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Input paper for the following Committee(s):	check as appropriate	Purpose of paper:
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Agenda item	
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Summary

As part of the Future VTS program, the port authority is investigating the impact of digitization and automation on the future of Vessel Traffic Services (VTS) in Rotterdam. Based on the assumption that digitization and information exchange between systems will take place more and more and verbal exchange will ultimately remain limited, it has started investigating the VHF communications for VTS within Rotterdam.

Purpose of the document

providing input for the working group to substantiate choices in terms of attention and focus

Creating silent VTS at the Port of Rotterdam

An impact analyses of digitalizing VHF communications

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Main topic: Silent VTS and the reduction of verbal communication

Abstract

As part of the Future VTS program, the port authority is investigating the impact of digitization and automation on the future of Vessel Traffic Services (VTS) in Rotterdam. Based on the assumption that digitization and information exchange between systems will take place more and more and verbal exchange will ultimately remain limited, it has started investigating the VHF communications for VTS within Rotterdam

VTS monitors the vessels in ports and provide the ship masters with the required information to ensure the safety and efficiency of the vessel traffic in the port. Information is communicated using very high frequency (VHF) radios on the corresponding VHF-channels of the sectors. In busy sectors in the port, these VHF-channels are crowded, which results in unclear situations and high workloads for the VTS. Based on a “Silent VTS” concept The Rotterdam Port Authority is currently investigating measures to reduce VHF-traffic.

In order to determine which and to what extent communication elements can make a major contribution to the intended goal, further research is carried out. Port of Rotterdam concluded that about 80% of the communication contains three of the five indicated categories. Namely: ship announcement (35% - 45%), the sharing intentions (20% - 30%) and sharing the traffic image for (15% - 25%) and simulator tests with concepts for digital transmission of information about attentions and intended / predicted routes shows that the verbal communication via VHF radio can be reduced by more than 70%.

With all efforts on MASS and Artifical Inteligent systems on board and in line with the prospects that systems will become more complex and connected, technologies will become more advanced and the role for supporttools in increase , digital exchange of VTS services will be needed. Further research on the impact of digital VTS services should give a solution to the discussion on how to be sure of a Common Situational Awareness and understanding of intended actions are created without a verbal confirmation.

The presentation of information in a clear manner will be key and to eliminate the risk of missing crucial information it will be likely that some kind of a conformation that a master has noticed the added attentions should be created. To create more digital Aid to Navigation (ATON), incl the provision of VTS, a communication strategy on digital services will be needed.

Content

Introduction Future VTS and communication

The Port of Rotterdam Authority started 2019 a so called “Future VTS” program to developing an adaptive VTS organization that responds to external changes in, among other things, the labor market, technology and shipping needs. We believe that conventional, smart and autonomous ships need a VTS organization that provides all shipping traffic with traffic information in a timely manner, manages the traffic and responds to developing unsafe situations so that the safe and efficient flow of traffic is guaranteed. This hybrid traffic supply will be created from 2023 and the Port Authority anticipates developments in the market.

With the Future VTS program, the Port of Rotterdam Authority wants to respond to the effects and opportunities of changes in the field of digitization of maritime transport in favor of Vessel Traffic Service (VTS). The Port Authority has drawn up a vision for the VTS (Dorsser, 2020). Based on the assumption that digitization and information exchange between systems will take place more and more and verbal exchange will ultimately remain limited, it has started investigating the VHF communications for VTS within Rotterdam.

In addition the Port of Rotterdam contributed to the IALA VTS Committee’s on MASS and Future VTS. The Future VTS working group, that has been analyzing the technological and procedural changes and created a living document providing insights into trends, emerging technologies, and realized practices impacting Future VTS services (IALA Future VTS woring group , 2022). One of the challenges will be the transition towards more digital VTS services. To give answers to that IALA started a new working group on VTS Digital Communication. This paper will be input to that working group as well.

VTS communication at the Port of Rotterdam

The Port of Rotterdam Authority has a radar chain at its disposal for the provision of VTS, supplemented with cameras and visual observation at the manned radar posts using VHF radio for one on one contact with ships. The VTS operator are now confronted with an increasingly complex mix of highly automated and conventional shipping. Next to that a mix of commercial seagoing vessel, inland barges, pleasure craft and fast boats (including the city water taxis).

The Port Authority wants to gradually arrive at a renewed and modern Vessel Traffic Services (VTS) that is suitable for optimally monitoring and supervising the current highly heterogeneous mix of transport flows and is also prepared for future developments and techniques on situational awareness and communication.

Within the Port of Rotterdam different VTS sectors and with that different types of VHF channels are used. Three channels (11, 14 and 19) are for planning related communication and used by the Harbour Coordination Centre. Eleven channels are used for vessel traffic services at the different sectors, one of them used as well for remote pilotage.

Traffic information

The exchange of traffic information and coordination of maneuvers takes all place verbally via the VHF. Within Rotterdam there are 11 sectors where traffic information services are delivered on a specific VHF channel. Five more sea-related sectors are served from the Hoek van Holland Traffic Center (channels 01, 02, 03, 65 and 66) and six more inland -related sectors from the Rotterdam Traffic Center in the Botlek (channels 60, 61, 62, 63, 80 and 81).

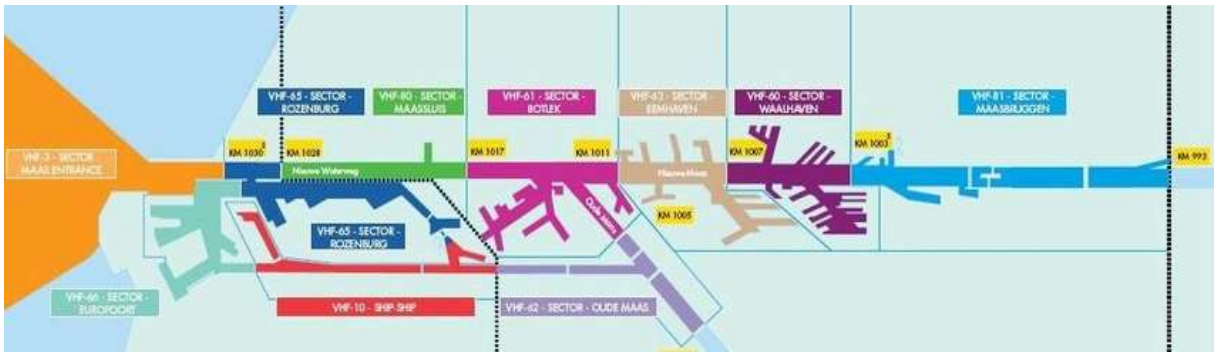

Figure 1: overview of VTS area's at the Port of Rotterdam

Hoek van Holland Traffic center

Rotterdam Traffic Center (Botlek)

Planning and destination

The Port Planning information for seagoing vessels has been digitized via Portbase, a central gateway for digital port logistics that connects all parties in the logistics chains of the Dutch ports to this end. Via the Port Community System, Portbase facilitates data sharing between companies and information exchange with governments in order to work faster, more efficiently and at lower costs. Portbase is automatically connected with in the Harbour management information system (HAMIS) and the ship planning data is with that real-time available to the VTS operator (VTSO). The channels 11,14 and 19 are not used by VTSO and therefore excluded within this research.

For Inland shipping a European information system (CoRISMa) is being developed, but this is not yet available for the VTSO. Information for intentions and destinations from inland vessels is currently obtained through VHF contact on one of the 11 VTS sectors, with the VTSO asking a skipper and with that part of this research

Analysis of VHF radio and traffic

Meta-analysis

In order to gain insight into the auditory workload, an analysis was made on the basis of the meta data (date of recording, duration of recording, channel) from the period 1-1-2021 up to and including 31-12-2021. So-called “Heatmaps” are used for this analysis, which concern the duration of the observed conversations on the one hand and the number of conversations in which a silence longer than 2 seconds is used as a separation between the conversations.

Different occupation between sectors

Figure 2 makes clear that there is a substantial difference between the auditory occupation on the different VHF channels, for example in the Botlek sector a total of between approximately 1400 and 1600 minutes of conversations are made per month and in the Maassluis sector between 130 and 440 minutes. In addition to the difference in quantity, the deviation is also different.

01 - Maas Aanloop (av. 940.8)	1057	982	964	1006	871	957	869	936	931	924	823	970	7%
02 - Pilot Maas (av. 745.8)	805	735	723	761	727	761	761	770	748	646	756	756	5%
03 - Maas Mond (av. 407.6)	386	402	390	426	524	512	480	407	381	314	403	266	18%
60 - Waalhaven (av. 764.4)	685	806	724	798	685	836	653	857	861	706	800	762	9%
61 - Botlek (av. 1495.8)	1595	1549	1533	1551	1493	1491	1486	1408	1588	1378	1456	1421	5%
62 - Oude Maas (av. 556.7)	613	524	520	613	549	531	525	502	619	546	638	500	9%
63 - Eemhaven (av. 1050.8)	1146	1099	1108	1179	948	1072	1068	964	1149	920	997	960	9%
65 - Rozenburg (av. 864.4)	946	1062	859	933	783	829	850	900	864	784	806	757	10%
66 - Europoort (av. 1188.3)	1436	1369	1224	1191	1137	1024	1135	1120	1015	1191	1249	1169	10%
80 - Maassluis (av. 270.9)	171	159	130	381	323	222	363	178	249	440	331	304	37%
81 - Maasbruggen (av. 558.4)	413	544	458	565	524	637	531	704	561	596	567	601	14%
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Deviation

Figure 2: Total hours of registered communication per channel per month

The difference between work and weekend days is not the same for all sectors

The days of the week can also be observed differently. The sectors served from the Hoek van Holland traffic control center, with the exception of Sector Rozenburg, do not have no significant variation between work and weekend days. Rozenburg is a so-called fresh water sector where more inland shipping-related shipping movements takes place. The sectors of the Rotterdam Traffic Center do have a clear difference. In the more inland port sectors, 1.5 to 2 times as many minutes of speech are processed on a weekday as compared to the weekend day.

01 - Maas Aanloop (av. 8.7)	8,4	8,8	9	9,1	8,7	8,5	8,3
02 - Pilot Maas (av. 6.9)	6,9	7	6,9	7,2	7	7	6,3
03 - Maas Mond (av. 3.8)	3,5	4,1	3,7	4	3,8	4	3,2
60 - Waalhaven (av. 7.1)	8,1	7,7	8,5	7,4	7,9	5,8	4,5
61 - Botlek (av. 13.9)	14,6	14,8	16,2	15,7	15,1	11,3	9,6
62 - Oude Maas (av. 5.2)	5,5	5,5	6,1	5,8	5,9	4,3	3,3
63 - Eemhaven (av. 9.8)	11,5	10,6	12,4	11,3	10,9	6,5	5,6
65 - Rozenburg (av. 8.0)	8	8,3	9,4	9,4	8,3	6,9	5,9
66 - Europoort (av. 11.0)	10,3	10,5	11,9	11,9	11,3	10,9	9,9
80 - Maassluis (av. 2.5)	1,7	2,5	2,9	3,1	2,7	2,1	2,7
81 - Maas Bruggen (av. 5.1)	4,8	5,1	5,5	5,5	4,9	5,7	4,5
	Mon	Tue	Wed	Thu	Fri	Sat	Sun

Figure 3: average amount of hours of communication registered per channel per weekday in 2021

Day and night differences are not the same for all sectors

As figure 4 shows the pattern of communication over the hours also provides different insights. The offshore sectors of Hoek van Holland (01,02 and 03) have an even auditory workload. Maas approach as the most seaward positioned sector establishes the first contact for incoming ships and has the entire 24 hours an average between 7 and 10 minutes of registration, while the more inland port-related sector does have a day and night pattern. In the Eemhaven sector, for example, the total minutes of communication over 24 hours varies between 3 and 19 minutes an hour, while it varies between 16 and 19 minutes between 7 am and 3 pm.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
01 - Maas Aanloop (Av. 9.1)	8,9	7,9	9,4	10,1	9,4	10,7	11,3	9,2	9,5	8,8	8,4	9,5	8,2	6,9	7,4	11,4	7,3	9,1	9,7	9,2	7,9	11	8,1	8,3
02 - Pilot Maas (Av. 7.2)	7,2	8	8,4	8,2	7,1	8,4	8,3	6,5	6,2	5,9	6,6	6,3	6,4	6,1	6,1	6,2	5,8	5,3	6,7	8,3	7,4	8,9	8,8	8,8
03 - Maas Mond (Av. 4.0)	4,4	4,7	3,3	3,6	4,4	4,2	3,1	5,3	5,3	4,4	3,2	2,9	4,4	3,1	4,8	3,3	3,9	3,2	3,5	3	6,1	4,1	4,5	3,3
60 - Waalhaven (Av. 7.4)	3,6	2,6	2,5	2,2	1,7	2,9	6,1	7,4	8,7	10,5	11,1	12,8	11,3	13,6	13,2	13,2	11,7	10,3	6,8	6,3	6,4	4,4	5	4
61 - Botlek (Av. 15.7)	9,9	7,4	10,6	10,1	8,4	8	11,5	17,3	18,7	17,8	23,9	20,2	21,7	20,9	20	21,8	20,7	19,9	18,1	17,5	14,8	14,2	12,9	10,8
62 - Oude Maas (Av. 5.8)	2,9	2,6	3,6	1,9	2,6	2,6	4,7	6,9	7,7	7,6	6,6	7	7,5	8,5	8,3	8,9	9,6	8	6,9	6,5	4,7	5,2	4,5	2,7
63 - Eemhaven (Av. 11.4)	6,4	3,3	3,8	4,9	4,5	3,8	10,2	15,9	15	16,1	17,7	16,3	18,9	19,2	15,4	17,7	12	15,9	12,7	9	11,7	11	7,2	4,6
65 - Rozenburg (Av. 9.4)	4,7	5,7	5,3	3,1	4,2	5,6	8,5	11,6	14,4	9,9	12,8	12,2	11	11,5	12,3	12,4	13,5	9,4	8,6	11,4	14,1	9,7	8	5,4
66 - Europoort (Av. 11.9)	10,3	11,5	8,3	7,5	7,7	7,8	12,1	12,3	15,3	14	13	15,4	12,5	12,1	14,3	13,8	14,1	12,8	11,7	12,4	12,3	11,7	13,1	10,3
80 - Maassluis (Av. 3.1)	6,5	4,3	6,1	5,4	4,4	5,8	2,1	1,9	1,3	2	2,4	1,2	2	2,4	1,7	1,8	1,7	1,7	1,8	1,9	1,7	2,3	4,5	7,2
81 - Maas Bruggen (Av. 5.5)	3,6	2,6	2	1,6	1,7	2,8	4,3	4,2	5,3	6,9	8,3	8,8	8	9,1	11,1	10,1	7,6	7	6,2	4,3	4,6	2,9	4,9	4

Figure 4: average amount of minutes of communication registered per hour for the Thursdays in 2021

Figure 5 shows that the conversations are longer at the more inland related sectors and during daytime hours. Figure 6 plots the relation between the total amount of registered minutes of communication and the average duration. It makes clear that there is a relation between the duration and total amount of communication. The more communication on a sector, the longer the conversations are.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
01 - Maas Aanloop (Av. 12,0)	10,2	11,1	12,4	13,5	11,7	13,1	13,7	14,2	11,9	12,2	8,9	12,2	11,1	11,8	11,6	14,8	11	12,8	12,2	13,2	9,1	12,8	10	12,2
02 - Pilot Maas (Av. 12,4)	13	13,6	12,8	12,5	12,5	12,3	13,9	12,9	11	13,7	12,2	11,8	11,4	12,2	9,4	9,9	14,1	11,9	13,3	12,6	12,3	12,7	13,9	12,5
03 - Maas Mond (Av. 11,4)	10,6	12,5	11,1	11,7	8,8	12,3	12,3	12,3	14,7	13,7	8,5	11,7	11	8,6	10,6	8,4	11,7	13,7	11	10,7	13,3	11,4	11,8	12,3
60 - Waalhaven (Av. 13,2)	10	12,2	12,2	11	9	11,5	12,3	13	14,2	15,6	12,7	15	17,4	13,6	13	16,1	16,5	15,3	13,6	11,6	13,1	10,8	14,8	13,2
61 - Botlek (Av. 15.8)	15,2	11,3	12,6	16,5	13,9	15,4	14,2	16,7	16	14,4	21,1	17,7	17,8	18,3	15,8	16,9	15,9	14,7	16,2	16,9	15,4	17,8	16,1	13,1
62 - Oude Maas (Av. 14,4)	14,7	12,6	13,3	15,4	13,4	10,8	14,6	16,1	14,7	15,7	15,4	15,2	14,3	15,3	14	14,3	16,4	15,8	13,4	14,3	13,3	14,3	16,4	12,2
63 - Eemhaven (Av. 15,0)	17,7	11,7	11,2	12,3	13,8	13,4	14,9	15,3	16,9	17,3	17,7	14,1	17,9	16,4	17,1	19,7	15,7	14,9	14,6	12	13,8	16,1	14,5	10,5
65 - Rozenburg (Av. 13,4)	11,2	12,4	12,9	13,6	10,3	13,4	12,2	13,3	11,9	12	19	12,3	11,1	13,9	13,7	14,5	15,7	12,4	12,5	15,3	15,1	17,3	12,3	13,5
66 - Europoort (Av. 13,2)	11,9	14,6	13,7	11,3	12,2	10,6	13	14,4	14,5	13,8	11,7	14	13	13	12,1	14,5	13	14	12,7	13,4	14,7	14,4	13,3	12,5
80 - Maassluis (Av. 11,8)	14,8	11,6	9,6	20,1	12,6	17,2	10	11,2	7,6	10,8	11,8	8,9	10,2	11,4	9,5	12,2	10,3	11,5	10,9	11,4	9,7	13,2	13,1	13,3
81 - Maas Bruggen (Av. 12,7)	10	12,1	12,8	10,2	9,3	14,2	12,5	11,2	13,3	12	15,3	13,3	13,1	11,8	14,4	14,6	13,2	14,1	13,6	10,6	10,3	11,4	14,9	13,6

Figure 5: average duration registered interaction per second for the Thursdays in 2021

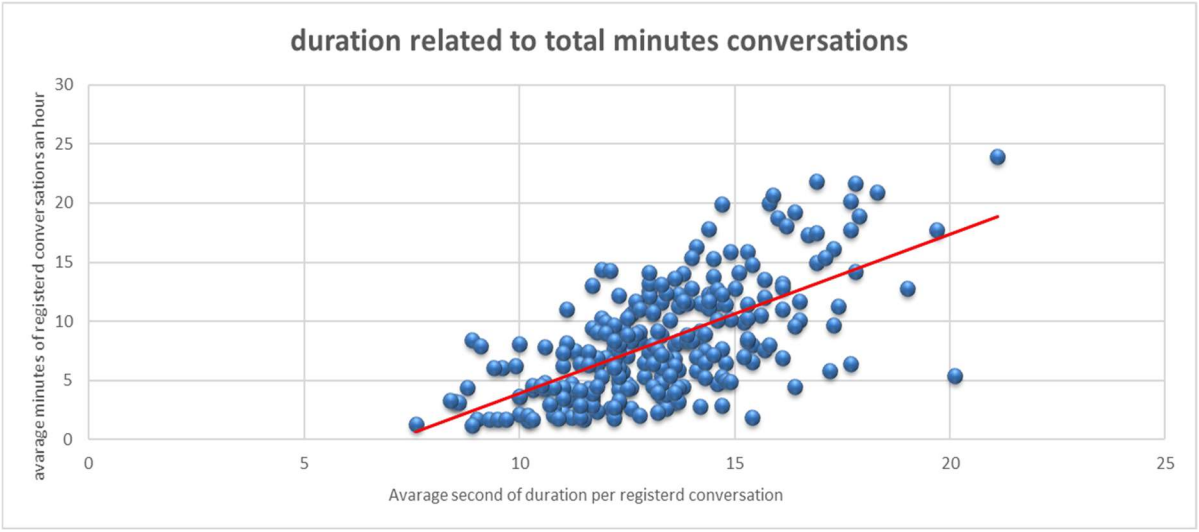

Figure 6: relation between average duration per registration and minutes of registered conversations per hour on Thursdays

Conclusion meta-analysis

It can be concluded that the more seaward positioned saltwater sectors at the Hoek van Holland Traffic Center and the more inland positioned freshwater sectors have different communication patterns. The exchange of information via VHF on sectors closer to the sea has a more even communication pattern. The inland port-related sectors, on the other hand, have large differences in the number of calls and duration, with influences from weekdays and weekends and day and night.

Content analysis

The purpose of VTS is (1) to provide timely and relevant information on factors that may influence ship movements and assist onboard decision-making, (2) monitor and manage ship traffic and (3) respond to developing unsafe situations. Communication which has been carried out by VHF until now. To gain insight into the substantive intention of the conversations a global survey was carried out (Allersma, 2021). This research has shown that the majority of messages consist of, the announcing a message and making the traffic situation clear (imaging). In many cases this is followed by the planned maneuver of the ship.

In order to arrive at these findings, Allersma used the VHF communication of sector Botlek logged and then digitized, the messages between the VTS and the shipping divided into 5 categories;

- Announcement / (first) contact of a ship	(Sector … here is …)
- Sharing the ship's intentions	(We are destined for…)
- Providing the traffic image	(400 meters in the approach and ...)
- Tuning maneuvers between ships	(Then I would like to do SB-SB with ...)
- Other / safety messages	(Diving work at the ... request to ..)

Allersma investigated the Botlek area. Due the insight of the meta-analysis, that there is a substantial difference between the sectors, three additional sectors have been analyzed. Sectors with different busy patterns and profiles have been chosen. Maas Entrance (Maas Mond) as a saltwater sector, Europoort as port area with daily 400+ container vessels pas and Maas Bruggen as more inland freshwater river within the city center of Rotterdam.

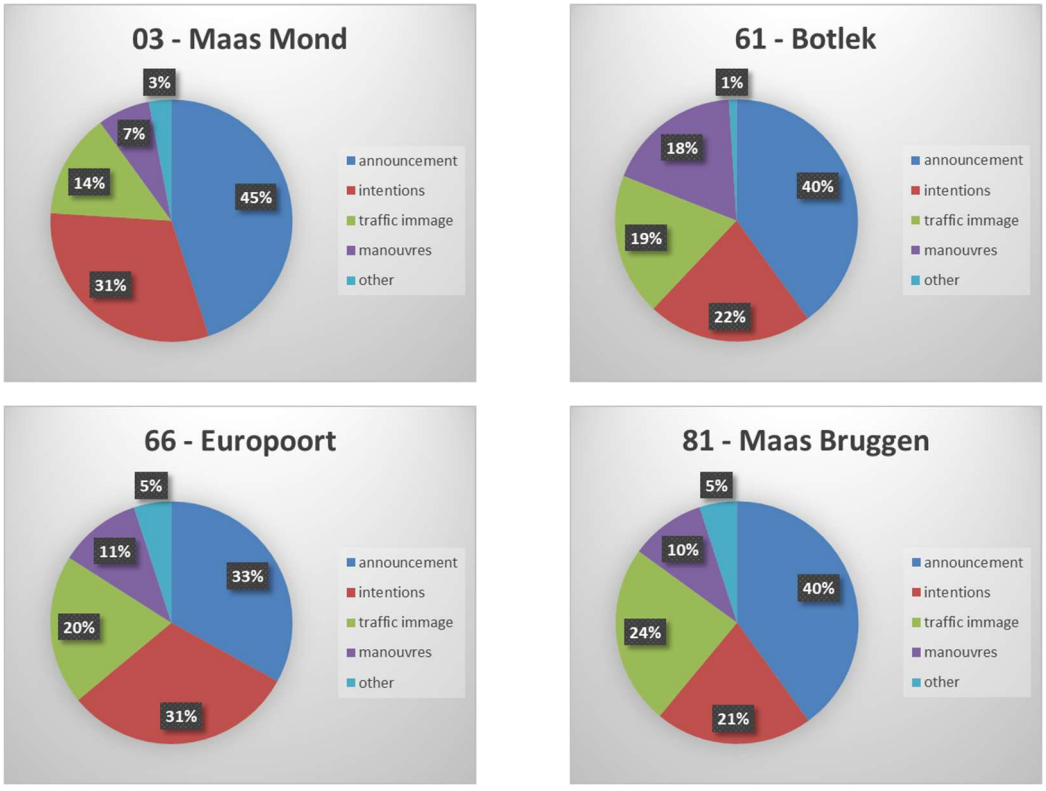

Figure 7: Information element within the VHF communication categorized by method Allersma

Data-elements

In addition to the content analysis, various methods were used to investigate the data elements. Weijers performed an analysis based on a manual transcription and a script to filter out the data elements (Weijers, 2021) . Our storage software supplier has tried to automatically generate and bundle the data elements based on phonetic aspects. (Bumicon, 2021)

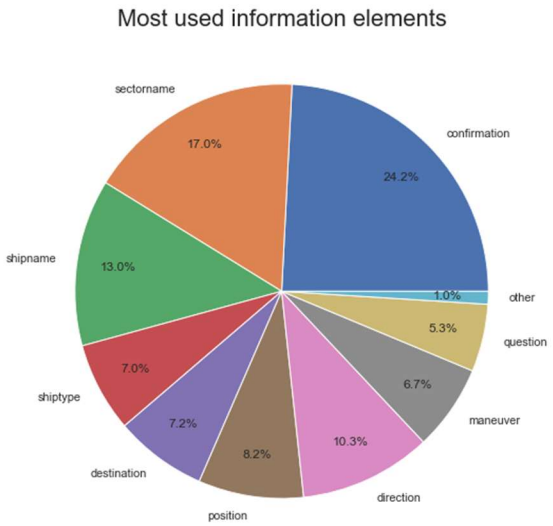

Figure 8: data elements VHF Botlek (Weijers, 2021))

Figure 9: data elements of VHF obtained from phonetic analysis (BUMICON, 2021)

Phonetic analysis provides insight that standard elements such as ship and sector names are, as expected, the most common. Although the phonetic analysis is suitable for large-scale analysis of data elements, it has been decided not to provide insight into the data elements in view of the cost price and expected (random) outcomes. One of the problems was that interpreting a conversation requires a lot of knowledge. For example, sectors and ships are often named after areas and/or rivers and a phonetic analysis clashes between location, destination, sector name and/or even ship names.

Conclusions content analyses.

About 80% of the communication contains three of the five indicated categories, announcement (35% - 45%), sharing intentions (20% - 30%) and traffic image (15% - 25%) and have an informative character. The analyses of data element makes clear that elements communicated are quite standard however hard to analyses with generic large scale phonetic tools.

Impact analyses silent VTS components

To visualized the As-Is situation and understand the flow of the VHF communication process Weijers created an as-is Flowchart (figure 10). The chart made clear that at least six steps are required to handle a traffic situation and that within high density traffic situations the amount of transmissions increases to more than 25 calls. Weijers concluded that, from the flowchart, a high number of confirmations show the limitation of voice communication.

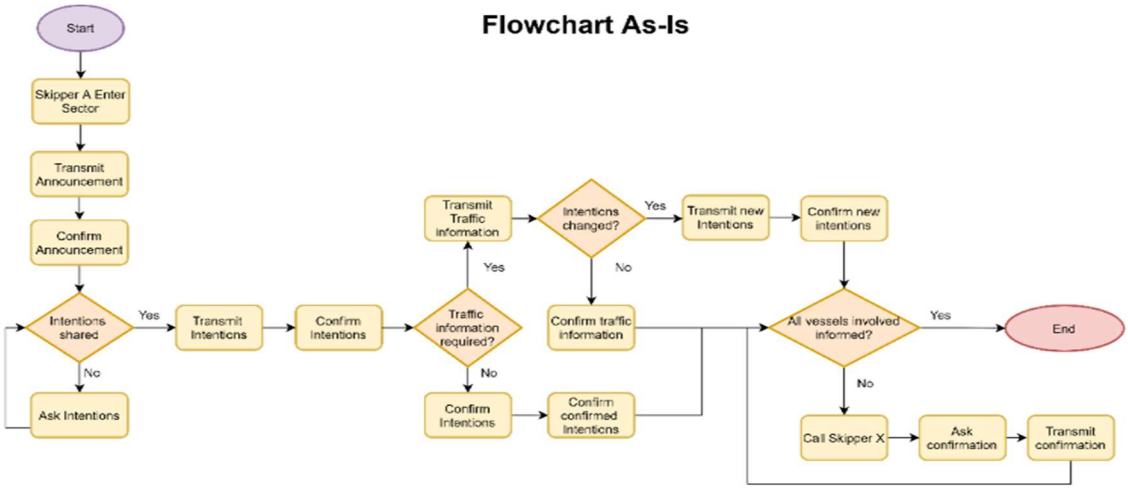

Figure 10: Flowchart VTS communication As-Is (Weijers 2021)

Weijers analyzed the causes related to the categories and concluded that many are related to the limitation of a master not sharing his intentions. Based on the counter measure, Weijers advises a system where the master can share his voyage plan and intended route with the VTSO in a visualized manner and assumed a more automated system where a master would send, route and intentions. With such system, when answering all the decision points with 'yes,' the chart shows (figure 11) fore steps from which two manual. The To-Be process seems promising by removing five manual steps from the process in which VTSO only one task is required and potentially reduces 75% of the manual steps for the VTSO.

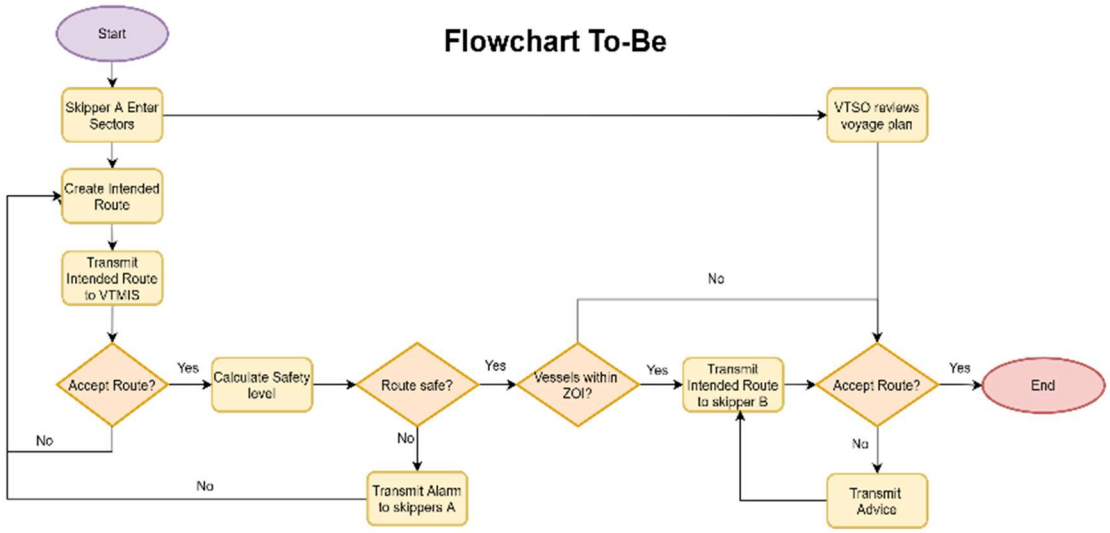

Figure 11: Flowchart VTS communication To-Be (Weijers 2021)

Simulator test

Students from the STC Rotterdam Mainport Institute conducted a simulator tested based on the concept of Silent VTS (Bongaertz, 2022). The Silent VTS study looked at whether information normally transfer by the Vessel Traffic Service Operator (VTSO), could be replaced by a digital screen that shares the operational image of the VTSO with the skipper. Furthermore, the influence of the shared operational picture on the situational awareness of the skipper. Within the study two concept were tested. First the concept of safety messages about appealing situations like a diver and of other work. Second the impact of track information from other vessels.

Safety massages

With the used software the information exchanged couldn't completely be replaced. A disadvantage of the tested way of transferring text messages was that it wasn't clear to the VTSO whether the message had been received and understood. Tekst massages where not always read by the master and the use of icon representation on ENC was suggested.

Track information

In the field of situational awareness the master was given an added screen with the intended / predicted tracks of vessels nearby. However it would be nice that these function are incorporated within ENC this study shows that it had a positive effect on amount of communication. "The feature gives a quick overview of a ship's intentions". However, the risk here is that: relying too much on the information given when a ship's track forecast doesn't can represent the actual situation.

Conclusions simulator

Transferring digital information about added attentions and transferring intended / predicted routes could reduce the communication by more than 70%. The presentation of information in a clear manner however are key and to eliminate the risk of missing crucial information a conformation that a master has noticed the added attentions will be needed.

The students concluded that it is not entirely clear what role the VTSO will play in the Silent-VTS and traffic management in future. However, based on this research, an indication can be given. The expectation of the students will be that VTS will not disappear, but that the role will modify. The preferred methods of information transfer to be determined should be investigated further on.

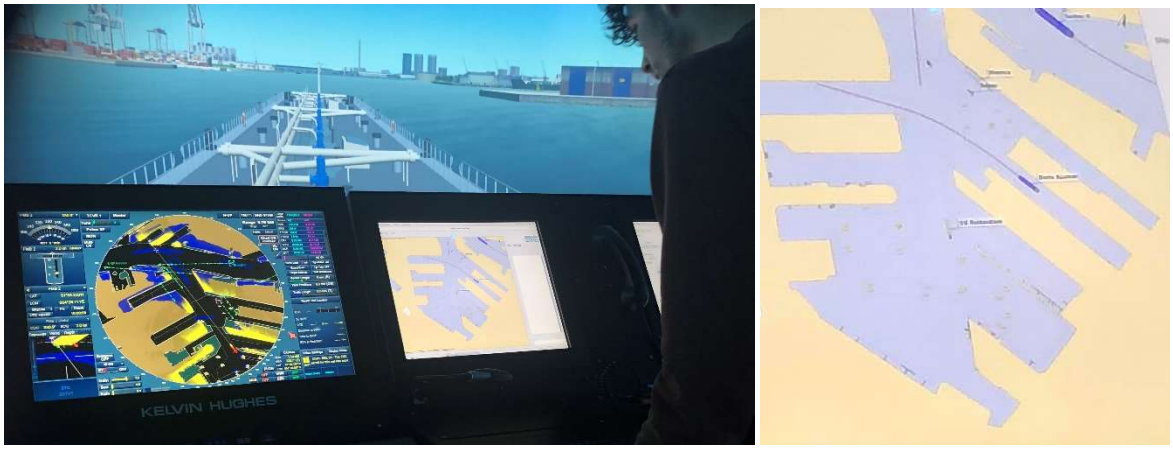

Figure 12: Simulator test with predicted tracks on screen (STC 2022)

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