief pilot who works at the office of HCC. The planning will then start.

C.7.2 Interests, objectives and problem perception

The main interest of HCC is to perform public tasks from the Dutch government and municipalities. Its objective is to ensure a safe and smooth vessel traffic by keeping sustainability in mind. In order to achieve this, it must communicate and collaborate with other stakeholders in a port call.

The Just-In-Time initiative does not have the same incentives for HCC compared to other actors. The public department cannot increase their profits for example. However, if the clearances to enter/leave the port are given earlier in the process, safety in the port area may be increased. It must be noted that the initiative is currently not a hot topic in the division.

C.7.3 Interdependencies between actors

The most important resource of HCC is obviously formal power. It has been given the power to perform public tasks by the Dutch government and several municipalities. Vessels needs permission from HCC to enter/leave the Port of Rotterdam.

HCC cannot be replaced in a port call due to the current regulation and laws. It plays an important role since it decides if vessels are allowed to enter/leave the Port of Rotterdam. This makes the resource dependency high. It is, therefore, also a critical actor in the process.

HCC is a public organisation with different interests as commercial companies. This makes it more difficult to determine whether it is a dedicated actor or not. Interviews with the division have shown that HCC is not really involved in the Just-In-Time initiative. Therefore, HCC cannot be considered as a party that will probably participate. However, it does also not mean that it is a potential blocker. According to Table 5.3, HCC is expected to be a non-dedicated actor since the Just-In-Time initiative cannot have the same advantages for them as for the nautical service providers for example.

C.8 PORTBASE – PORT COMMUNITY SYSTEM[9]

***Port Community System* |** Portbase is active in the Port of Rotterdam since 2002. It is founded since port authorities wanted to improve the data sharing infrastructure in ports. A central platform, operated by one party, was needed to easily share and exchange information between other parties. The idea was that companies could continue focusing on the core business and did not need to worry about links to other parties to exchange data. Previously, companies had to organise matters by themselves such as pre-reporting a vessel and exporting documentation. Lots of paperwork and communication via email and telephone were involved in these processes. Portbase solved these problems and merged everything in a central system which is known as the Port Community System (PCS) in the Port of Rotterdam.

***Portbase* |** Portbase operates as IT company and logistic service provider. It serves as the link of logistic information between several parties in the ports of Rotterdam and Amsterdam. Authorities and companies in these ports can easily and safely exchange data and information via the Port Community System (PCS) of Portbase. Portbase currently offers 43 services in 1 central platform for parties involved in the logistics chain. Some are mandatory in the Port of Rotterdam. The services are available for all port sectors such as dry bulk, liquid bulk, containers. Services of Portbase are related to ships' calls, import cargo, export cargo and hinterland transport.

The most relevant for this thesis are the ships call's services. Today, it is mandatory for shipping operators to pre-report a vessel via PCS. Nautical services are also requested through the central system in the Port of Rotterdam.

Figure C.11: Illustration of connectivity in a port through Port Community System by Portbase (Portbase, 2020).

***Non-profit organisation* |** Portbase is a neutral company offering services for the port community. It is a non-profit and public organisation which operates costs based. Portbase has only two shareholders: Port of Rotterdam Authority and Port of Amsterdam Authority. Services beneficial for the strategic position of the port are funded by the shareholders. In addition, companies are charged for the use of specific services. Some services are still free of charge.

C.8.1 Formal relations

Some services of Portbase, such as vessel notification, are mandatory in the Port of Rotterdam. Agents are required to submit the required vessel information through PCS. For example, agents must provide information to several parties, such as ship name, port of destination, ETA, ETD, number of persons on board. Portbase makes sure the information is delivered to the right parties such as the harbour master and customs. In addition, agents are required to order nautical services electronically via PCS for outbound and shift voyages. Agents also obtain

[9] Most information in this section is obtained by an interview with Business Manager Portbase (Coumans, personal communication, April 16, 2020), and by literature on the website of Portbase (Portbase, 2020). References are placed when other sources are used.

the confirmation or rejection of the proposed order time from HCC via PCS. More information of these procedures is clarified in Chapter 13.

C.8.2 Interests, objectives and problem perception

Portbase is a non-profit organisation funded by their clients and shareholders which are, among others, port authorities, agents, customs, terminals. The interest of Portbase is satisfying the needs of these parties regarding data exchange and optimization.

The main objective of Portbase is to make processes electronically so that each party in the port can continue focusing on their core business. Portbase functions as a channel which takes the responsibility to exchange information between the right parties. The other objectives of Portbase are related to process optimization by the obtained data. It wants to provide data to parties for optimizations. In addition, it also wants to contribute to business intelligence. Companies can ask Portbase to perform analysis on their processes.

Portbase is a supporter of port call optimization in the form of Just-In-Time arrivals and services. It considers that it can have major benefits for their clients such as shipping companies and port authorities. Portbase is of the opinion that it can be an important player to enable Just-In-Time arrivals and services in the Port of Rotterdam. It can facilitate a platform that satisfy the requirements of clients.

Data authorisation is of great importance for companies when sharing data on a platform. Many parties are afraid of sharing data when it is not clear what happens to the data. It must be clear that 'sensitive' data is not shared with parties which are not allowed to obtain these data. Portbase is able to satisfy these needs of clients by their data authorisation models. Portbase is a public organisation and companies are, therefore, more willing to share their data with Portbase in comparison with private commercial companies. Subsequently, Portbase can also exchange data between the right parties according to a data authorisation model.

Portbase can link systems of involved parties to their own central system PCS. In this way, it can enable data sharing which is important to achieve Just-In-Time operations. However, for some parties it may be difficult due to system technical reasons. Consultation of experts in this field reveals that some parties, especially in bulk trade, are lagging behind on systems and would not be able to link their system to a central system as PCS.

C.8.3 Interdependencies between actors

The most important resource of Portbase is the knowledge/skills and formal power. The organisation has the knowledge/skills which is needed to facilitate a central platform to exchange data. In addition, certain services are mandatory for companies. For example, it is mandatory to report a ship call through the port community system of Portbase.

There are currently no options to replace the mandatory services of Portbase in a port call. Moreover, the central platform of Portbase is of great importance in the implementation of Just-In-Time arrivals and services. Portbase resource dependency is, therefore considered as high (Table 5.1). Today it is a critical actor; it cannot be ignored in a port call process.

Portbase possibly perceives benefits with the Just-In-Time initiative. The organisation is an important player in implementing the initiative. The position of Portbase can grow in the Port of Rotterdam. It is, therefore, considered as a dedicated actor. Portbase will probably participate in the Just-In-Time initiative and are potentially strong allies to get it implemented (Table 5.3).

C.9 PortXchange – Pronto[10]

***Pronto project* |** PortXchange is a shared digital platform in which actors exchange information related to port calls. It started in 2015 when the port authority started to develop an application as part of the Pronto project of PCO Taskforce. Its aim is, by using PCO Taskforce standards, to improve event data such as start and completion time of services. In August 2018, Port of Rotterdam launched the first version of the application. The new digital application was a major step forward in improving event data in the Port of Rotterdam.

***Pronto application* |** The application consists of a common platform in which shipping companies, service providers (terminals, bunker, pilots etc.) and the Port of Rotterdam Authority can exchange information. It can be used to enhance the planning, completion and monitoring of port call activities. Involved actors can give updates about the activity status in the platform. The application displays this information in a time schedule for each vessel and berth. By combining updated data of the service providers with public information and forecasts, the application is able to show more accurate port call data.

***PortXchange* |** The application is initially developed to improve event data in the Port of Rotterdam. A team of primarily developers, working for the Port of Rotterdam authority, were responsible for the application. Since it is relatively successful in this port, ideas came up to extend the application to other ports. The venture PortXchange Products BV ("PortXchange") was launched in August 2019. The application's name is also changed to PortXchange. A team of 23 persons, now working for PortXchange Products BV, collaborate to further develop the application. Its focus is on ports worldwide.

Figure C.12: Logo PortXchange (PortXchange, 2020c).

***PortXchange in Port of Rotterdam* |** PortXchange supports and improves the application in the Port of Rotterdam. The team of PortXchange works together with a small team of the Port of Rotterdam Authority in order to make the application successful in the Port of Rotterdam. Today the Port of Rotterdam Authority is still 100% shareholder of PortXchange Products BV.

***Revenue streams* |** PortXchange Products BV obtains revenues by clients who pay for the software licence. Clients are parties interesting in the use of the application such as shipping lines and port authorities. Port of Rotterdam Authority is 100% owner of the licence in Port of Rotterdam. It pays PortXchange Products BV and offers the application to the port community.

***Enabler* |** PortXchange may be considered as a tool making Just-In-Time arrivals and services possible. It is an enabler to obtain the desired data at a central place. The application consists of a shared digital platform including real-time data of port call processes.

***Current status in container sector Port of Rotterdam* |** Most actors involved in container transport deliver data to PortXchange. In the Port of Rotterdam, the following actors in the container sector share data: all deep-sea container terminals, 80-90% of container deep-sea carriers, all agents, pilots, boatmen and the harbour master. Towage companies do not share data. Since towage companies do not have a monopolistic position, data sharing may be a sensitive topic. In addition, towage companies only obtain benefits if most parties are involved

[10] Most information in this section is obtained by an interview with Proposition Manager and Director of Product of PortXchange (Engels & Koggel, personal communication, April 17, 2020), and by literature on the website of PortXchange and Port of Rotterdam (PortXchange, 2020a; Port of Rotterdam, 2018). References are placed when other sources are used.

in the application. The container sector is not enough since it must consider all clients in the planning. If it does not obtain data from bulk vessels, it can still not guarantee the planning.

It must also be noted that not all data is shared in the right way. The frequency and type of data is not always complete and accurate enough. Moreover, some organisations do not share all data. For example, MSC delivers data via Portbase. It does not share data about the schedules of MSC vessels since these data is not required to deliver to Portbase. MSC does not trust data authorisation of PortXchange. It wants more clarity what happens with the data.

C.9.1 Formal relations

The licence of the PortXchange application software is held by the Port of Rotterdam Authority. It offers the application to the community since it believes in the benefits of PortXchange. The use of the application is, however, not compulsory in the Port of Rotterdam. Companies choose to work with the application since it believes in the added value. Companies, that want to use the application in the Port of Rotterdam, must also share data to the platform (data-for-data).

C.9.2 Interests, objectives and problem perception

Although PortXchange Products BV is a private company, the most important approach is not commercial related according to the employees. Its main interest is to continue business and growth internationally. Its ambition is to be present in 30 ports internationally within 5 years.

The main objective of PortXchange is to make the shipping industry more efficient and, thus, cleaner. PortXchange wants to reduce carbon emissions in shipping. This is also the main interest of the Port of Rotterdam Authority.

PortXchange is obviously a supporter of Just-In-Time arrivals and services. It wants to play a key role in this initiative. The application provides a platform to improve event data in a port. It collects and presents data of actors in a port call. If all actors are connected to the application and deliver data to PortXchange, it can all monitor the processes and, if needed, adjust to it.

However, some actors are not willing to share data with PortXchange. In order to be successful, it is important that most actors are involved in the platform. PortXchange is in contact with Portbase to cooperate. Portbase is a public company and companies may, therefore, be more willing to share data with a platform of Portbase. By means of a data authorisation model, actors can choose to share data to PortXchange via Portbase.

C.9.3 Interdependencies between actors

The most important resource for PortXchange is the knowledge/skills. Developers try to improve the PortXchange application. The software skills to develop a product and knowledge to adapt it to a port call in the Port of Rotterdam is of great importance to make it a success.

In the implementation of the Just-In-Time initiative, an application as PortXchange is needed. It cannot be ignored and is, thus, considered as a critical actor. However, it must be noted that applications as PortXchange are interoperable. Other ports can decide to use another application in order to implement the Just-In-Time initiative. The only requirement is that the application meets the developed standards of PCO Taskforce. The resource dependency of PortXchange is considered medium; PortXchange is of great importance to implement Just-In-Time arrivals and service but other applications may also satisfy (Table 5.1).

PortXchange is obviously a dedicated actor in a port call process. It is willing to use resources for the Just-In-Time initiative. PortXchange is considered as an actor that will probably participate and be potentially strong allies to enable Just-In-Time arrivals and services.

C.10 PCO Taskforce – Port Call Optimization[11]

***Background* |** PCO Taskforce is an international taskforce in which shipping industry and ports collaborate and promote port call optimization. It is founded by Capt. B. van Scherpenzeel in 2014. The previous captain noticed that shipping industries and port authorities were trying to tackle common problems. However, the organisations scarcely worked together. Capt. B. van Scherpenzeel tried to change it by organising meetings in which parties come together and find solutions to optimize shipping. Many shipping companies, port authorities, endorsers have joined PCO Taskforce over the years.

***PCO Taskforce* |** PCO Taskforce brings together parties involved in the shipping industry. In the past, most initiatives tried to find solutions for a specific trade or port. The industry was (and is) rather fragmented. In the PCO Taskforce shipping companies, agents and ports collaborate to optimize a port call by solutions that work for each trade (e.g. container, bulk, chemical), each port, and from port to port. This is what PCO Taskforce makes unique. Ports and shipping companies work together but also shipping companies from different trades collaborate as MSC and Shell. Appendix A.2 shows the involved parties in PCO Taskforce.

Figure C.13: Feature of PCO Taskforce (PCO Taskforce, 2020).

It is worth noting that it is not a profit-oriented project. Members do also not pay membership fees. The involved members see it as a challenge to optimize a port call. Each member contributes in-kind; it spends time to attend meetings and perform activities.

***Pronto & Avanti* |** PCO Taskforce has set up two projects to improve the information within a port. Both projects bring existing standards together. A distinction is made between event and master data which are included in the projects 'Pronto' and 'Avanti' respectively. Both projects consist of standards developed by PCO Taskforce.

More reliable master data, such as depths and admission requirements, available for port users is the aim of Avanti. It helps harbour masters in providing nautical port information in a way it is up-to-date and accessible for port users. By obtaining right information the vessel could make improved decisions about which moment it can enter or leave the port safely.

The aim of 'Pronto' relates to improving event data in a port. Event data contains information about starting and completion times, such as estimated time of arrival. The project must allow service providers to exchange planning information. This enables pre-planning of ports, service providers and vessels. PortXchange originates from the Pronto standards.

***Working procedure* |** All things PCO Taskforce want to achieve are included in papers such as the Port Information Manual (PCO Taskforce, 2019a). The papers are submitted as proposal to changes to the IMO (International Maritime Organization) or IHO (International Hydrographic Organization), in collaboration with non-governmental organisation or Member States of IMO. IMO and IHO are the two united nations organisations who decide democratically about whether proposed changes must be endorsed and included in official books.

In addition, PCO Taskforce frequently communicates with the IMO GIA, a partnership initiative of the IMO launched in June 2017. Each day a one-hour meeting takes place between the project manager of IMO GIA and PCO Taskforce chairman.

[11] Most information in this section is obtained by an interview with the Chairman Capt. B. van Scherpenzeel and member B. den Ouden (Van Scherpenzeel & Den Ouden, personal communication, April 27, 2020) working for the Port of Rotterdam Authority and MSC respectively. In addition, literature on the website of PCO Taskforce is consulted (PCO Taskforce, 2020). References are placed when other sources are used.

***Just-In-Time initiative* |** IMO GIA has currently proposed Just-In-Time arrivals and services as solution for speed optimization. It is considered as one of the most cost-effective solutions to reach safe and sustainable shipping. IMO GIA uses input of PCO Taskforce to get it successful.

C.10.1 Formal relations

PCO Taskforce consists of, among others, several shipping companies and port authorities. It does not have formal relations with other stakeholders. In fact, PCO Taskforce is a collection of several actors. This is also the power of PCO Taskforce. Members collaborate to find solutions to optimize port calls. Members do not come together based on company relations.

C.10.2 Interests, objectives and problem perception

Members of PCO Taskforce have interests in more reliability and safety, cleaner environment and lower costs for actors as shipping lines, shippers, terminals and ports. These advantages must be satisfied by port call optimization. The objective of PCO Taskforce is to optimize port calls by improving availability and quality of both event and master data in ports.

PCO Taskforce is obviously a supporter of Just-In-Time arrivals and services. PCO Taskforce stands for port call optimization which is a pre-requisite of the Just-In-Time initiative. Members of the PCO Taskforce consider it as a challenge. It wants to improve shipping.

However, it also knows that an initiative needs to have incentives for all involved actors. Just-In-Time arrivals and services must have added value for each actor in the chain. Incentives of each party must be found in order to accelerate implementation of the initiative.

Besides, PCO Taskforce is of the opinion that a central platform in which data is shared and exchanged must be facilitated by a neutral public company. In the Port of Rotterdam, a company as Portbase may take the lead in it.

C.10.3 Interdependencies between actors

The most important resource of PCO Taskforce is knowledge/skills of the members. Members from different parts of the industry come together to find solutions for common shipping problems. PCO Taskforce uses the knowledge and skills of persons from several parties.

The work of PCO Taskforce gets more and more attention in the industry. Many parties want to join the PCO Taskforce. In addition, it gets more recognition of united nations. For example, the IMO has shown interest in the PCO Taskforce. IMO uses the work of PCO Taskforce to identify the top five of mid-term measures. IMO researches what the most cost-effective solutions are in order to reach a safe and sustainable shipping based on return on investment.

PCO Taskforce can obviously be considered as an actor with power of realisation; it is a supporter of port call optimization and Just-In-Time arrivals and services. PCO Taskforce is a unique organisation; there are currently no options to replace this taskforce. In addition, PCO Taskforce is an important player in order to implement the Just-In-Time initiative in the right way. The resource dependency is, therefore, assumed to be high. PCO Taskforce standards are a pre-requisite for the Just-In-Time initiative which means it is a critical actor in this process.

Members of PCO Taskforce want to optimize port calls since it also obtains benefits for their company. For this reason, PCO Taskforce can be considered as a dedicated actor. It is an actor that participates and is a strong ally in the implementation of Just-In-Time arrivals and services.

D. OVERVIEW MAPS MAAS APPROACH - MAASVLAKTE

Vessels have multiple sailing options, dependent on ship type and size, to reach and leave the Port of Rotterdam. Appendix D shows the overview maps of Maas Approach, Pilot Maas, Maasmond and Maasvlakte. Each map is an enlarged view of the previous map. Appendix D.1 gives an image of the total Maas approach area. Appendix D.2 zooms in at the Pilot Maas area. The map also shows where incoming and outgoing vessels sail. A closer look at the entrance of the Port of Rotterdam is visible in Appendix D.3 (Maasmond). Subsequently, Appendix D.4 provides information about the operators at the Maasvlakte I and II. Many container terminals are located at the Maasvlakte. MSC vessels load and un(load) cargo at three container terminals in the Maasvlakte area: ECT Delta Terminal, APM Terminals Rotterdam and the APM Terminal Maasvlakte II.

Besides, an overview is provided of the complete Rotterdam-Rijnmond area in Appendix D.5. It shows the operating area of Loodswezen in the Rotterdam-Rijnmond area. The operating area of KRVE is also presented (Appendix D.6).

D.1 OVERVIEW MAP OF MAAS APPROACH

Overview map of Maas approach . Figure D.1 gives an overview of Maas approach. Vessels have several possibilities to find their way to/from the Port of Rotterdam. Some vessels are restricted to a certain fairway.

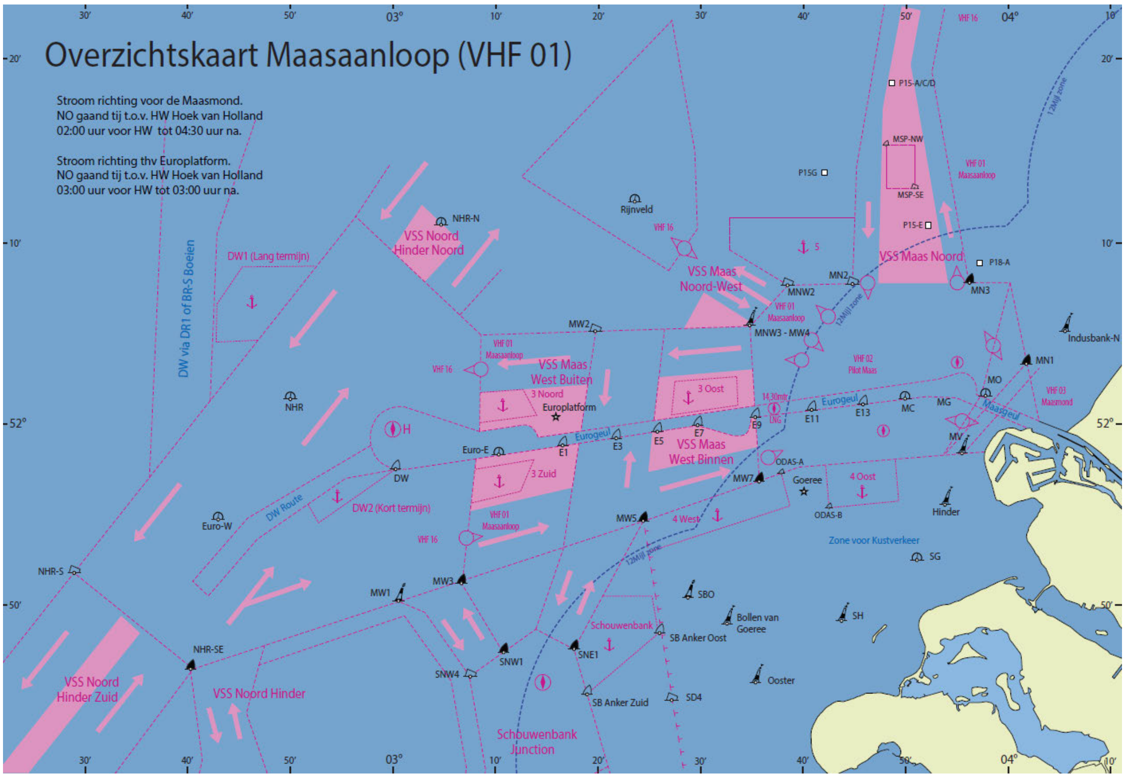


Figure D.1: Overview map of Maas approach (MT Maritiemfreelancer, 2020).

D.2 Overview map of Pilot Maas

Figure D.2 give an overview of Pilot Maas area. The sailing options for a vessel are also shown.

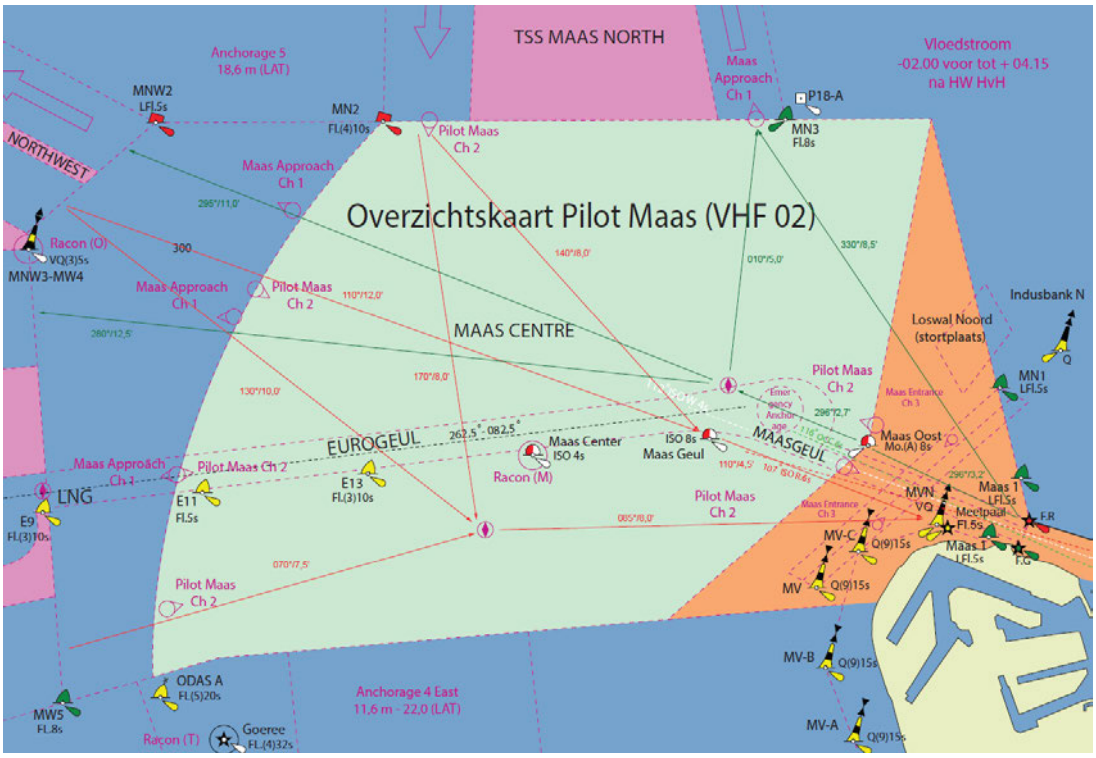


Figure D.2: Overview map of Pilot Maas (MT Maritiemfreelancer, 2020).

D.3 Overview map of Maasmond

Figure D.3 gives an overview of the Maasmond area. It also shows the Euro- and Maasgeul.

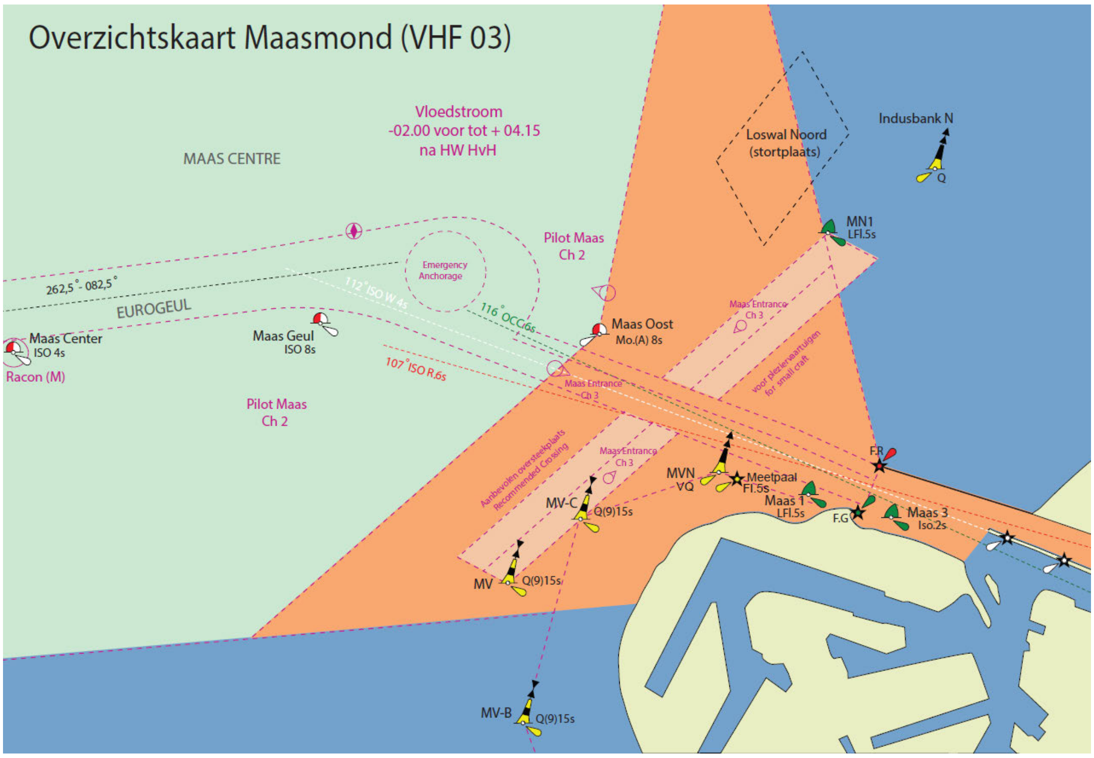


Figure D.3: Overview map of the Maasmond (MT Maritiemfreelancer, 2020).

D.4 Overview map of Maasvlakte area

Figure D.4 gives an overview of the Maasvlakte area. MSC vessels usually (un)load containers at the ECT DDN, APM Terminals Rotterdam and the APM Terminals Maasvlakte II.

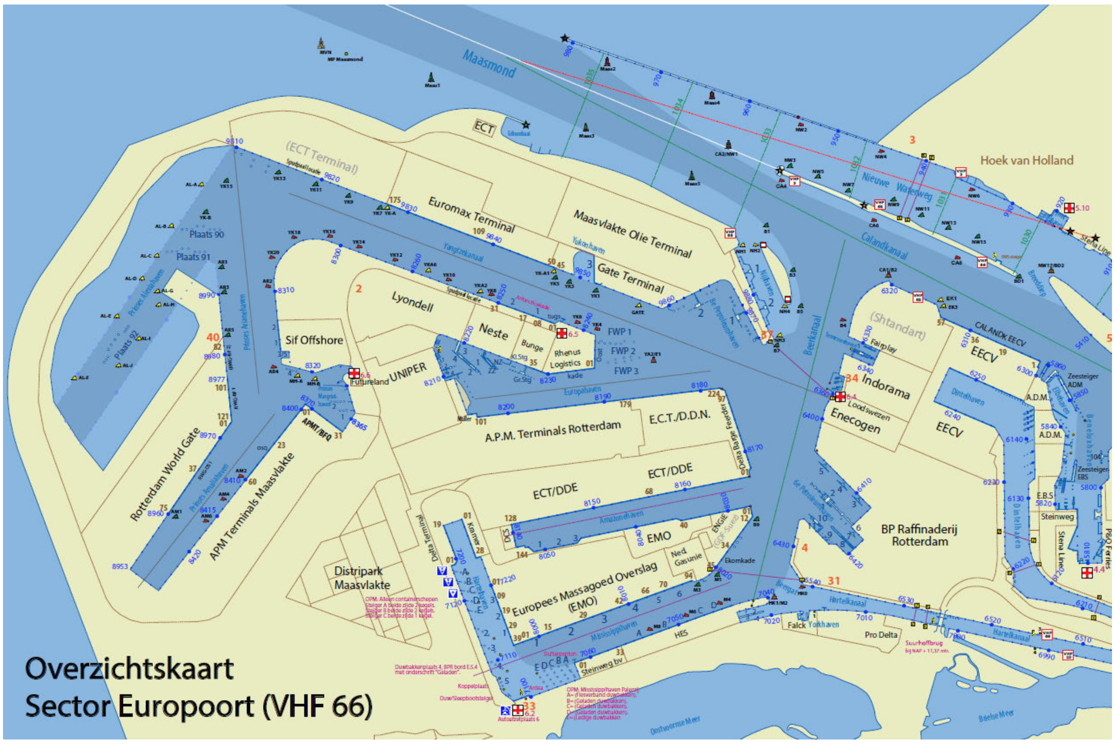


Figure D.4: Overview map of Maasvlakte area (MT Maritiemfreelancer, 2020).

D.5 Map of operating area Loodswezen Rotterdam-Rijnmond

Figure D.5 shows the operating area of Loodswezen in the Rotterdam-Rijnmond region. The port area is divided into several areas based on tariff differences.

Figure D.5: Overview map of operating area Loodswezen in Rotterdam-Rijnmond region (Loodswezen, 2020a).

D.6 MAP OF OPERATING AREA KRVE IN ROTTERDAM REGION

Figure D.6 provides an overview of the operating area of the KRVE. The red dots represent the locations where mooring equipment is placed. The locations are strategically chosen to provide the best possible service to the client.

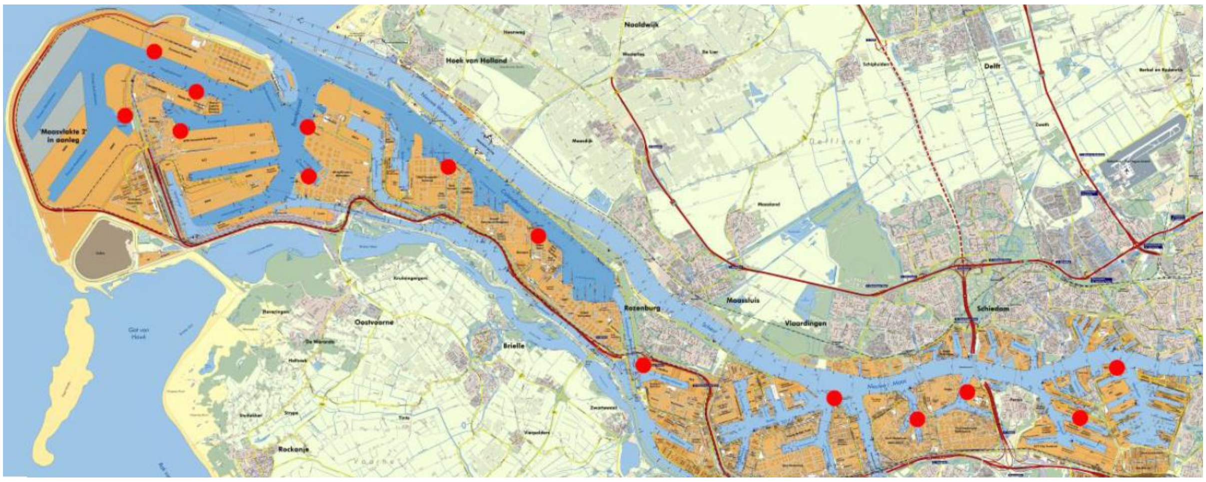


Figure D.6: Schematic overview of operating area KRVE in the Port of Rotterdam (KRVE, n.d.).

E. Tariffs of nautical services

Appendix E gives insight in the tariffs and waiting time costs of the nautical service providers. The waiting time costs of the pilots are shown in Appendix E.1. The tariffs for pilot services are non-negotiable and publicly available (Loodswezen, 2020a). Appendix E.2 and E.3 provide information about the standard tariffs and conditions of Boluda (towage company) and KRVE (boatmen). These tariffs are standard and may differ per contract with shipping companies.

E.1 Waiting time costs pilots

Figure E.1 shows the pilot expense reimbursements costs when a pilot experiences a delay. It means that the vessel leaves later than the confirmed pilot order time. The delay costs are dependent on the delay period.

Delay	From (in minutes)	Until (in minutes)	To Invoice (in hours)	Amount (in €)
0>1 hr	0	30	-	-
	31	45	0,50	50
	46	60	0,50	50
1>2 hr	61	75	0,50	50
	76	90	1,00	100
	91	105	1,00	100
	106	120	1,50	150
2>3 hr	121	135	1,50	150
	136	150	2,00	200
	151	165	2,00	200
	166	180	2,50	250
3>4 hr	181	195	2,50	250
	196	210	3,00	300
	211	225	3,00	300
	226	240	3,50	350
4>5 hr	241	255	3,50	350
	256	270	4,00	400
	271	285	4,00	400
	286	300	4,50	450
5>6 hr	301	315	4,50	450
	316	330	5,00	500
	331	345	5,00	500
	346	360	5,50	550

Figure E.1: Delay costs during pilotage voyage caused by vessel or special transport (Loodswezen, 2020a).

E.2 STANDARD TARIFFS AND CONDITIONS BOLUDA

Figure E.2 shows the tariffs and conditions of Boluda. It concerns the Boluda towage services in the Port of Rotterdam in 2020. The information is obtained by the published document 'Tariffs for third parties 2020' of the Port of Rotterdam (Port of Rotterdam, 2020c). It is important to realise that it concerns standard tariffs and conditions. Clients can still negotiate about the terms. Each vessel operator can have different contractual agreements with Boluda.

Note that the terms are only given for the Rotterdam/Europoort region. Additional terms are made for the Dordrecht-Moerdijk region. Since MSC deep-sea vessels do only sail to the Maasvlakte region, the Dordrecht-Moerdijk region has not been considered.

ROTTERDAM/EUROPOORT FROM THE RIVER TO OR FROM

1 Rotterdam area (from the river to the berth or v.v.):
from Erasmusbridge (km post 1001) up to Westgeul (km post 1014) including Botlek area.
2 Europoort area (from the river to the berth or v.v.).

L.o.a. of vessels in meters (a)			1	2
<	-	138	1,015	1,200
139	-	150	1,165	1,345
151	-	163	1,330	1,510
164	-	175	1,465	1,715
176	-	187	1,605	1,920
188	-	212	1,820	2,280
213	-	236	2,085	2,655
237	-	260	2,430	3,010
261	-	285	2,845	3,335
286	-	309	3,570	3,570
310	-	334	3,805	3,805
335	-	358	4,040	4,040
359	-	383	4,285	4,285
384	-	425	4,490	4,490

(a) Length according to the Lloyd's Register.

MISCELLANEOUS

1 Holding astream, extra pushing to berth (in connection with an assistance, if longer than 2 hours special arrangements have to be made): **595** per hour
2 Waiting (first half hour free, after which the 1st hour will be charged in full followed by a half hourly charge): **465** per hour
3 For shifting of ships within the Rotterdam or Europoort area 35% surcharge on the respective area rate is applicable. For shifting from the Rotterdam harbours to the Europoort harbours or v.v., special arrangements have to be made.
4 If bunker prices are above € 135 per ton a bunkersurcharge will be applicable.
5 Assistance of dead ships 50% surcharge on all rates (waiting and fog excluded).
6 Cancellation: If arrival, departure or shifting is cancelled or postponed without notice being given at least one hour before the services are due to commence and/or tug(s) is (are) dismissed without being used: 50% of the tariff will be charged.
7 In case of a visibility of less than 500 metres (according to the data of the Government Pilot- & Radar Service) an additional charge of 50% for assistance during fog will be charged on all rates (waiting excluded).
8 Vessels calling Maasvlakte 2 will be subjected to a surcharge of 25% on the Gross tariffs.
9 25% surcharge on holidays, officially recognized in the port of Rotterdam, from 17:00 the day before untill 07:00 the day after such holiday.
10 The Dutch Towage Conditions 2007 apply to all towage services, excluded emergency or salvage services, provided by Boluda Towage.

- For assistance outside above mentioned areas, special arrangements have to be made.
- The above rates will not apply in case of drift-ice, vessels broken loose from their mooring, assistances outside abovementioned area's and other unforeseen circumstances.
- Rates: per move and for each tug employed.
- Discount available for long term contracts.
- Payment to be made within 30 days.

Figure E.2: Standard tariffs and conditions of Boluda towage services in the Port of Rotterdam in 2020 (Port of Rotterdam, 2020c).

E.3 Standard tariffs and conditions KRVE

Figure E.3 and Figure E.4 show the tariffs and conditions of KRVE. It concerns the KRVE services in the Port of Rotterdam in 2020. The information is obtained by the published document 'Tariffs for third parties 2020' (Port of Rotterdam, 2020c). It is important to realise that it concerns standard tariffs and conditions. Clients can still negotiate about the terms.

A1	**RATES PER SEA-GOING VESSEL IN THE ROTTERDAM HARBOUR-AREA AND/OR THE MOERDIJK-AREA**										
Length in meters			**Mooring**			**Unmooring**			**Shifting**		
<	-	47.99	58			54			84		
48.00	-	64.99	91			84			132		
65.00	-	84.99	119			111			173		
85.00	-	99.99	158			147			229		
100.00	-	114.99	209			196			304		
115.00	-	124.99	223			207			323		
125.00	-	134.99	260			241			376		
135.00	-	144.99	283			263			410		
145.00	-	154.99	319			293			459		
155.00	-	164.99	369			340			532		
165.00	-	174.99	486			451			703		
175.00	-	199.99	556			514			803		
200.00	-	209.99	654			604			944		
210.00	-	224.99	736			681			1,063		
225.00	-	234.99	882			818			1,275		
235.00	-	244.99	977			904			1,411		
245.00	-	254.99	1,075			993			1,551		
255.00	-	259.99	1,172			1,084			1,692		
260.00	-	264.99	1,277			1,180			1,843		
265.00	-	269.99	1,369			1,265			1,976		
270.00	-	274.99	1,471			1,360			2,124		
275.00	-	279.99	1,565			1,447			2,259		
280.00	-	284.99	1,664			1,537			2,401		
285.00	-	289.99	1,764			1,630			2,546		
290.00	-	294.99	1,857			1,717			2,681		
295.00	-	299.99	1,958			1,809			2,826		
300.00	-	304.99	2,048			1,893			2,956		
305.00	-	309.99	2,145			1,981			3,095		
310.00	-	314.99	2,246			2,077			3,243		
315.00	-	319.99	2,338			2,163			3,376		
320.00	-	324.99	2,439			2,255			3,521		
325.00	-	329.99	2,533			2,341			3,656		
330.00	-	334.99	2,636			2,437			3,805		
335.00	-	339.99	2,733			2,525			3,944		
340.00	-	344.99	2,829			2,617			4,085		
345.00	-	349.99	2,929			2,706			4,227		
350.00	-	>	2,929			2,706			4,227		
for each additional 5 meters or part thereof in excess of 350 meters				+	102		+	96		+	149

PLEASE NOTE THE FOLLOWING

A1[a] In case of shifting along the quay the tariff of mooring under **A1** is applicable.

A1[b] For mooring and unmooring a vessel in the Rozenburgsluis (lock) the tariff of mooring under **A1** is applicable.

A1[c] For mooring and unmooring a vessel in the Krammersluis (lock) the tariff of shifting under **A1** increased with 50% is applicable.

A1[d] For mooring and unmooring a vessel in the Kreekraksluis (lock) the tariff of shifting under **A1** increased with 100% is applicable.

A2 For mooring a vessel during a gale or a vessel broken adrift in the harbour, the tariff of mooring under **A1**, increased by 50% is applicable.

A3 Extra linesmen: If, due to circumstances, the customary crew is not sufficient a pro-rated share of the tariff will be charged for each additional man.

A4 For rendering assistance on board vessels entering, shifting or leaving the port, **64.00** per man per hour will be charged with the minimum of 2 hours.

A5 For mooring/unmooring a vessel not being a vessel (e.g. an offshore-vessel) a tariff will be procured on application.

Figure E.3: Part I of standard tariffs and conditions of KRVE services in the Port of Rotterdam in 2020 (Port of Rotterdam, 2020c).

WAITING TIME

A6 If linesmen are kept waiting for more than 30 minutes after the appointed hour given in the orders when any services under A1 to **A2** should have begun, a surcharge per hour is due beginning at the end of the 30 minute period and continuing until the actual start of the work, this surcharge is as follows:

All over length in meters			Tariff
<	-	64.99	37
65.00	-	99.99	68
100.00	-	164.99	102
165.00	-	224.99	150
225.00	-	259.99	199
260.00	-	>	271

COUNTERMANDING

A7 If any services listed in **A1** to **A2** are cancelled within one hour before the appointed hour given in the orders when the work should have begun and the assigned linesmen have already left their station, the charges under **A6** are due.
A7[a] If the services listed in **A4** are cancelled within two hours before the appointed hour given in the orders when the work should have begun, 50% of the tariff given in **A4** will be due.

COMPANY TRANSPORTATION

B1 A manned motor launch can be made available on behalf of a specific company, agency or a Governmental Department. The tariffs are mentioned in the motor launch tariffs. The tariffs mentioned in the motor launch are applicable in the Rotterdam Waterway or adjacent harbours only in connection with the cargo of the seagoing vessel.

COMMUNICATION BY LAUNCH

B2 If a principal, in the case of motor launch services, wants to make use of one of our launches for a longer period of time, he has to make contact with our office.

GENERAL SURCHARGES

C1 For services during weekends and holidays, a 35% surcharge is due over and above all the tariffs mentioned above.
C2 During ice drift a surcharge is due over and above the tariffs and surcharges listed under **A1** to **A2[a]**, **A5**, **B1** en **B2**. The extent of this ice surcharge is dependent on the extent of the ice drift, but not higher than 100%.
C3 Value added tax is due on the tariffs listed in **B1**.

DEFINITIONS

1 Part of an hour will be considered as a whole hour, excluded a half-hour crossing mentioned under **B1** and **B2**.
2 The following days are regarded as a holiday: Easter Monday, Ascension Day, Whit Monday, Christmas Day, December 26th and New Year's Day, in so far as these days do not fall on Sunday. Furthermore, King's day and other national holidays, in so far as same are declared as such by the Mayor and Aldermen.
3 The tariffs for services during weekends apply from 18:00 hours on Friday till 06:00 hours on Monday. The tariffs for services on holiday(s) are applicable from the preceding day 18:00 hours until the day following holiday(s) 06:00 hours.
4 The NBC 2017, filed at the Chamber of Commerce, will be applicable to all our operations and services at all times.
5 This text is a translation of the original Dutch text. In case of any dispute the original Dutch text shall be conclusive.

Figure E.4: Part II of standard tariffs and conditions of KRVE services in the Port of Rotterdam in 2020 (Port of Rotterdam, 2020c).

F. PORT SECTION GUIDES

Several vessel requirements apply in the Port of Rotterdam. This information is included in the Port Sections Guide. These sections differ per port area. Appendix F shows the Port Sections Guide for Maasmond, Beerkanaal, Europahaven, Yangtzekanaal and Prinses Amaliahaven.

F.1 PORT SECTION GUIDE MAASMOND

Figure F.1 and Figure F.2 shows the requirements in the Port Sections Guide of the Maasmond region.

	Port Sections Guide
	Port of Rotterdam
	16-4-2019
Section	**Maasmond**
Check Section	**N/A**
Photo/Chart	**1 & 2**
Position (lat / lon)	51°59'.5N 004°02'.7E
UKC policy alongside	N/A
Tidal range	Mean range:1.65m
Range of water densities	1025 kg/m3
Bottom type	Course sand
Dredging regime	The fairway and berth depths are monitored by regular soundings and when necessary maintained by dredging. Maintained by Rijkswaterstaat.
Free text	N/A
Manoeuvre	**Arrival**
UKC policy	At least 1,00 m dynamic
Size restriction	Maximum draught 22.55 meters.
Tidal restriction	**For ships with draught 17.40 - 22.55 m:** entry time depends on vertical and horizontal tide and traffic.
Wind restriction	LNG carriers: 13,8 m/s
Visibility restriction	**Vessels with draught 17.40-22.55 meters**: 500 meters in Europoort **LNG Carriers:** 2000 meters at sea, 2000 meters in port. **Special transports:** 1500 meter at sea and in port
Speed restriction	N/A
Passing requirements	Vessels crossing a LNG carrier must give it a wide berth, this applies for both crossing ahead and astern. Ships with a draught more than 14.30 meters are not allowed to meet or overtake each other between buoy Maas 1 and Lage Licht.
Tug use	N/A
Berthing requirements	N/A
Free text option	Vessels with draught 17.40-22.55 meters might be escorted by patrol vessels between April and October due to presence of pleasure craft. LNG carries might be escorted all year.
Manoeuvre	**Departure**
UKC policy	See arrival
Size restriction	Maximum draught 21,50 meters.
Tidal restriction	N/A
Wind restriction	See arrival
Visibility restriction	LNG carriers: 2000 meter at sea, 2000 meter in port. For LNG carriers with L < 125 meter and when visibility is between 1000 and 2000 meter: to be discussed with HCC and Chief Pilot. If visibility is less than 1000 meter: no departure

Figure F.1: Part I of Port Sections Guide Maasmond (International Harbour Masters & Port of Rotterdam, 2020).

Port Sections Guide Port of Rotterdam 16-4-2019	
Section	Maasmond
Check Section	N/A
Photo/Chart	1 & 2

Speed restriction	N/A
Passing requirements	See arrival
Tug use	N/A
Unberthing requirements	N/A
Free text option	Vessels with draught 17.40-21.50 meters and LNG carriers might be escorted by patrol vessels between April and October due to presence of pleasure craft.

Figure F.2: Part II of Port Sections Guide Maasmond (International Harbour Masters & Port of Rotterdam, 2020).

F.2 PORT SECTION GUIDE BEERKANAAL

Figure F.3 and Figure F.4 shows the requirements in the Port Sections Guide of the Beerkanaal.

Port Sections Guide Port of Rotterdam 16-4-2019	
Section	Beerkanaal
Check Section	Check Maasmond & Calandkanaal
Photo/Chart	5 & 6

Position (lat / lon)	51°57'.6N 004°05'.1E
UKC policy alongside	**T<17,40:** always afloat, UKC recommended 0,30 meter static. **T≥17,40:** always afloat, UKC recommended 0,50 meter static.
Tidal range	Mean range: 1.95m
Range of water densities	Mean: 1016 kg/m^3, Min: 1015 kg/m^3, Max: 1016 kg/m^3
Bottom type	Mix of mud and silt. Mix rate depends on tidal situation.
Dredging regime	The fairway and berth depths are monitored by regular soundings and maintained by dredging when necessary. Maintained by Rotterdam Port Authority.
Free text	N/A

Manoeuvre	Arrival
UKC policy	**T<17,40:** UKC = 0,50 meter static. **T ≥ 17,40** At least 1,00 m UKC static
Size restriction	N/A
Tidal restriction	N/A
Wind restriction	Container vessels > 350 meter: 14 m/s
Visibility restriction	N/A
Speed restriction	N/A
Passing requirements	Vessels crossing a LNG carrier must give it a wide berth, this applies for both crossing ahead and astern. No passing of container vessels larger than 350 meter with container vessels larger than 350 meter or vessels deeper than 17,40 meter. Stemming the current abeam of the DBF quay with these vessels is allowed.
Tug use	**T ≥ 17,40 < 20,00:** In case 3 or 4 tugs are used, at least 2 of them should have a BP of ≥ 45 Tons **T ≥ 20,00:** In case 4 tugs are used, at least 3 of them should have a BP of ≥ 45 Tons **L ≥ 325 meter:** Only tugs with BP ≥ 45 Tons to be used if wind is ≥ 10,7 m/s. **L ≥ 325 meter:** Pilot determines number of tugs, minimum 45 T BP. If wind is ≥ 10,7 m/s the first tug should be ≥ 60 Tons BP.

Figure F.3: Part I of Port Sections Guide Beerkanaal (International Harbour Masters & Port of Rotterdam, 2020).

Berthing requirements	N/A
Free text option	LNG carriers, vessels destined for MOT terminal and vessels larger than 350 meters with destination Maasvlakte 2 might be escorted by patrol vessels.

Manoeuvre	Departure
UKC policy	See arrival
Size restriction	Because the ship is sailing against the incoming tide, the maximum draught on departure is 21,50 meters.
Tidal restriction	N/A
Wind restriction	N/A
Visibility restriction	N/A
Speed restriction	N/A
Passing requirements	See arrival
Tug use	**L ≥ 300 meter:** In case 2 or more tugs are used, at least 1 of them should have a BP of ≥ 45 Tons Shifting vessels: Same conditions as for arrival manoeuvre. Rendezvous point close to 51°59'.0N 004°04'.0E
Unberthing requirements	N/A
Free text option	See arrival

Figure F.4: Part II of Port Sections Guide Beerkanaal (International Harbour Masters & Port of Rotterdam, 2020).

F.3 Port section guide Europahaven

Figure F.5 and Figure F.6 shows the requirements in the Port Sections Guide of Europahaven.

	Port Sections Guide **Port of Rotterdam** 16-1-2018
Section	**Europahaven**
Check	**Check Maasmond & Beerkanaal**
Photo/Chart	**9 & 10**
Position (lat / lon)	51°57'.6N 004°02'.7E
UKC policy alongside	UKC recommended 0,30 meter static.
Tidal range	Mean range: 1.94m
Range of water densities	Mean: 1016 kg/m^3, Min: 1015 kg/m^3, Max: 1016 kg/m^3
Bottom type	Mix of mud and silt. Mix rate depends on tidal situation.
Dredging regime	The fairway and berth depths are monitored by regular soundings and maintained by dredging when necessary.Maintained by the Port authority.
Free text	N/A

Manoeuvre	Arrival
UKC policy	UKC = 0,50 meter static.
Size restriction	N/A
Tidal restriction	N/A
Wind restriction	L < 150 meter : no restrictions L ≥ 150, < 245 meter: max 20 m/s all directions L ≥ 245, < 300 meter: max 17 m/s all directions L ≥ 300, < 355 meter: max 15 m/s all directions L ≥ 355 meter: max 14 m/s all directions
Visibility restriction	Container vessels ≥ 375 meter: minimum 500 meters.
Speed restriction	N/A
Passing requirements	N/A
Tug use	**L ≥ 325 meter:** Only tugs with BP ≥ 45 Tons to be used if wind is ≥ 10,7 m/s **L ≥ 375 meter:** Pilot determines number of tugs, minimum 45 T BP. If wind is ≥ 10,7 m/s the first tug should be ≥ 60 Tons BP.
Berthing requirements	N/A
Free text option	N/A

Figure F.5: Part I of Port Sections Guide Europahaven (International Harbour Masters & Port of Rotterdam, 2020).

Manoeuvre	Departure
UKC policy	See arrival
Size restriction	16-1-2018
Tidal restriction	N/A
Wind restriction	See arrival
Visibility restriction	See arrival
Speed restriction	N/A
Passing requirements	N/A
Tug use	See arrival
Unberthing requirements	N/A
Free text option	N/A

Figure F.6: Part II of Port Sections Guide Europahaven (International Harbour Masters & Port of Rotterdam, 2020).

F.4 Port Section Guide Yangtzekanaal

Figure F.7 shows the requirements in the Port Sections Guide of the Yangtzekanaal.

	Port Sections Guide Port of Rotterdam 6-1-2015
Section	Yangtzekanaal
Check	Check Maasmond & Beerkanaal
Photo/Chart	7 & 8
Position (lat / lon)	51°58'.2N 004°02'.5 E
UKC policy alongside	**T<17,40:** always afloat, UKC recommended 0,30 meter static. **T≥17,40:** always afloat, UKC recommended 0,50 meter static.
Tidal range	Mean range: 1.94m
Range of water densities	Mean: 1015 kg/m³, Min: 1015 kg/m³, Max: 1016 kg/m³
Bottom type	Mix of mud and silt. Mix rate depends on tidal situation.
Dredging regime	The fairway and berth depths are monitored by regular soundings and maintained by dredging when necessary. Maintained by Rotterdam Port Authority.
Free text	N/A
Manoeuvre	**Arrival**
UKC policy	**T<17,40:** UKC = 0,50 meter static. **T ≥ 17,40** At least 1,00 m UKC static
Size restriction	N/A
Tidal restriction	N/A
Wind restriction	From West to Southeast: L < 150 meter : No restrictions L ≥ 150, < 245 meter: max 20 m/s L ≥ 245, < 300 meter: max 17 m/s L ≥ 300, < 355 meter: max 15 m/s L ≥ 355 meter: max 14 m/s From Southeast to West: L < 150 meter : No restrictions L ≥ 150, < 245 meter: max 18 m/s L ≥ 245, < 300 meter: max 15 m/s L ≥ 300, < 355 meter: max 13 m/s L ≥ 355 meter: max 12 m/s
Visibility restriction	Container vessels ≥ 375 meter: minimum 500 meters
Speed restriction	See passing requirements

Figure F.7: Port Sections Guide Yangtzekanaal (International Harbour Masters & Port of Rotterdam, 2020).

F.5 Port section guide Prinses Amaliahaven

Figure F.8 shows the requirements in the Port Sections Guide of the Prinses Amaliahaven.

	Port Sections Guide
	Port of Rotterdam
	6-1-2015
Section	**Prinses Amaliahaven**
Check	
Photo/Chart	**M2D**
Position (lat / lon)	
UKC policy alongside	**T<17,40:** always afloat, UKC recommended 0,30 meter static. **T≥17,40:** always afloat, UKC recommended 0,50 meter static.
Tidal range	Mean range: 1.94m
Range of water densities	Mean: 1015 kg/m^3, Min: 1015 kg/m^3, Max: 1016 kg/m^3
Bottom type	Mix of mud and silt. Mix rate depends on tidal situation.
Dredging regime	The fairway and berth depths are monitored by regular soundings and maintained by dredging when necessary.
Free text	N/A

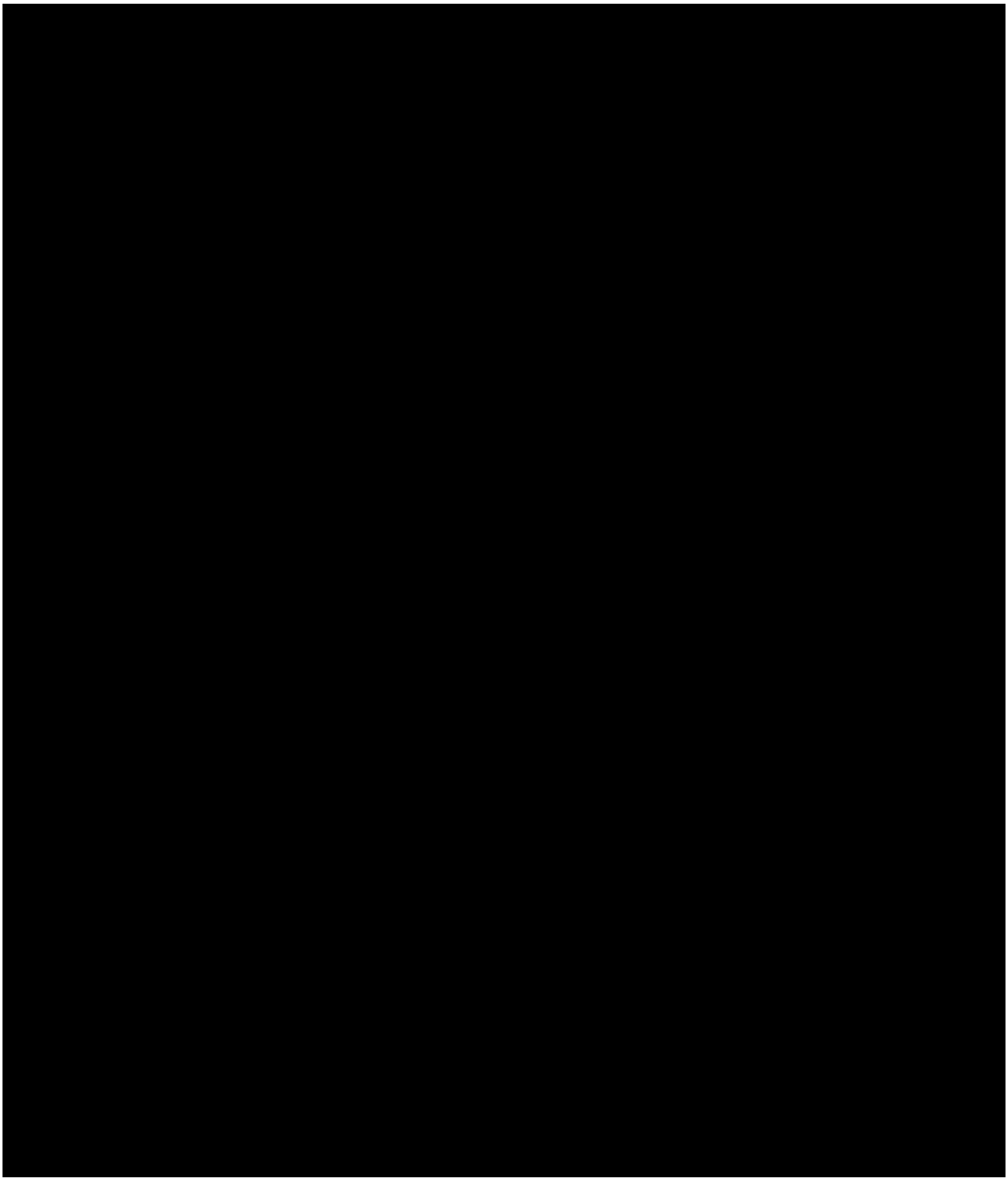
Manoeuvre	**Arrival**
UKC policy	T<17,40: UKC = 0,50 meter static. T ≥ 17,40 At least 1,00 m UKC static
Size restriction	NA
Tidal restriction	NA
Wind restriction	L < 150 meter: no restrictions all directions L ≥ 150, < 245 meter: max 18 m/s all directions L ≥ 245, < 300 meter: max 15 m/s all directions L ≥ 300, < 355 meter: max 13 m/s all directions L ≥ 355 meter: max 12 m/s all directions
Visibility restriction	NA
Speed restriction	NA
Passing requirements	Passing of 2 containervessels > 350 meter is not allowed.
Tug use	L ≥ 325 meter: Only tugs with BP ≥ 45 Tons to be used if wind is ≥ 10,7 m/s L ≥ 375 meter: Pilot determines number of tugs, minimum 45 T BP. If wind is ≥ 10,7 m/s the first tug should be ≥ 60 Tons BP.
Berthing requirements	NA
Free text option	NA

Manoeuvre	**Departure**
UKC policy	See arrival
Size restriction	NA
Tidal restriction	NA
Wind restriction	See arrival
Visibility restriction	NA
Speed restriction	NA
Passing requirements	See arrival
Tug use	NA
Unberthing requirements	NA
Free text option	NA

Figure F.8: Port Sections Guide Prinses Amaliahaven (International Harbour Masters & Port of Rotterdam, 2020).

G. INFORMATION FLOWS BETWEEN INVOLVED ACTORS

Multiple information flows take place in a port call. Appendix G provides extra information about these information flows. Each sub-section shows information about the information flows per phase.



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H. Data contract to obtain relevant data

Table H.1 shows the timestamps in the obtained data set of PortXchange. PortXchange collects data from several sources such as AIS, HaMIS, Portbase, ECT website and GIDS.

Table H.1: The timestamps (including sources) in obtained the data set of PortXchange.

Delivery 1: HbR – havenbedrijf Rotterdam (Source: AIS data PortXchange)	
Id	**Field name**
[1]	"anchorArea.ata.vessel"
[2]	"anchorArea.atd.vessel"
[3]	"berth.ata.vessel"
[4]	"berth.atd.vessel"
[5]	“berth.eta.predictor"
[6]	"berth.etd.predictor"
[7]	"bunkerService.atc.vessel"
[8]	"bunkerService.ats.vessel"
[9]	"customs.atc.vessel"
[10]	"customs.ats.vessel"
[11]	"fairway.ata.vessel"
[12]	"firstLineReleased.at.vessel"
[13]	"firstLineSecured.at.vessel"
[14]	"floatingCrane.atc.vessel"
[15]	"floatingCrane.ats.vessel"
[16]	"immigration.atc.vessel"
[17]	"immigration.ats.vessel"
[18]	"lastLineReleased.at.vessel"
[19]	"lastLineSecured.at.vessel"
[20]	"pilotBoardingPlace.ata.vessel"
[21]	"pilotBoardingPlace.atd.vessel"
[22]	"pilotBoardingPlace.eta.predictor"
[23]	"pilotBoardingPlace.eta.vessel"
[24]	"pilotBoardingPlace.etd.predictor"
[25]	"pilotDisembarked.at.vessel"
[26]	"pilotOnBoard.at.vessel"
[27]	"port.ata.vessel"
[28]	"port.atd.vessel"
[29]	"anchorArea.ata.vessel"
[30]	"tugsstandby.at.vessel"
[31]	"tugsnomorestandby.at.vessel"

Delivery 2: Rotterdam Port Authority (Source: HaMIS)	
Id	**Field name**
[1]	"anchorArea.ata.portAuthority"
[2]	"anchorArea.atd.portAuthority"
[3]	"berth.ata.portAuthority"
[4]	"berth.atd.portAuthority"
[5]	"berth.cancel.portAuthority"
[6]	"berth.eta.portAuthority"
[7]	"berth.etd.portAuthority"
[8]	"berth.ptd.portAuthority"
[9]	"pilotBoardingPlace.pta.portAuthority"
[10]	"port.eta.portAuthority"
[11]	"port.etd.portAuthority"

Delivery 3: MSC (Source: Portbase)	
Id	**Field name**
[1]	"berth.cancel.agent"
[2]	"berth.eta.agent"
[3]	"berth.etd.agent"
[4]	"pilotBoardingPlace.eta.agent"
[5]	"port.ata.agent"
[6]	"port.atd.agent"
[7]	"port.cancel.agent"
[8]	"port.eta.agent"
[9]	"port.etd.agent"

Delivery 4: ECT DELTA TERMINAL (Source: ECT website)	
Id	**Field name**
[1]	"berth.eta.terminal"
[2]	"berth.pta.terminal"
[3]	"berth.etd.terminal"
[4]	"berth.ptd.terminal"
[5]	"berth.ata.terminal"
[6]	"berth.atd.terminal"

Delivery 5: Pilots and boatmen (Source: GIDS)	
Id	**Field name**
[1]	"pilotOnBoard.et.pilot"
[2]	"pilotOnBoard.at.pilot"
[3]	"pilotDisembarked.at.pilot"
[4]	"firstLineReleased.at.linesmen"
[5]	"firstLineSecured.at.linesmen"
[6]	"lastLineReleased.at.linesmen"
[7]	"lastLineSecured.at.linesmen"

I. POWER BI SCRIPTS OF DATA ANALYSIS TOOL

Since the data set only consists of specific (time) events, a data analysis tool is developed to calculate the desired indicators. Scripts including formulas are made in Power BI for these calculations. For each indicator a different script is made to obtain the desired information. Figure I.1 - Figure I.10 shows the made scripts for each indicator.

Anchorage times of vessels

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_location] = "anchorArea") and ([event_source] = "portAuthority")),
    #"Inserted Merged Column" = Table.AddColumn(#"Filtered Rows", "UCRN_EVENT_TYPE", each Text.Combine({[ucrn], [event_type]}, "_"), type text),
    #"Removed Duplicates" = Table.Distinct(#"Inserted Merged Column", {"UCRN_EVENT_TYPE"}),
    #"Sorted Rows" = Table.Sort(#"Removed Duplicates",{{"ucrn", Order.Ascending}, {"event_type", Order.Ascending}}),
    #"Added Conditional Column" = Table.AddColumn(#"Sorted Rows", "ATA ANCHORAGE", each if [event_type] = "ata" then [event_time] else null),
    #"Added Conditional Column1" = Table.AddColumn(#"Added Conditional Column", "ATD ANCHORAGE", each if [event_type] = "atd" then [event_time] else null),
    #"Added Index" = Table.AddIndexColumn(#"Added Conditional Column1", "Index", 1, 1),
    #"Added Index1" = Table.AddIndexColumn(#"Added Index", "Index.1", 0, 1),
    #"Merged Queries" = Table.NestedJoin(#"Added Index1", {"Index"}, #"Added Index1", {"Index.1"}, "Added Index1", JoinKind.LeftOuter),
    #"Expanded Added Index1" = Table.ExpandTableColumn(#"Merged Queries", "Added Index1", {"UCRN_EVENT_TYPE", "ATD ANCHORAGE"}, {"UCRN_EVENT_TYPE.1", "ATD ANCHORAGE.1"}),
    #"Filtered Rows1" = Table.SelectRows(#"Expanded Added Index1", each ([ATA ANCHORAGE] <> null)),
    #"Removed Columns" = Table.RemoveColumns(#"Filtered Rows1",{"ATD ANCHORAGE", "Index", "Index.1"}),
    #"Inserted Time Subtraction" = Table.AddColumn(#"Removed Columns", "Subtraction", each [ATD ANCHORAGE.1] - [ATA ANCHORAGE], type duration),
    #"Calculated Total Hours" = Table.TransformColumns(#"Inserted Time Subtraction",{{"Subtraction", Duration.TotalHours, type number}}),
    #"Renamed Columns" = Table.RenameColumns(#"Calculated Total Hours",{{"Subtraction", "Anchorage periods"}})
in
    #"Renamed Columns"
```

Figure I.1: Power BI script used for calculating the anchorage duration of vessels. Source: own script.

Arrival and departure times of vessels

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "linesmen") and ([event_location] = "firstLineSecured")),
    #"Inserted Time" = Table.AddColumn(#"Filtered Rows", "Time", each DateTime.Time([event_time]), type time),
    #"Renamed Columns" = Table.RenameColumns(#"Inserted Time",{{"Time", "Time of day vessels arrive"}})
in
    #"Renamed Columns"
```

Figure I.2: Power BI script used for obtaining the arrival times of vessels. Source: own script.

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "linesmen") and ([event_location] = "lastLineReleased")),
    #"Inserted Time" = Table.AddColumn(#"Filtered Rows", "Time", each DateTime.Time([event_time]), type time),
    #"Renamed Columns" = Table.RenameColumns(#"Inserted Time",{{"Time", "Time of day vessels depart"}})
in
    #"Renamed Columns"
```

Figure I.3: Power BI script for obtaining the departure times of vessels. Source: own script.

Notification of nautical services in- and outbound voyage

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_type] = "pta") and ([event_source] = "portAuthority")),
    #"Merged Queries1" = Table.NestedJoin(#"Filtered Rows", {"ucrn"}, #"Don't use (group PTA PBP)",
    {"ucrn"}, "PTA PBP PORT AUTHORITY RECORD TIME (2)", JoinKind.LeftOuter),
    #"Expanded PTA PBP PORT AUTHORITY RECORD TIME (2)" = Table.ExpandTableColumn(#"Merged Queries1", "PTA PBP PORT AUTHORITY RECORD TIME (2)", {"Count"}, {"Count"}),
    #"Filtered Rows1" = Table.SelectRows(#"Expanded PTA PBP PORT AUTHORITY RECORD TIME (2)", each ([Count] = 1)),
    #"Merged Queries" = Table.NestedJoin(#"Filtered Rows1", {"ucrn"}, #"AT PILOT ON BOARD (INBOUND)", {"ucrn"}, "AT PILOT ON BOARD (INBOUND)", JoinKind.LeftOuter),
    #"Expanded AT PILOT ON BOARD (INBOUND)" = Table.ExpandTableColumn(#"Merged Queries", "AT PILOT ON BOARD (INBOUND)", {"event_time"},
    {"AT PILOT ON BOARD (INBOUND).event_time"}),
    #"Inserted Time Subtraction" = Table.AddColumn(#"Expanded AT PILOT ON BOARD (INBOUND)", "Subtraction",
    each [#"AT PILOT ON BOARD (INBOUND).event_time"] - [record_time]),
    #"Calculated Total Hours" = Table.TransformColumns(#"Inserted Time Subtraction",{{"Subtraction", Duration.TotalHours, type number}}),
    #"Renamed Columns" = Table.RenameColumns(#"Calculated Total Hours",
    {{"Subtraction", "Difference between record time PTA PBP (VTS) and event time AT Pilot on Board (pilots) [hours]"}})
in
    #"Renamed Columns"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_type] = "pta") and ([event_source] = "portAuthority")),
    #"Sorted Rows" = Table.Sort(#"Filtered Rows",{{"record_time", Order.Descending}}),
    #"Grouped Rows" = Table.Group(#"Sorted Rows", {"ucrn"}, {{"Count", each Table.RowCount(_), Int64.Type}})
in
    #"Grouped Rows"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "pilot") and ([event_type] = "at") and ([event_location] = "pilotOnBoard") and ([source] = "Gids")),
    #"Sorted Rows" = Table.Sort(#"Filtered Rows",{{"event_time", Order.Ascending}}),
    #"Added Index" = Table.AddIndexColumn(#"Sorted Rows", "Index", 0, 1),
    #"Sorted Rows1" = Table.Sort(#"Added Index",{{"Index", Order.Ascending}}),
    #"Removed Duplicates" = Table.Distinct(#"Sorted Rows1", {"ucrn"})
in
    #"Removed Duplicates"
```

Figure I.4: Power BI scripts used for calculating the notification period of nautical services for incoming vessels. Source: own script.

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "agent") and ([event_type] = "etd") and ([location_name] = "EUROPAH ECT DDN")),
    #"Sorted Rows" = Table.Sort(#"Filtered Rows",{{"record_time", Order.Descending}}),
    #"Added Index" = Table.AddIndexColumn(#"Sorted Rows", "Index", 0, 1),
    #"Sorted Rows1" = Table.Sort(#"Added Index",{{"Index", Order.Ascending}}),
    #"Removed Duplicates" = Table.Distinct(#"Sorted Rows1", {"ucrn"}),
    #"Merged Queries" = Table.NestedJoin(#"Removed Duplicates", {"ucrn"}, #"ATLastLineReleased - LINESMEN - GIDS",
    {"ucrn"}, "ATLastLineReleased - Linesmen - GIDS", JoinKind.Inner),
    #"Expanded ATLastLineReleased - Linesmen - GIDS" = Table.ExpandTableColumn(#"Merged Queries", "ATLastLineReleased - Linesmen - GIDS", {"event_time"},
    {"ATLastLineReleased - Linesmen - GIDS.event_time"}),
    #"Inserted Time Subtraction" = Table.AddColumn(#"Expanded ATLastLineReleased - Linesmen - GIDS", "Subtraction",
    each [#"ATLastLineReleased - Linesmen - GIDS.event_time"] - [event_time], type duration),
    #"Calculated Total Hours" = Table.TransformColumns(#"Inserted Time Subtraction",{{"Subtraction", Duration.TotalHours, type number}}),
    #"Inserted Time Subtraction1" = Table.AddColumn(#"Calculated Total Hours", "Subtraction.1",
    each [#"ATLastLineReleased - Linesmen - GIDS.event_time"] - [record_time], type duration),
    #"Calculated Total Hours1" = Table.TransformColumns(#"Inserted Time Subtraction1",{{"Subtraction.1", Duration.TotalHours, type number}}),
    #"Renamed Columns" = Table.RenameColumns(#"Calculated Total Hours1",{{"Subtraction", "Delta between AT Last Line Released (Boatmen) and ETD Berth (Agent) [hours]"},
    {"Subtraction.1", "Subtraction (ATLastlineReleased - record time ETD berth)"}})
in
    #"Renamed Columns"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "linesmen") and ([event_location] = "lastLineReleased")),
    #"Merged Queries" = Table.NestedJoin(#"Filtered Rows", {"ucrn"}, #"Don't use (group ATLastLineReleased)",
    {"ucrn"}, "Don't use (group ATLastLineReleased)", JoinKind.LeftOuter),
    #"Expanded Don't use (group ATLastLineReleased)" = Table.ExpandTableColumn(#"Merged Queries", "Don't use (group ATLastLineReleased)", {"Count"},
    {"Don't use (group ATLastLineReleased).Count"}),
    #"Filtered Rows1" = Table.SelectRows(#"Expanded Don't use (group ATLastLineReleased)", each ([#"Don't use (group ATLastLineReleased).Count"] = 1))
in
    #"Filtered Rows1"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "linesmen") and ([event_location] = "lastLineReleased")),
    #"Grouped Rows" = Table.Group(#"Filtered Rows", {"ucrn"}, {{"Count", each Table.RowCount(_), Int64.Type}})
in
    #"Grouped Rows"
```

Figure I.5: Power BI scripts used for calculating the difference between the last line released and the estimated time of departure berth for outgoing vessels. Source: own script.

Number and size of updates per timestamp

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_location] = "pilotBoardingPlace") and ([event_type] = "eta") and ([event_source] = "agent")
    and ([source] = "HaMIS")),
    #"Added Conditional Column" = Table.AddColumn(#"Filtered Rows", "Eventtime>Recordtime", each if [record_time] > [event_time] then false else true),
    #"Filtered Rows1" = Table.SelectRows(#"Added Conditional Column", each ([#"Eventtime>Recordtime"] = true)),
    #"Merged Queries" = Table.NestedJoin(#"Filtered Rows1", {"ucrn"}, #"AT PILOT ON BOARD (INBOUND)", {"ucrn"}, "AT PILOT ON BOARD (INBOUND)", JoinKind.Inner),
    #"Expanded AT PILOT ON BOARD (INBOUND)" = Table.ExpandTableColumn(#"Merged Queries", "AT PILOT ON BOARD (INBOUND)", {"event_time"},
    {"AT PILOT ON BOARD (INBOUND).event_time"}),
    #"Inserted Time Subtraction" = Table.AddColumn(#"Expanded AT PILOT ON BOARD (INBOUND)", "Subtraction",
    each [#"AT PILOT ON BOARD (INBOUND).event_time"] - [record_time], type duration),
    #"Calculated Total Hours" = Table.TransformColumns(#"Inserted Time Subtraction",{{"Subtraction", Duration.TotalHours, type number}}),
    #"Renamed Columns" = Table.RenameColumns(#"Calculated Total Hours",{{"Subtraction", "ATPilotOnBoard_event - ETAPBP_recordtime"}}),
    #"Sorted Rows" = Table.Sort(#"Renamed Columns",{{"ucrn", Order.Ascending}, {"record_time", Order.Ascending}}),
    #"Added Index" = Table.AddIndexColumn(#"Sorted Rows", "Index", 0, 1),
    #"Added Index1" = Table.AddIndexColumn(#"Added Index", "Index.1", 1, 1),
    #"Merged Queries1" = Table.NestedJoin(#"Added Index1", {"Index"}, #"Added Index1", {"Index.1"}, "Added Index1", JoinKind.LeftOuter),
    #"Expanded Added Index1" = Table.ExpandTableColumn(#"Merged Queries1", "Added Index1", {"ucrn", "event_time"}, {"Added Index1.ucrn", "Added Index1.event_time"}),
    #"Added Conditional Column1" = Table.AddColumn(#"Expanded Added Index1", "Extract from event_time",
    each if [ucrn] = [Added Index1.ucrn] then [Added Index1.event_time] else [event_time]),
    #"Inserted Time Subtraction1" = Table.AddColumn(#"Added Conditional Column1", "Subtraction", each [Extract from event_time] - [event_time], type duration),
    #"Inserted Total Hours" = Table.AddColumn(#"Inserted Time Subtraction1", "Total Hours", each Duration.TotalHours([Subtraction]), type number),
    #"Calculated Absolute Value" = Table.TransformColumns(#"Inserted Total Hours",{{"Total Hours", Number.Abs, type number}}),
    #"Added Conditional Column2" = Table.AddColumn(#"Calculated Absolute Value", "Updates <12 hours from ATPilotOnBoard",
    each if [#"ATPilotOnBoard_event - ETAPBP_recordtime"] <= 12 then true else false),
    #"Renamed Columns1" = Table.RenameColumns(#"Added Conditional Column2",{{"Total Hours", "Size updates ETA PBP AGENT event time"},
    {"AT PILOT ON BOARD (INBOUND).event_time", "ATPilotOnBoard.event_time"}, {"ATPilotOnBoard_event - ETAPBP_recordtime", "ATPilotOnBoard_event - ETAPBP_recordtime"}}),
    #"Added Conditional Column3" = Table.AddColumn(#"Renamed Columns1", "Size updates ETP PBP Agent (bins)",
    each if [Size updates ETA PBP AGENT event time] <= 1 then "0-1" else if [Size updates ETA PBP AGENT event time] <= 2 then "1-2"
    else if [Size updates ETA PBP AGENT event time] <= 3 then "2-3" else if [Size updates ETA PBP AGENT event time] <= 4 then "3-4"
    else if [Size updates ETA PBP AGENT event time] <= 6 then "4-6" else if [Size updates ETA PBP AGENT event time] <= 8 then "6-8"
    else if [Size updates ETA PBP AGENT event time] <= 12 then "8-12" else ">12"),
    #"Changed Type" = Table.TransformColumnTypes(#"Added Conditional Column3",{{"Size updates ETP PBP Agent (bins)", type text}}),
    #"Added Conditional Column4" = Table.AddColumn(#"Changed Type", "Sequence", each if [#"Size updates ETP PBP Agent (bins)"] = "0-1" then 0
    else if [#"Size updates ETP PBP Agent (bins)"] = "1-2" then 1 else if [#"Size updates ETP PBP Agent (bins)"] = "2-3" then 2
    else if [#"Size updates ETP PBP Agent (bins)"] = "3-4" then 3 else if [#"Size updates ETP PBP Agent (bins)"] = "4-6" then 4
    else if [#"Size updates ETP PBP Agent (bins)"] = "6-8" then 5 else if [#"Size updates ETP PBP Agent (bins)"] = "8-12" then 8 else 9)
in
    #"Added Conditional Column4"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "pilot") and ([event_type] = "at") and ([event_location] = "pilotOnBoard") and ([source] = "Gids")),
    #"Sorted Rows" = Table.Sort(#"Filtered Rows",{{"event_time", Order.Ascending}}),
    #"Added Index" = Table.AddIndexColumn(#"Sorted Rows", "Index", 0, 1),
    #"Sorted Rows1" = Table.Sort(#"Added Index",{{"Index", Order.Ascending}}),
    #"Removed Duplicates" = Table.Distinct(#"Sorted Rows1", {"ucrn"})
in
    #"Removed Duplicates"
```

Figure I.6: Power BI scripts used for calculating the size of updates of ETA PBP by the agent within the last 12 hours before execution (AT Pilot On Board – pilots). Source: own script.

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_type] = "eta") and ([event_source] = "agent") and ([source] = "HaMIS") and ([event_location] = "berth")
    and ([location_name] = "EUROPAH ECT DDN")),
    #"Added Conditional Column" = Table.AddColumn(#"Filtered Rows", "Eventtime>Recordtime", each if [record_time] > [event_time] then false else true),
    #"Filtered Rows1" = Table.SelectRows(#"Added Conditional Column", each ([#"Eventtime>Recordtime"] = true)),
    #"Merged Queries" = Table.NestedJoin(#"Filtered Rows1", {"ucrn"}, #"ATFirstLineSecured - LINESMEN - GIDS", {"ucrn"}, "ATFirstLineSecured - LINESMEN - GIDS",
    JoinKind.Inner),
    #"Expanded ATFirstLineSecured - LINESMEN - GIDS" = Table.ExpandTableColumn(#"Merged Queries", "ATFirstLineSecured - LINESMEN - GIDS", {"event_time"},
    {"ATFirstLineSecured - LINESMEN - GIDS.event_time"}),
    #"Inserted Time Subtraction" = Table.AddColumn(#"Expanded ATFirstLineSecured - LINESMEN - GIDS", "Subtraction",
    each [#"ATFirstLineSecured - LINESMEN - GIDS.event_time"] - [record_time], type duration),
    #"Calculated Total Hours" = Table.TransformColumns(#"Inserted Time Subtraction",{{"Subtraction", Duration.TotalHours, type number}}),
    #"Renamed Columns" = Table.RenameColumns(#"Calculated Total Hours",{{"Subtraction", "ATFirstLineSecured_event - ETABERTH_recordtime"}}),
    #"Sorted Rows" = Table.Sort(#"Renamed Columns",{{"ucrn", Order.Ascending}, {"record_time", Order.Ascending}}),
    #"Added Index" = Table.AddIndexColumn(#"Sorted Rows", "Index", 0, 1),
    #"Added Index1" = Table.AddIndexColumn(#"Added Index", "Index.1", 1, 1),
    #"Merged Queries1" = Table.NestedJoin(#"Added Index1", {"Index"}, #"Added Index1", {"Index.1"}, "Added Index1", JoinKind.LeftOuter),
    #"Expanded Added Index1" = Table.ExpandTableColumn(#"Merged Queries1", "Added Index1", {"ucrn", "event_time"},
    {"Added Index1.ucrn", "Added Index1.event_time"}),
    #"Added Conditional Column1" = Table.AddColumn(#"Expanded Added Index1", "Extract from event_time", each if [ucrn] = [Added Index1.ucrn]
    then [Added Index1.event_time] else [event_time]),
    #"Inserted Time Subtraction1" = Table.AddColumn(#"Added Conditional Column1", "Subtraction", each [Extract from event_time] - [event_time], type duration),
    #"Inserted Total Hours" = Table.AddColumn(#"Inserted Time Subtraction1", "Total Hours", each Duration.TotalHours([Subtraction]), type number),
    #"Calculated Absolute Value" = Table.TransformColumns(#"Inserted Total Hours",{{"Total Hours", Number.Abs, type number}}),
    #"Added Conditional Column2" = Table.AddColumn(#"Calculated Absolute Value", "Updates <12 hours from ATFirstLineSecured",
    each if [#"ATFirstLineSecured_event - ETABERTH_recordtime"] <= 12 then true else false),
    #"Renamed Columns1" = Table.RenameColumns(#"Added Conditional Column2",{{"Total Hours", "Size updates ETA BERTH AGENT event time"}}),
    #"Added Conditional Column3" = Table.AddColumn(#"Renamed Columns1", "Size updates ETA Berth Agent (bins)",
    each if [Size updates ETA BERTH AGENT event time] <= 1 then "0-1" else if [Size updates ETA BERTH AGENT event time] <= 2 then "1-2"
    else if [Size updates ETA BERTH AGENT event time] <= 3 then "2-3" else if [Size updates ETA BERTH AGENT event time] <= 4 then "3-4"
    else if [Size updates ETA BERTH AGENT event time] <= 6 then "4-6" else if [Size updates ETA BERTH AGENT event time] <= 8 then "6-8"
    else if [Size updates ETA BERTH AGENT event time] <= 12 then "8-12" else ">12"),
    #"Changed Type" = Table.TransformColumnTypes(#"Added Conditional Column3",{{"Size updates ETA Berth Agent (bins)", type text}}),
    #"Added Conditional Column4" = Table.AddColumn(#"Changed Type", "Sequence", each if [#"Size updates ETA Berth Agent (bins)"] = "0-1" then 0
    else if [#"Size updates ETA Berth Agent (bins)"] = "1-2" then 1 else if [#"Size updates ETA Berth Agent (bins)"] = "2-3" then 2
    else if [#"Size updates ETA Berth Agent (bins)"] = "3-4" then 3 else if [#"Size updates ETA Berth Agent (bins)"] = "4-6" then 4
    else if [#"Size updates ETA Berth Agent (bins)"] = "6-8" then 5 else if [#"Size updates ETA Berth Agent (bins)"] = "8-12" then 6 else 7),
    #"Changed Type1" = Table.TransformColumnTypes(#"Added Conditional Column4",{{"Sequence", type text}})
in
    #"Changed Type1"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "linesmen") and ([event_location] = "firstLineSecured")),
    #"Merged Queries" = Table.NestedJoin(#"Filtered Rows", {"ucrn"}, #"Don't use (group ATFirstLineSecured)", {"ucrn"}, "Don't use (group ATFirstLineSecured)",
    JoinKind.LeftOuter),
    #"Expanded Don't use (group ATFirstLineSecured)" = Table.ExpandTableColumn(#"Merged Queries", "Don't use (group ATFirstLineSecured)", {"Count"},
    {"Don't use (group ATFirstLineSecured).Count"}),
    #"Filtered Rows1" = Table.SelectRows(#"Expanded Don't use (group ATFirstLineSecured)", each ([#"Don't use (group ATFirstLineSecured).Count"] = 1))
in
    #"Filtered Rows1"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "linesmen") and ([event_location] = "firstLineSecured")),
    #"Grouped Rows" = Table.Group(#"Filtered Rows", {"ucrn"}, {{"Count", each Table.RowCount(_), Int64.Type}})
in
    #"Grouped Rows"
```

Figure I.7: Power BI scripts used for calculating the size of updates of ETA berth by the agent within the last 12 hours before execution (AT First Line Secured – boatmen). Source: own script.

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_type] = "etd") and ([event_source] = "agent") and ([source] = "HaMIS") and ([event_location] = "berth")
    and ([location_name] = "EUROPAH ECT DDN")),
    #"Added Conditional Column" = Table.AddColumn(#"Filtered Rows", "Eventtime>Recordtime", each if [record_time] > [event_time] then false else true),
    #"Filtered Rows1" = Table.SelectRows(#"Added Conditional Column", each ([#"Eventtime>Recordtime"] = true)),
    #"Merged Queries" = Table.NestedJoin(#"Filtered Rows1", {"ucrn"}, #"ATLastLineReleased - LINESMEN - GIDS", {"ucrn"}, "ATLastLineReleased - LINESMEN - GIDS",
    JoinKind.Inner),
    #"Expanded ATLastLineReleased - LINESMEN - GIDS" = Table.ExpandTableColumn(#"Merged Queries", "ATLastLineReleased - LINESMEN - GIDS", {"event_time"},
    {"ATLastLineReleased - LINESMEN - GIDS.event_time"}),
    #"Inserted Time Subtraction" = Table.AddColumn(#"Expanded ATLastLineReleased - LINESMEN - GIDS", "Subtraction",
    each [#"ATLastLineReleased - LINESMEN - GIDS.event_time"] - [record_time], type duration),
    #"Calculated Total Hours" = Table.TransformColumns(#"Inserted Time Subtraction",{{"Subtraction", Duration.TotalHours, type number}}),
    #"Renamed Columns" = Table.RenameColumns(#"Calculated Total Hours",{{"Subtraction", "ATLastLineReleased_event - ETDBERTH_recordtime"}}),
    #"Sorted Rows" = Table.Sort(#"Renamed Columns",{{"ucrn", Order.Ascending}, {"record_time", Order.Ascending}}),
    #"Added Index" = Table.AddIndexColumn(#"Sorted Rows", "Index", 0, 1),
    #"Added Index1" = Table.AddIndexColumn(#"Added Index", "Index.1", 1, 1),
    #"Merged Queries1" = Table.NestedJoin(#"Added Index1", {"Index"}, #"Added Index1", {"Index.1"}, "Added Index1", JoinKind.LeftOuter),
    #"Expanded Added Index1" = Table.ExpandTableColumn(#"Merged Queries1", "Added Index1", {"ucrn", "event_time"}, {"Added Index1.ucrn", "Added Index1.event_time"}),
    #"Added Conditional Column1" = Table.AddColumn(#"Expanded Added Index1", "Extract from event_time", each if [ucrn] = [Added Index1.ucrn]
    then [Added Index1.event_time] else [event_time]),
    #"Inserted Time Subtraction1" = Table.AddColumn(#"Added Conditional Column1", "Subtraction", each [Extract from event_time] - [event_time], type duration),
    #"Inserted Total Hours" = Table.AddColumn(#"Inserted Time Subtraction1", "Total Hours", each Duration.TotalHours([Subtraction]), type number),
    #"Calculated Absolute Value" = Table.TransformColumns(#"Inserted Total Hours",{{"Total Hours", Number.Abs, type number}}),
    #"Added Conditional Column2" = Table.AddColumn(#"Calculated Absolute Value", "Updates <12 hours from ATLastLineReleased",
    each if [#"ATLastLineReleased_event - ETDBERTH_recordtime"] <= 12 then true else false),
    #"Renamed Columns1" = Table.RenameColumns(#"Added Conditional Column2",{{"Total Hours", "Size updates ETD BERTH AGENT event time"}}),
    #"Added Conditional Column3" = Table.AddColumn(#"Renamed Columns1", "Size updates ETD Berth Agent (bins)",
    each if [Size updates ETD BERTH AGENT event time] <= 1 then "0-1" else if [Size updates ETD BERTH AGENT event time] <= 2 then "1-2"
    else if [Size updates ETD BERTH AGENT event time] <= 3 then "2-3" else if [Size updates ETD BERTH AGENT event time] <= 4 then "3-4"
    else if [Size updates ETD BERTH AGENT event time] <= 6 then "4-6" else if [Size updates ETD BERTH AGENT event time] <= 8 then "6-8"
    else if [Size updates ETD BERTH AGENT event time] <= 12 then "8-12" else ">12"),
    #"Changed Type" = Table.TransformColumnTypes(#"Added Conditional Column3",{{"Size updates ETD Berth Agent (bins)", type text}}),
    #"Added Conditional Column4" = Table.AddColumn(#"Changed Type", "Sequence", each if [#"Size updates ETD Berth Agent (bins)"] = "0-1" then 0
    else if [#"Size updates ETD Berth Agent (bins)"] = "1-2" then 1 else if [#"Size updates ETD Berth Agent (bins)"] = "2-3" then 2
    else if [#"Size updates ETD Berth Agent (bins)"] = "3-4" then 3 else if [#"Size updates ETD Berth Agent (bins)"] = "4-6" then 4
    else if [#"Size updates ETD Berth Agent (bins)"] = "6-8" then 5 else if [#"Size updates ETD Berth Agent (bins)"] = "8-12" then 6 else 7)
in
    #"Added Conditional Column4"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "linesmen") and ([event_location] = "lastLineReleased")),
    #"Merged Queries" = Table.NestedJoin(#"Filtered Rows", {"ucrn"}, #"Don't use (group ATLastLineReleased)",
    {"ucrn"}, "Don't use (group ATLastLineReleased)", JoinKind.LeftOuter),
    #"Expanded Don't use (group ATLastLineReleased)" = Table.ExpandTableColumn(#"Merged Queries", "Don't use (group ATLastLineReleased)", {"Count"},
    {"Don't use (group ATLastLineReleased).Count"}),
    #"Filtered Rows1" = Table.SelectRows(#"Expanded Don't use (group ATLastLineReleased)", each ([#"Don't use (group ATLastLineReleased).Count"] = 1))
in
    #"Filtered Rows1"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "linesmen") and ([event_location] = "lastLineReleased")),
    #"Grouped Rows" = Table.Group(#"Filtered Rows", {"ucrn"}, {{"Count", each Table.RowCount(_), Int64.Type}})
in
    #"Grouped Rows"
```

Figure I.8: Power BI scripts used for calculating the size of updates of ETD berth by the agent within the last 12 hours before execution (AT Last Line Released – boatmen). Source: own script.

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_location] = "berth") and ([event_source] = "terminal") and ([event_type] = "pta") and
    ([location_name] = "ECT DDN")),
    #"Added Conditional Column" = Table.AddColumn(#"Filtered Rows", "Eventtime>Recordtime", each if [record_time] > [event_time] then false else true),
    #"Filtered Rows1" = Table.SelectRows(#"Added Conditional Column", each ([#"Eventtime>Recordtime"] = true)),
    #"Merged Queries" = Table.NestedJoin(#"Filtered Rows1", {"ucrn"}, #"ATFirstLineSecured - LINESMEN - GIDS", {"ucrn"},
    "ATFirstLineSecured - LINESMEN - GIDS", JoinKind.Inner),
    #"Expanded ATFirstLineSecured - LINESMEN - GIDS" = Table.ExpandTableColumn(#"Merged Queries", "ATFirstLineSecured - LINESMEN - GIDS",
    {"event_time"}, {"ATFirstLineSecured - LINESMEN - GIDS.event_time"}),
    #"Inserted Time Subtraction" = Table.AddColumn(#"Expanded ATFirstLineSecured - LINESMEN - GIDS", "Subtraction",
    each [#"ATFirstLineSecured - LINESMEN - GIDS.event_time"] - [record_time], type duration),
    #"Calculated Total Hours" = Table.TransformColumns(#"Inserted Time Subtraction",{{"Subtraction", Duration.TotalHours, type number}}),
    #"Renamed Columns" = Table.RenameColumns(#"Calculated Total Hours",{{"Subtraction", "ATFirstLineSecured_event - PTABERTH_recordtime"}}),
    #"Sorted Rows" = Table.Sort(#"Renamed Columns",{{"ucrn", Order.Ascending}, {"record_time", Order.Ascending}}),
    #"Added Index" = Table.AddIndexColumn(#"Sorted Rows", "Index", 0, 1),
    #"Added Index1" = Table.AddIndexColumn(#"Added Index", "Index.1", 1, 1),
    #"Merged Queries1" = Table.NestedJoin(#"Added Index1", {"Index"}, #"Added Index1", {"Index.1"}, "Added Index1", JoinKind.LeftOuter),
    #"Expanded Added Index1" = Table.ExpandTableColumn(#"Merged Queries1", "Added Index1", {"ucrn", "event_time"}, {"Added Index1.ucrn", "Added Index1.event_time"}),
    #"Added Conditional Column1" = Table.AddColumn(#"Expanded Added Index1", "Extract from event_time", each if [ucrn] = [Added Index1.ucrn]
    then [Added Index1.event_time] else [event_time]),
    #"Inserted Time Subtraction1" = Table.AddColumn(#"Added Conditional Column1", "Subtraction", each [Extract from event_time] - [event_time], type duration),
    #"Inserted Total Hours" = Table.AddColumn(#"Inserted Time Subtraction1", "Total Hours", each Duration.TotalHours([Subtraction]), type number),
    #"Calculated Absolute Value" = Table.TransformColumns(#"Inserted Total Hours",{{"Total Hours", Number.Abs, type number}}),
    #"Added Conditional Column2" = Table.AddColumn(#"Calculated Absolute Value", "Updates <12 hours from ATFirstLineSecured",
    each if [#"ATFirstLineSecured_event - PTABERTH_recordtime"] <= 12 then true else false),
    #"Renamed Columns1" = Table.RenameColumns(#"Added Conditional Column2",{{"Total Hours", "Size updates PTA BERTH TERMINAL event time"}}),
    #"Added Conditional Column3" = Table.AddColumn(#"Renamed Columns1", "Size updates PTA Berth Terminal (Bins)",
    each if [Size updates PTA BERTH TERMINAL event time] <= 1 then "0-1" else if [Size updates PTA BERTH TERMINAL event time] <= 2 then "1-2"
    else if [Size updates PTA BERTH TERMINAL event time] <= 3 then "2-3" else if [Size updates PTA BERTH TERMINAL event time] <= 4 then "3-4"
    else if [Size updates PTA BERTH TERMINAL event time] <= 6 then "4-6" else if [Size updates PTA BERTH TERMINAL event time] <= 8 then "6-8"
    else if [Size updates PTA BERTH TERMINAL event time] <= 12 then "8-12" else ">12"),
    #"Changed Type" = Table.TransformColumnTypes(#"Added Conditional Column3",{{"Size updates PTA Berth Terminal (Bins)", type text}}),
    #"Added Conditional Column4" = Table.AddColumn(#"Changed Type", "Sequence", each if [#"Size updates PTA Berth Terminal (Bins)"] = "0-1" then 0
    else if [#"Size updates PTA Berth Terminal (Bins)"] = "1-2" then 1 else if [#"Size updates PTA Berth Terminal (Bins)"] = "2-3" then 2
    else if [#"Size updates PTA Berth Terminal (Bins)"] = "3-4" then 3 else if [#"Size updates PTA Berth Terminal (Bins)"] = "4-6" then 4
    else if [#"Size updates PTA Berth Terminal (Bins)"] = "6-8" then 5 else if [#"Size updates PTA Berth Terminal (Bins)"] = "8-12" then 6 else 7)
in
    #"Added Conditional Column4"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "linesmen") and ([event_location] = "firstLineSecured")),
    #"Merged Queries" = Table.NestedJoin(#"Filtered Rows", {"ucrn"}, #"Don't use (group ATFirstLineSecured)", {"ucrn"}, "Don't use (group ATFirstLineSecured)",
    JoinKind.LeftOuter),
    #"Expanded Don't use (group ATFirstLineSecured)" = Table.ExpandTableColumn(#"Merged Queries", "Don't use (group ATFirstLineSecured)", {"Count"},
    {"Don't use (group ATFirstLineSecured).Count"}),
    #"Filtered Rows1" = Table.SelectRows(#"Expanded Don't use (group ATFirstLineSecured)", each ([#"Don't use (group ATFirstLineSecured).Count"] = 1))
in
    #"Filtered Rows1"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "linesmen") and ([event_location] = "firstLineSecured")),
    #"Grouped Rows" = Table.Group(#"Filtered Rows", {"ucrn"}, {{"Count", each Table.RowCount(_), Int64.Type}})
in
    #"Grouped Rows"
```

Figure I.9: Power BI scripts used for calculating the size of updates of RTA berth by the terminal within the last 12 hours before execution (AT First Line Secured – boatmen). Source: own script.

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_location] = "berth") and ([event_type] = "ptd") and ([event_source] = "terminal")
    and ([location_name] = "ECT DDN")),
    #"Added Conditional Column" = Table.AddColumn(#"Filtered Rows", "Eventtime>Recordtime", each if [record_time] > [event_time] then false else true),
    #"Filtered Rows1" = Table.SelectRows(#"Added Conditional Column", each ([#"Eventtime>Recordtime"] = true)),
    #"Merged Queries" = Table.NestedJoin(#"Filtered Rows1", {"ucrn"}, #"ATLastLineReleased - LINESMEN - GIDS", {"ucrn"}, "ATLastLineReleased - LINESMEN - GIDS",
    JoinKind.Inner),
    #"Expanded ATLastLineReleased - LINESMEN - GIDS" = Table.ExpandTableColumn(#"Merged Queries", "ATLastLineReleased - LINESMEN - GIDS", {"event_time"},
    {"ATLastLineReleased - LINESMEN - GIDS.event_time"}),
    #"Inserted Time Subtraction" = Table.AddColumn(#"Expanded ATLastLineReleased - LINESMEN - GIDS", "Subtraction",
    each [#"ATLastLineReleased - LINESMEN - GIDS.event_time"] - [record_time], type duration),
    #"Calculated Total Hours" = Table.TransformColumns(#"Inserted Time Subtraction",{{"Subtraction", Duration.TotalHours, type number}}),
    #"Renamed Columns" = Table.RenameColumns(#"Calculated Total Hours",{{"Subtraction", "ATLastLineReleased_event - PTDBERTH_recordtime"}}),
    #"Sorted Rows" = Table.Sort(#"Renamed Columns",{{"ucrn", Order.Ascending}, {"record_time", Order.Ascending}}),
    #"Added Index" = Table.AddIndexColumn(#"Sorted Rows", "Index", 0, 1),
    #"Added Index1" = Table.AddIndexColumn(#"Added Index", "Index.1", 1, 1),
    #"Merged Queries1" = Table.NestedJoin(#"Added Index1", {"Index"}, #"Added Index1", {"Index.1"}, "Added Index1", JoinKind.LeftOuter),
    #"Expanded Added Index1" = Table.ExpandTableColumn(#"Merged Queries1", "Added Index1", {"ucrn", "event_time"},
    {"Added Index1.ucrn", "Added Index1.event_time"}),
    #"Added Conditional Column1" = Table.AddColumn(#"Expanded Added Index1", "Extract from event_time", each if [ucrn] = [Added Index1.ucrn]
    then [Added Index1.event_time] else [event_time]),
    #"Inserted Time Subtraction1" = Table.AddColumn(#"Added Conditional Column1", "Subtraction", each [Extract from event_time] - [event_time], type duration),
    #"Inserted Total Hours" = Table.AddColumn(#"Inserted Time Subtraction1", "Total Hours", each Duration.TotalHours([Subtraction]), type number),
    #"Calculated Absolute Value" = Table.TransformColumns(#"Inserted Total Hours",{{"Total Hours", Number.Abs, type number}}),
    #"Added Conditional Column2" = Table.AddColumn(#"Calculated Absolute Value", "Updates <12 hours from ATLastLineReleased",
    each if [#"ATLastLineReleased_event - PTDBERTH_recordtime"] <= 12 then true else false),
    #"Renamed Columns1" = Table.RenameColumns(#"Added Conditional Column2",{{"Total Hours", "Size updates PTD BERTH TERMINAL event time"}}),
    #"Added Conditional Column3" = Table.AddColumn(#"Renamed Columns1", "Size updates PTD Berth Terminal (Bins)",
    each if [Size updates PTD BERTH TERMINAL event time] <= 1 then "0-1" else if [Size updates PTD BERTH TERMINAL event time] <= 2 then "1-2"
    else if [Size updates PTD BERTH TERMINAL event time] <= 3 then "2-3" else if [Size updates PTD BERTH TERMINAL event time] <= 4 then "3-4"
    else if [Size updates PTD BERTH TERMINAL event time] <= 6 then "4-6" else if [Size updates PTD BERTH TERMINAL event time] <= 8 then "6-8"
    else if [Size updates PTD BERTH TERMINAL event time] <= 12 then "8-12" else ">12"),
    #"Changed Type" = Table.TransformColumnTypes(#"Added Conditional Column3",{{"Size updates PTD Berth Terminal (Bins)", type text}}),
    #"Added Conditional Column4" = Table.AddColumn(#"Changed Type", "Sequence", each if [#"Size updates PTD Berth Terminal (Bins)"] = "0-1" then 0
    else if [#"Size updates PTD Berth Terminal (Bins)"] = "1-2" then 1 else if [#"Size updates PTD Berth Terminal (Bins)"] = "2-3" then 2
    else if [#"Size updates PTD Berth Terminal (Bins)"] = "3-4" then 3 else if [#"Size updates PTD Berth Terminal (Bins)"] = "4-6" then 4
    else if [#"Size updates PTD Berth Terminal (Bins)"] = "6-8" then 5 else if [#"Size updates PTD Berth Terminal (Bins)"] = "8-12" then 6 else 7)
in
    #"Added Conditional Column4"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "linesmen") and ([event_location] = "lastLineReleased")),
    #"Merged Queries" = Table.NestedJoin(#"Filtered Rows", {"ucrn"}, #"Don't use (group ATLastLineReleased)",
    {"ucrn"}, "Don't use (group ATLastLineReleased)", JoinKind.LeftOuter),
    #"Expanded Don't use (group ATLastLineReleased)" = Table.ExpandTableColumn(#"Merged Queries", "Don't use (group ATLastLineReleased)", {"Count"},
    {"Don't use (group ATLastLineReleased).Count"}),
    #"Filtered Rows1" = Table.SelectRows(#"Expanded Don't use (group ATLastLineReleased)", each ([#"Don't use (group ATLastLineReleased).Count"] = 1))
in
    #"Filtered Rows1"
```

```
let
    Source = #"PortXchange Data 07_07_2020",
    #"Filtered Rows" = Table.SelectRows(Source, each ([event_source] = "linesmen") and ([event_location] = "lastLineReleased")),
    #"Grouped Rows" = Table.Group(#"Filtered Rows", {"ucrn"}, {{"Count", each Table.RowCount(_), Int64.Type}})
in
    #"Grouped Rows"
```

Figure I.10: Power BI scripts used for calculating the size of updates of RTD berth by the terminal within the last 12 hours before execution (AT Last Line Released – boatmen). Source: own script.

J. ENLARGED CHARTS – SIZE OF UPDATES

This appendix gives an enlarged overview of the histograms about the size of updates of timestamps. Figure J.1 displays the size of updates of ETA PBP, ETA berth, ETD berth, RTA berth and ETC cargo services.

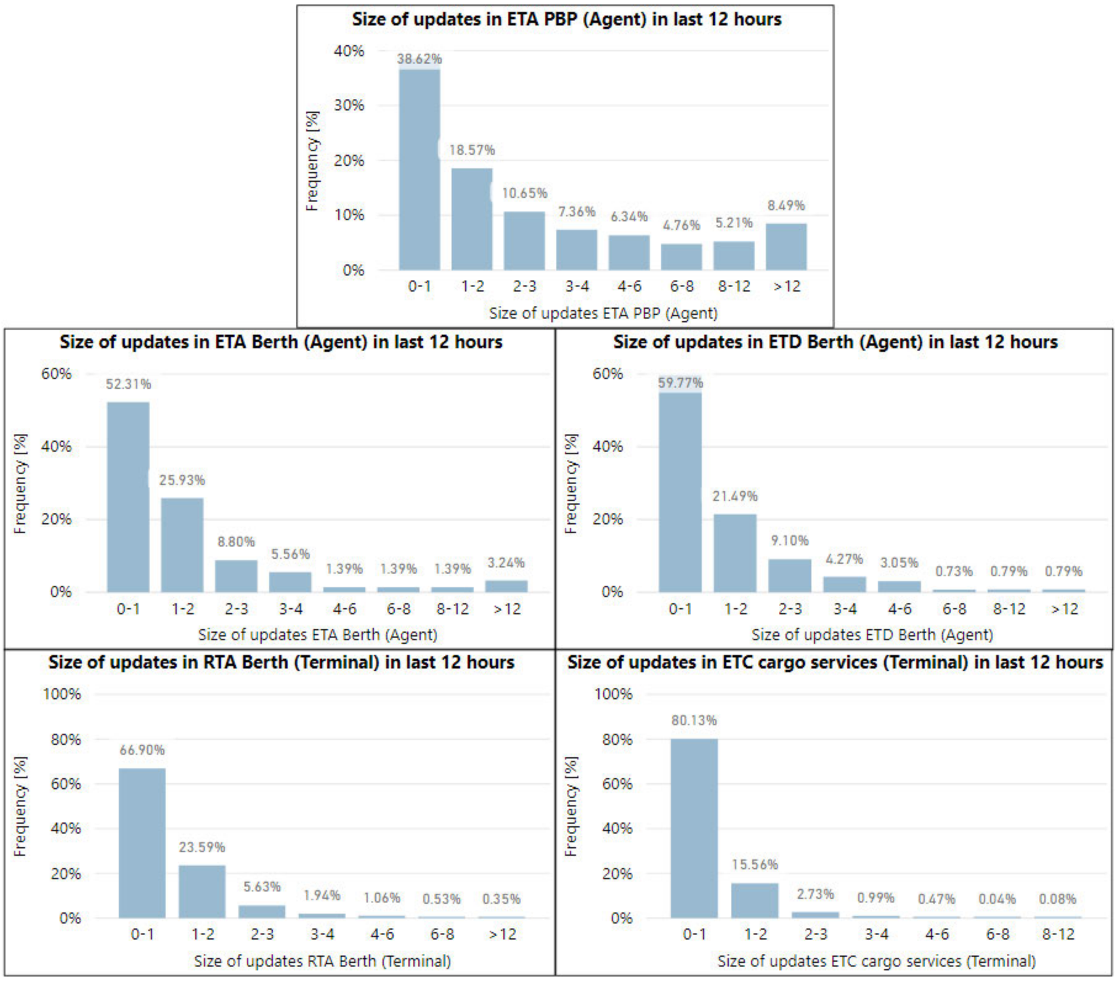

Figure J.1: Size of updates per timestamp within 12 hours of execution (enlarged figure). Source: own figure.

K. BUSINESS PROCESS MAP OF PORT CALL INCLUDING NAUTICAL SERVICES

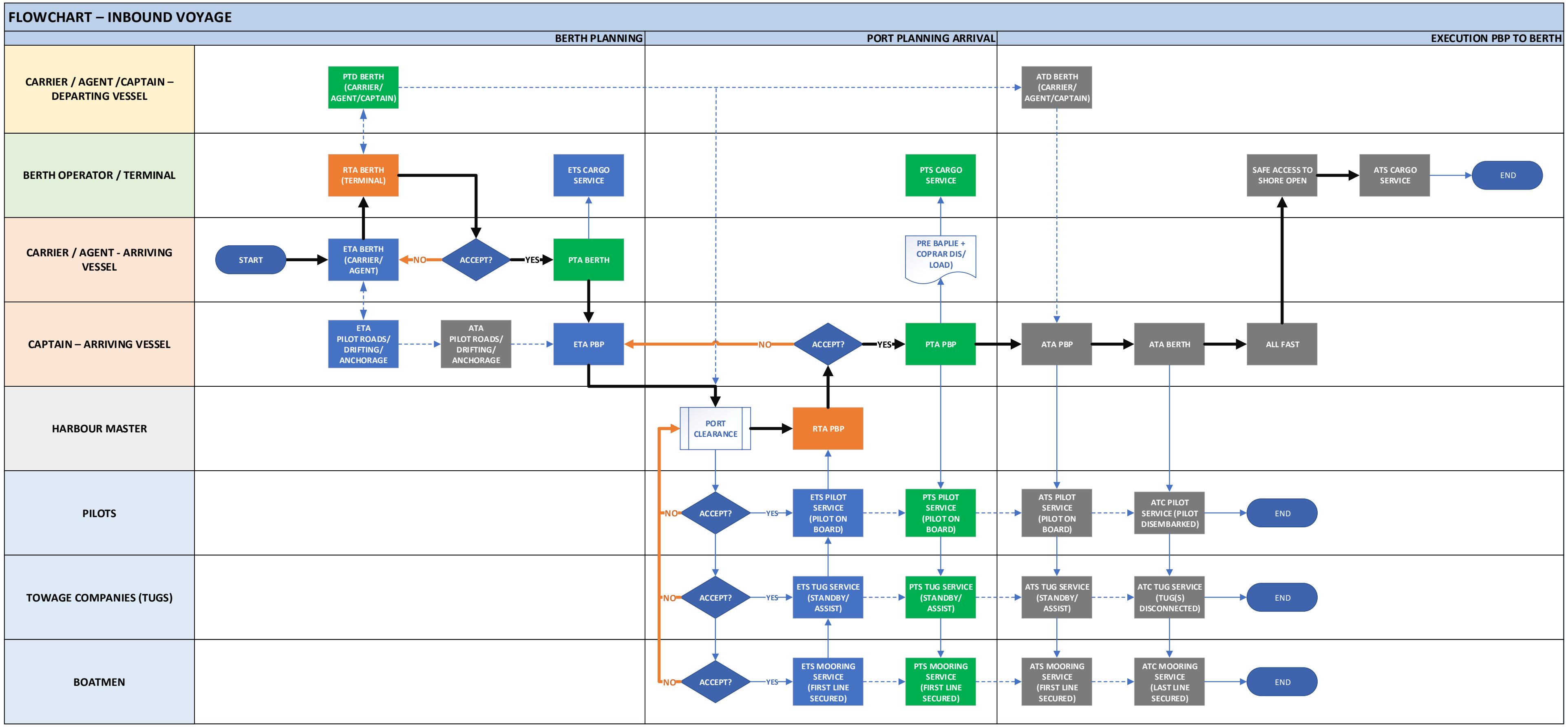

Figure K.1: Business process map of port call including nautical services for inbound voyages. Source: own figure, inspired by B. den Ouden.