MPX

A Highway to Human Error or a Stronghold Against System Variability?

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Abstract
The cooperation between the bridge team members onboard merchant vessel has been given considerable attention since the mid 90´s when the focus on non-technical skills (NTS) was adopted from the aviation industry. In the maritime industry NTS training is called Bridge Resource Management (BRM) training and was introduced to avoid single person errors resulting in accidents. Initially the focus on BRM was concentrated on the ship crews learning to function as a team, later also maritime pilots had to participate in BRM training. The training of the pilots is concentrated on the cooperation with the master and the crew of the vessel under pilotage. This cooperation is called the Master Pilot Exchange (MPX) named after the initial exchange of information between master and pilot when the pilot has boarded the vessel. Despite years of training and attention several studies and conclusions in accident reports indicate that the cooperation between pilot and ship crew is not always adequate.

In this qualitative study inspired by narrative research and storytelling we would like to explore how the cooperation between pilot and master/crew is established. We interviewed 6 masters and 7 pilots and asked them to tell their stories concerning the cooperation in order to shed light on issues supporting and constraining the teamwork. Regarding the MPX as a Joint Activity (G. Klein, Feltovich, Bradshaw, & Woods, 2005) we will describe how the cooperation between pilot and bridge crew is established and maintained. Furthermore, we will examine how the cooperation between pilot and bridge crew is established and maintained. Furthermore, we will examine how the cognitive workload of the bridge team is increased when adding a stranger, the pilot, to the team.

We found that there is a fundamental wish to do a good job. Both masters and pilots want the operation to be a success and they usually have an understanding that they can benefit from each other when they work as a team. The adaptive capacity of the masters and pilots, their wish to cooperate, their mutual understanding of the common ground and their way of communication, was found as contributing factors making the joint activity a success.

We also found that language problems, national differences, and high cognitive workload could be constraining factors for the master and pilot during their cooperation.

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Glossary

Con	Short for conning.
Conning	The conducting of a vessel e.g. rudder commands, engine commands, course commands
Helmsman	A sailor steering the ship manually
ICS	International Chamber of Shipping
IMO	International Maritime Organization
Master	The master of a ship also known as captain
MPX	Master/pilot exchange
NTS	Non-technical skills
Pilot	An experienced master with special training and local knowledge of an area
SOLAS	A code issued by IMO describing the construction and equipment of a vessel
Tugboat	A small powerful boat designed to push and pull on other vessels to assist them.
Vessel	A ship.

Abstract

The cooperation between the bridge team members onboard merchant vessel has been given considerable attention since the mid 90´s when the focus on non-technical skills (NTS) was adopted from the aviation industry. In the maritime industry NTS training is called Bridge Resource Management (BRM) training and was introduced to avoid single person errors resulting in accidents. Initially the focus on BRM was concentrated on the ship crews learning to function as a team, later also maritime pilots had to participate in BRM training. The training of the pilots is concentrated on the cooperation with the master and the crew of the vessel under pilotage. This cooperation is called the Master Pilot Exchange (MPX) named after the initial exchange of information between master and pilot when the pilot has boarded the vessel. Despite years of training and attention several studies and conclusions in accident reports indicate that the cooperation between pilot and ship crew is not always adequate.

In this qualitative study inspired by narrative research and storytelling we would like to explore how the cooperation between pilot and master/crew is established. We interviewed 6 masters and 7 pilots and asked them to tell their stories concerning the cooperation in order to shed light on issues supporting and constraining the teamwork. Regarding the MPX as a Joint Activity (G. Klein et al., 2005) we will describe how the cooperation between pilot and bridge crew is established and maintained. Furthermore, we will examine how the cognitive workload of the bridge team is increased when adding a stranger, the pilot, to the team.

We found that there is a fundamental wish to do a good job. Both masters and pilots want the operation to be a success and they usually have an understanding that they can benefit from each other when they work as a team. The adaptive capacity of the masters and pilots, their wish to cooperate, their mutual understanding of the common ground and their way of communication, was found as contributing factors making the joint activity a success.

We also found that language problems, national differences, and high cognitive workload could be constraining factors for the master and pilot during their cooperation.

1. Introduction

The use of pilots in the maritime domain has been going on for hundreds of years. A pilot is a skilled seafarer with knowledge of the local conditions, who is able to advise the master of a vessel regarding the sailing and maneuvering of the vessel in narrow straits, rivers and during harbor operations. This type of advisory has been described as early as 64 AD (Hignett, 1990, p. 16). As many other domains the safety systems at sea has developed during the industrialization and especially they have been evolving rapidly since the loss of S/S Titanic which led to the development of common safety standards called the Safety Of Life At Sea (SOLAS-code) (IMO, 2018). Through the years the maritime domain has been looking to other safety critical industries for inspiration regarding safety standards, especially the aviation domain. Training of non-technical skills (NTS) is one example; Wahl & Kongsvik (2018) and Grech, Horberry and Koester (2008) describe how Crew Resource Management was developed in aviation during the 1970´s as a training concept to improve situational awareness, decision-making, teamwork, leadership and closed loop communication, also called NTS. This concept was adopted by the maritime industry in the 1990´s and labelled Bridge Resource Management (BRM) (Wahl & Kongsvik, 2018).

As a part of the increasing safety standards and focus on the NTS there has been developed a standardized way for the master and pilot to start their cooperation, the master/pilot exchange (MPX). MPX is often referred to the hand-shake ceremony taking place when the pilot enters the bridge, meets the master and exchange information relevant to the upcoming pilotage. This is indeed a part of the MPX but MPX is also the process of information-sharing in the duration of the pilotage involving both the master, the officer of the watch, the look-out, the helmsman and the pilot (IMO, 2004). The procedures describing MPX are listed in IMO resolution A.960 (International Maritime Organization & International Maritime Pilots Association, 2004) and the shipowners' organizations have published guidelines for their members (International Chamber of Shipping, 2016). The maritime insurance companies (Protection & Indemnity Clubs) have also issued guidelines regarding the cooperation between bridge team members, an example is UK-P&I (2016). Therefore, we have a good idea of how the authorities and stakeholders in general think the cooperation between the master and the pilot should work. A number of accident reports (ATSB, 2019; MAIB, 2019; TSB, 2019) and previous studies (Lappalainen et al., 2011; Mansson, Lutzhoft, & Brooks, 2017; Norros, 2004) indicate the reality of this cooperation is occasionally different.

A 1995 safety study conducted by the Transportation Safety Board of Canada (1995) revealed 273 accidents on vessels during pilotage between 1981 and 1992. Many of the accident reports mentioned lack of communication and inadequate bridge teamwork as contributing cause to these accidents. A review of accident reports concerning vessels under pilotage published in the period 2008-2018 in Canada (TSB, 2019), United Kingdom (MAIB, 2019) and Australia (ATSB, 2019) shows that inadequate exchange of information between pilot and bridge crew has been seen as a contributory cause in the majority of these accidents. Though accidents during pilotage are rare, the consequences of an accident such as a collision or a grounding can be disastrous. We therefore believe a study of the cooperation between pilot and master/bridge crew is relevant since this is deemed as the cause in many of the accidents.

To avoid single person error causing accidents teamwork is needed in pilotage. Drouin (2008) examined the Cosco Busan collision with the San Francisco – Oakland Bay Bridge in 2007, he found that all too often pilotage is a "one man show". The pilot is navigating the vessel giving orders to the helmsman without support from the rest of the bridge team. A similar scenario is described by Wild (2011), even when vessel crews have attended BRM courses frequently the pilot often is sole responsible for the conduct of safe navigation.

One reason for this is found by Drouin and Heath (2009), "there is a sense of relief – the pilot has the con and finally the officer of the watch and master can relax and, quite possibly, get some other pressing work done before arriving at port" (p. 1), though these trade-offs may be necessary to keep the vessel running, the imperative common ground for safe navigation is absent (Mansson et al., 2017).

Another reason for the crew not to participate sufficiently as members of the bridge team can be lack of assertiveness (Grech, Horberry & Koester, 2008). Assertiveness being the ability to communicate in a sincere and equal way without violating the rights of others (Wu, Miwa, Shimamoto, & Uchida, 2015). One aim of BRM training has been to flatten the formal hierarchy gradient existing between master/pilot and the rest of the bridge team, and sometimes between pilot and master. This is done partly by lowering the informal authority of the master/pilot i.e. training of personal appearance and behavior to encourage the bridge team members to speak up and challenge decisions they find dubious and partly by raising the assertiveness of all members of the team (Grech et al., 2008)

A third explanation of the pilotage turning into a one man show is that a joint passage plan is not followed, the vessel has prepared a plan but the plan which is followed is that of the pilot, often existing only in his head (Wild, 2011; Lappalainen, 2012, Lutzhoft & Nyce, 2006). The advantages of having a shared passage plan is emphasized by several researchers (Drouin, 2008; Drouin & Robin, 2009; Lappalainen, 2012; TSB, 1995; Rønningen & Øvergård, 2017). Drouin and Robin (2009) draw the attention to a system introduced in Brisbane, Australia where the pilot will not take the con until the pilot agrees with the passage plans of the vessel. Wild (2011) question whether this approach is applicable in congested areas off major European and Asian ports. Of course, it is technically possible to send a standardized passage plan to the vessels well in advance enabling the crew to prepare for the upcoming pilotage (Wild, 2011; Drouin & Robin, 2009) limiting the number of voyage plan discrepancy situations, but as far as we know it is not commonly done yet.

The importance of sharing verbal information about the intentions of the pilot is stressed by Wild (2011) and Wild & Constable (2013). Norros (2004) looked at piloting activity when she was describing the development of the Core Task Analysis (CTA) method. As part of her research she did an ethnographic study onboard ships going to and from Finnish ports and she describes how ship and pilot as a system is interacting internally (BRM), with their navigational equipment and with the larger environment in which they are situated. One of the obstacles the ship has to overcome is identified as the cooperation between the master and the pilot or as Norros (2004) states "The development of a historically new form of an interpretative and explicitly cooperative way of piloting is an acute challenge for this profession" (p. 202). We will not be able to solve this challenge here, but we could contribute to the knowledge about work-as-done (Hollnagel, 2014) during the MPX.

A later scientific study on the subject of master/pilot cooperation by Mansson, Lutzhoft and Brook explores the everyday activities in the cooperation of masters and pilots and ends up concluding that a way to bring this research forward could be "to explore the trade-off between common ground and participants' ability to be adaptive"(Mansson et al., 2017, p. 558). The common ground is, according to G. Klein, Feltovich, Bradshaw, and Woods (2005), a mutual understanding of "pertinent knowledge, beliefs, and assumptions that are shared among the involved parties"(p. 139) and is established and kept updated during the MPX. The problem is that it is difficult to stay adaptive when cooperating with another person on a complex task as any deviation from the common ground has to be again (re)coordinated with co-workers. The master's and pilot's knowledge, assumptions and beliefs and strategy has to be coordinated all the time as "It is not cooperation if either you do it all or I do it all" (Woods, 2002).

1.1 Research question

In the light of the discussion above, our research question is:

How is the cooperation between the master and the pilot supported during the MPX?

What challenges and constraints do masters and pilots experience conducting MPX?

2. Theoretical framework

As we were starting the work of writing this thesis, we made a search on Scopus.com, a database containing academic literature, for: 'Master' AND 'Pilot' AND 'Exchange'. This resulted in 28 documents whereof two were found to be within the topic of this thesis. Another search on; ('Master' AND 'Pilot') AND ('ship' OR 'vessel'), resulted in 85 results whereof three were found within this topic. We have used all of these documents and some previous thesis from Lund University, either directly as a base in this thesis or as an offset for 'snowballing' our way through the literature. As indicated above we found the literature concerning MPX to be limited.

When a ship is going to do a challenging maneuver like passing a narrow strait, navigate a river or enter a port, the master of the ship has the opportunity to embark a pilot to assist him. This could be seen as what David Woods would name a graceful extension of the ships system (Woods, 2019). The task for these two persons then is to cooperate in such a manor so they achieve resilience instead of brittleness. This means they must cooperate so that their combined efforts make the system stronger and more adaptive than it would have been the case if they were acting on their own. Woods also states that:

1. Initiative is critical to adaptive capacity as a unit has to possess some degree and form of initiative to contribute to graceful extensibility; and

2. Interactions across roles and units in the network affect the expression of initiative, and those effects depend on the potential for surprise in that setting. (Woods, 2019, p. 56)

As a description of the master/pilot cooperation, this is not far off. The task of cooperating with strangers (in most cases the master and pilot are strangers to each other) is demanding in an environment where all actions including 'no action' can have fatal consequences.

We believe communication is the key to balance common ground with adaptivity. Based on the principle of local rationality (Dekker, 2014) we explore why this communication is not always adequate. According to Dekker, "people are doing what makes sense given the situational indications, operational pressures, and organizational norms existing at the time" (2011, p. 12).

2.1 Joint Activity

G. Klein et al. (2005) use the concepts of "the criteria for joint activity" - a mutual understanding of intentions [basic compact] and interdependence, "the requirements for joint activity" - a mutual understanding of the activity termed common ground, interpredictability and directability and finally "the choreography of joint activity" – consisting of phases, signaling, coordination devises and coordination costs. These concepts come together in "joint activity", which is shown in Figure 1.

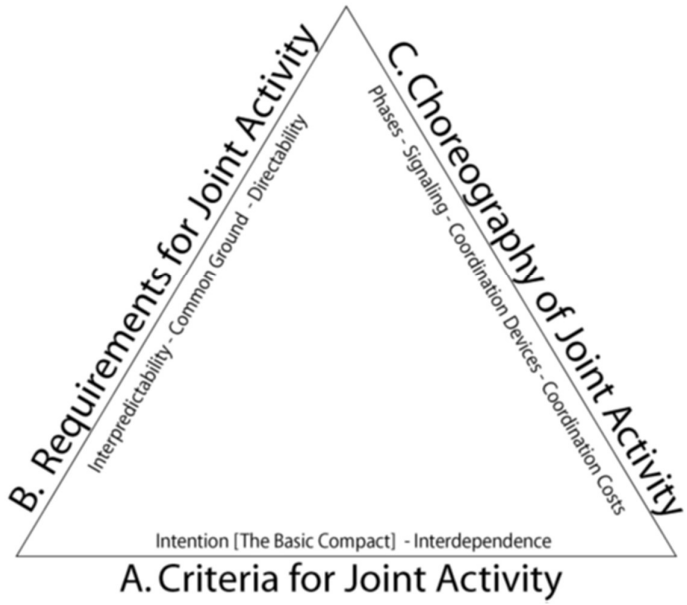

Figure 1. Description of Joint activity. Adapted by Klein, Feltovich, Bradshaw, and Woods (2005, p. 143)

The point of the triangle in fig. 1 is that if one of the sides in the triangle is missing the activity no longer qualifies as a joint activity but will instead be an individual activity.

2.1.1 The Criteria for Joint Activity

The criteria for joint activity are divided into intention, i.e. basic compact, and interdependence. "'The Basic Compact' is an agreement (usually tacit) to participate in the joint activity and to carry out the required coordination responsibilities" (G. Klein et al., 2005, p. 143). The understanding of interdependence, that there is a benefit from using other persons skills and knowledge to reach a common goal, is also a criterion for a joint activity (G. Klein et al., 2005).

2.1.2 The Requirements for Joint Activity

The requirements for a joint activity is interpredictability, directability and common ground (G. Klein et al., 2005). Interpredictability is that the present actions and the next actions of a co-worker is known, and directability is the possibility to lead the common effort in a new direction in case a problem has been identified. The common ground can be broken into three parts: Initial common ground, public events so far, and current state of joint activity (Clark, 1996). The initial common ground concerns the shared knowledge and conventions regarding an activity and also the knowledge regarding each team member´s background and training. The public events so far include the knowledge of the activity (and maybe prior activities) that the team has been doing together. Individual performance and who has been the team leader has been, sometimes tacitly, defined and a shared language has been developed. The current state of joint activity will give the team a direction either because they are following a shared plan or simply because their shared goal makes their next action salient.

2.1.3 The Choreography of Joint Activity

Finally the choreography of joint activity describes how the team coordinates their activity (G. Klein et al., 2005). Their way of signaling by communicating verbally, non-verbal, through checklists and by using the instruments on the bridge is important. The choreography is described as phases of activity with an entry, a body of action and an exit (G. Klein et al., 2005). A systematic way of communicating during a certain activity will ensure that no team member is left without knowledge of the plan for the activity and the present state of the activity (Flinn, O'Connor,

& Crichton, 2008). The choreography of the joint activity centers on the means with which the coordination of the activity is achieved (G. Klein et al., 2005). Several coordination devices are mentioned by G. Klein et al. (2005) and the devices correspond well with the topics contained in BRM training e.g. regulation-based check lists, communication and agreement as to who on the team will take the lead, the control of the vessel.

The cost of coordination needs to be mentioned. It is easy to imagine that there is a waste of time and effort when a team is working together on the same task. The simple fact that multiple persons are watching and/or participating in the same activity will generate an overlap of cognitive resources. G. Klein et al. (2005) terms these cost synchronization overhead (it is not possible to issue a new command until the previous command has been confirmed in a closed loop), communication overhead (to keep all team members updated regarding the plan for an activity, the present state of an activity and for team members to communicate what they see as the planned/present state for an activity, is a surplus of communication), redirection overhead (it can take a while from the time that one person identifies a problem until he has convinced the other person of its existence) and diagnosis overhead (time wasted by having multiple persons solving the same problem).

2.2 National differences

H. A. Klein & McHugh (2005) and H. Klein (2004) describe how people of different nationalities vary in teamwork in the Cultural Lens Model. The possibility of being assertive is influenced by the social context of cognition and has been described by H. Klein (2004) in the cultural lens model and depends among other things like dimensions of Relationship, Mutual trust, Tolerance for uncertainty, and Power distances. H. Klein (2004) describes the difficulties of overcoming the cultural barriers:

> When people differ in the cognition and the behavior/social dimensions important for a particular natural setting and task, there is a potential source of conflict and failure. People cannot adjust mismatches by altering their underlying cognitive processes, i.e. how they think about the world. Differences on dimensions cannot be changed at will because they reflect the demands of earlier experience. Even when the dimensions cause conflict in a new ecological and social context, they tend to persist. Although people can learn new content, it is difficult to acquire new reasoning forms.(p. 258)

Descriptions of teamwork like the "Big Five" model (Mutual performance monitoring, Back-up behavior, Adaptability/flexibility, Team orientation and Leadership) summarized by Salas, Sims, and Burke (2005) are reflecting team competencies and mechanisms compatible with western organizations (Klein & McHugh, 2005), but as seafarers and pilots come from all over the world it could be beneficial to acknowledge that these particular ways of setting up teamwork could make cooperation in a team problematic. Grech et al. (2008) touch on the same problem area and elaborate on the effect of the power distances (Hofstede, 1997) in different ethnicities and cultures as another obstacle to be overcome by the master, pilot and the bridge team.

2.3 Cognition

Using Neisser's definition of cognition; "'cognition' refers to all the processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used" (Neisser, 2014, p. 4), we will be identifying some of the challenges that the masters and pilots face when doing MPX. However, cognitive processes are something that we cannot observe directly when interviewing masters and pilots. What we can do is to listen to their narratives and try to identify cognitive processes as they are describing their work. This will give us an idea on what their challenges are when they are cooperating in a joint activity.

We have named 3 aspects of cognition: sensing and adaptation, trade-offs and decision making. Neisser explains how such terms "refer to hypothetical stages or aspects of cognition" (Neisser, 2014, p. 4), and therefore we will not claim that our 3 aspects exist but use them only to describe the mental workload of the master and pilot.

Norman and Bobrow (1975) describe how cognitive processes can compete for the finite resources of the brain and how they can be hampered by lack of data. Without going deeper into the theory of the brain's functioning

we will note that there is a finite limit to the amount of resources a human can use to solve a problem, control an activity and speak a second language - all at the same time.

3. Methods

This qualitative study was inspired by narrative research and storytelling (Clandinin & Huber, 2010) and used a semi-structured interview approach as described by Kvale (1996).

3.1 Ontological considerations

In our research project we were interested in studying the cooperation between the master and the pilot onboard merchant vessels. In order to shed light on this phenomenon we needed to determine where to look for answers, which part of reality we believed could provide the knowledge we were in search of. This ontological consideration led us to determine that a contact with the participating practitioners, the masters and the pilots, would serve our purpose.

3.2 Epistemological considerations

The next question was how to gain the knowledge from the masters and pilots. Being pilots and therefore part of the domain we had some insider knowledge (Brannick & Coghlan, 2007) about the phenomenon we were about to study. This insider knowledge was at the same time both an advantage and a disadvantage (Blaxter, Hughes & Tight, 2010). The ethical considerations concerning preconceptions and biases will be addressed below, here it is sufficient to state that acknowledging our biases made our insider knowledge an asset in the effort to co-create understandings with our respondents (Denzin & Lincoln, 2018).

3.3 Methodology and method

Blaxter et al. (2010) make the distinction between methodology and method stating that the methodology is the approach supporting the research in a more philosophical sense while the method relates to the tools used for data collection and analysis. In our case we followed a qualitative methodological approach using interviews as method. The qualitative approach or paradigm was chosen because of the ability of this approach to achieve depth in the data via a smaller number of examples (Blaxter et al., 2010). We were interested in the lived experience of the masters and pilots and Kvale finds:" the qualitative interview is a uniquely sensitive and powerful method for capturing the experiences and lived meaning of the subject´s everyday world" (1996, p 70). As indicated by this citation above the distinction between methodology and method is not always made explicit.

Narrative research provided us with stories of the respondent´s lived experiences, constructed and negotiated by the interviewee and the interviewers. By allowing our informants to tell their stories as well we obtained/negotiated some observations and collected a description of the context in which these observations were collected.

Clandinin and Huber (2010) mention three types of justification considered important in connection with narrative research - Personal Justification, Practical Justification and Social Justification. The Personal Justification means justifying the research on the personal level of the researcher. Being maritime pilots ourselves and former shipmasters we have been working with master/pilot exchange for many years. We think it is an important aspect of our job and would like to know more about why it is so difficult. According to procedures it should be a fairly simple task to do, but the reality often seems quite different.

Clandinin and Huber describe Practical Justification as" researchers attend to the importance of considering the possibility of shifting or changing practice" (2010, p. 438). Our research may not change the practice of master/pilot exchange on a global level but might influence how it is conducted within our company.

The Social Justification addresses the *so what* and *who cares* questions, whether the research is justified in terms of creating new methodological and disciplinary knowledge. This question can only be answered with certainty sometime in the future but of course we can hope that the study will contribute to the knowledge about master/pilot exchange.

3.4 Ethical considerations

Ethical considerations concerning the participants in the research were guided by Lund University Research Ethics (https://www.researchethics.lu.se/), Good Research Practice (Swedish Research Council, 2017) and The Handbook of Social Research Ethics by Mertens and Ginsberg (2009). Consulting Lund University Research Ethics (https://www.researchethics.lu.se/) revealed that our student project was not considered research in a legal sense and therefore did not have to undergo an ethical review in accordance with The Act on the Ethical Review of Research Involving Humans. Of course, good research ethics will be employed, nonetheless.
Confidentiality was maintained by applying numerical codes to each interviewee, only the two researchers have access to the codes and any information able to identify research participants was removed from interview transcripts. Informed consent is considered a cornerstone in research ethics, we produced a consent form for informants that contained

- the overall plan for the research,
- the purpose of the research,
- the methods used,
- the consequences and risks that the research may entail,
- the persons responsible for the research,
- that participation in the research is voluntary, and
- that the research volunteer has the right to terminate his or her participation at any time.

The consent form was forwarded to the research participants together with the invitation to participate in the research. The invitation included an explanation of the study and the possible gains for masters and pilots. Before conducting each interview, we went through the consent form with the interviewee and obtained written consent. An example of the consent form can be found in appendix A.

Confidentiality was maintained with reference to Good Research Practice, "individuals participating in research should be protected from harms or wrongs" (Swedish Research Council, p. 13). The Swedish Research Council (2017) does however emphasize that researchers often cannot guarantee secrecy, anonymity or confidentiality, in our case a court ruling could suspend the promise of confidentiality provided by us. We consider this possibility most unlikely though.

Conducting insider research requires additional ethical consideration, the role duality and possible conflict must be addressed (Toy-Cronin, 2018). For example, colleagues participating in the research may feel that we were breaking peer norms (Brannick & Coghlan, 2007), this issue was dealt with by a thorough explanation of our intention with the research.

3.5 Data collection

3.5.1 Pilots

In order to conduct interviews with the pilots we invited 58 Danish pilots to participate. The 58 pilots were chosen because they lived in reasonable distance from us. 8 pilots responded positively, and we ended up interviewing 7 pilots representing transit piloting and harbor piloting in ports of various sizes. We chose to interview Danish pilots only in order in to, "achieve depth rather than breadth" (Blaxter et al., 2010, p. 64) in the data. Before each interview we obtained written consent from the interviewee, furthermore the interviewees agreed to the interview being audio recorded. The interviews were conducted and transcribed in Danish; relevant citations then translated to English. Due to the work schedule of the researchers and the respondents the planning of the interviews turned out to be more of a challenge than we had anticipated, this is why we interviewed 7 out of the 8 pilots who responded to the invitation. The low number of positive replies to our invitation (8 out of 58) could partly be caused by the fact that the interviews were conducted during the summer holidays.

3.5.2 Masters

The selection of masters to interview was to a great extent determined by practical circumstances. We interviewed 6 masters of 5 different nationalities and in command of vessels of varying types and sizes. Initially we made contact with three masters by mail and invited them to participate in the interviews. We had learned that their vessels had a planned stay at a Danish shipyard within a timeframe suitable for conducting the interviews. The masters agreed to participate in our research, two of the masters had to obtain permission from their owner, the third had the authority to make the decision himself. Conducting the last three interviews we visited two vessels in a major Danish port and one vessel in a smaller Danish port and simply asked the masters for an interview after introducing ourselves. Before each interview we obtained written consent from the interviewee and they agreed to the interview being audio recorded. The audio recordings of the interviews were transcribed verbatim to the best of our ability, inaudible passages were marked [inaudible].

3.6 The storytelling/interviews

The storytelling/interviews started by getting a description from the informant of his job and professional experience, the masters were in addition asked to describe the characteristics of their vessels. Then the masters were asked the following question: "Tell me about your last pilotage. Start from your first reception of voyage instructions – what happened?". In the same vein the pilots were asked to tell about a pilotage from being assigned to the vessel until saying goodbye to the master. The informants told their stories with as little guidance as possible. Upon completion of the narration, we asked questions based on Kvale´s (1996) interview approach, see below. The questions were related to the story and the thesis' main topics if they had not already been covered: Common ground, adaptiveness, support of the MPX procedure and challenges/constraints to the MPX.

According to Kvale (1996), the analysis starts already during the interview where the first step of analysis is the interviewee´s description of his or her experiences and feelings concerning the object of study. The second step is that the interviewees, during the interview, themselves reflect and discover new meanings in what they feel and do (Kvale, 1996). In the third step the interviewer condenses and interprets the meaning of what the interviewees through dialog, "yes, that's exactly it…" or, "it´s more like…" to reach the interviewee´s understanding of the subject (Kvale, 1996).

Kvale (1996) emphasizes that the analysis of an interview is the link between the story told by the interviewee and the story told by the researcher to the reader. The analysis is a tool to fulfil the purpose of the qualitative research interview i.e., "the description and interpretation of themes in the subjects´ lived world" (Kvale, 1996, p. 187).

3.7 Coding

Bearing in mind Kvale (1996), the output from the interviews has been transcribed and a form of coding was developed using Saldaña (2013) description of coding techniques and Bruner (1991) features of the narrative interview.

First cycle coding methods:

1. Attribute coding. This means we focused on data about the respondent: Ships name, place, type of ship, size of ship, nationality of crew, and size of crew etc.
2. Structural coding or holistic coding. Here we divided the text into relevant topics i.e. pilot boarding, route planning, MPX, power gradients, personal relations, and ships particulars etc.
3. Narrative coding. We tried to deduce the meaning out of the narratives in our data. This can include descriptions, feelings, values, beliefs, attitudes, theories, desires etc. Here we tried to abstract the small stories (what are they about), the orientation (who, when, where?), complicating actions (then what happened?), evaluation (so what?), result (what finally happened?), motifs (naming of stories), canonicity and breach (tacit conventions on bridge procedures and the breach of them), genericness (ex. Hero-stories, disaster-stories), and normativeness (what is right or wrong according to our respondents).

The findings from first cycle coding was then recoded in a second cycle coding:

1. Pattern coding or theoretical coding. Here we tried to collect findings under some reasonable descriptive headlines that match our research question and theories.

We also tried to note what is missing. This has been difficult but being part of the maritime domain as former masters and colleagues with the pilots, we had a chance to spot if our informants were reluctant to talk about certain topics.

The second cycle coding resulted in the following main types of observations:

1. Joint activity:
    1.1. Criteria for joint activity
    1.2. Requirements for joint activity
    1.3. Choreography of joint activity
2. Cognitive workload:
    2.1. Sensing and adaptation
    2.2. Trade-offs
    2.3. Decision making

The joint activity model came to us through the theoretical framework and the cognitive workloads appeared interesting as our informants described how they were struggling with certain cognitive challenges. The categories of cognitive workload could have been named differently as it is difficult to assign a special category to a specific challenge. The point here is however not to investigate different cognitive challenges but just note that they are present and consume cognitive resources as described in the theory section above.

In the following we will present our findings for each type of observation. The masters are named M# and the pilots are named P#. A list of respondents can be found in the appendix B.

4. Results and Analysis

4.1 Joint Activity

As mentioned in the Theoretical Framework there are three prerequisites that is key to successful cooperation, the joint activity, between the master and pilot (G. Klein et al., 2005). To qualify the activity as a joint activity the master and pilot need to have a mutual understanding of their own and others role during the pilotage, termed basic compact, of the job that needs to be done, termed common ground, and how all involved persons are supposed to cooperate, termed the choreography (G. Klein et al., 2005).

4.1.1 The Criteria for Joint Activity

To describe the basic compact and interdependency, we are looking at the statements from our informers when they are describing the roles of the master and pilot. The first thing most of our informant articulates is that the master is the ultimate responsible person, as illustrated by:

> Well the truth is, the simple truth is that the master is still legally, he has the ultimate responsibility. I have haven't seen that this has been changed. (M1)

> It is always the master's responsibility. (P1)

Interestingly it seems like this ultimate responsibility is not something that is on the forefront of all the pilot's chain of thoughts, the pilots seem keen to help the master with the upcoming job, as illustrated in the following examples:

> The task is to make a comfortable passage, make him feel safe, increase the level of safety and not just say: 'This is how it's done.' (P6)

> The pilot's function is to bring the ship, crew and cargo safely from A to B. (P7)

On the other hand, the pilot's role is described by both masters and pilots as an advisor:

> He can do whatever he wants with the controls, I can just advise him. (P1)

> So, you can say we are very active advisors. (P6)

> It has been made very clear on this ship as well as in this company that any orders or any advice given by the pilot has to be repeated by the bridge team. (M3)

This perception of the role of the master and pilot correspond well with the recommendation from the International Maritime Organization:

> Despite the duties and obligations of a pilot, the pilot's presence on board does not relieve the master or officer in charge of the navigational watch from their duties and obligations for the safety of the ship. It is important that, upon the pilot boarding the ship and before the pilotage commences, the pilot, the master and the bridge personnel are aware of their respective roles in the safe passage of the ship. (Annex II, §2.1, International Maritime Organization & International Maritime Pilots Association, 2004)

That the perceptions of the role of the master and pilot correspond with the recommendations does not mean that there are no nuances. If we look at the stories told by our informants, we can see that even though the intension is to stay in the official roles the reality sometimes is different. As informant P3 stated:

> But otherwise I don't think there is a lot of communication until we are alongside, I'm just standing … it's just running. I don't even know what he should say – the master can of course express if he thinks something is wrong but it's very rare that anybody says anything.

And informant M3 follows:

> So I order my officers on watch or the helmsman and the pilot is saying, ok stop engines so it is me who is saying to stop the engines, so the crew is responding back to my order which I respond back to the pilot, so it is 3 phase actually. So pilots order is being relayed by me to my crew and once the action has been taking the crew response back saying that this is what, is the helm order or the engines order, I pass it on to the pilot, even though the pilot is next to him, so it is 3 phase.

Informant M3 is here describing the very hierarchical organization onboard a ship. The master is on top followed by the officers in rank and the crew will respond to their orders. When a ship is maneuvering/sailing this type of organization works very well as the time to respond to identified hazards can be limited. However, when a pilot shows up, this normal way of operation can change in several ways. As informant M3 is stating above that the master can be reduced to a relay station with an option to block the signal. M3 is backed by M2:

> Yes, especially when the local, because I have not much knowledge about the local conditions in the local [inaudible]. You have to rely on the pilot, but what you can go about is only as per the chart, where I can, if somebody will tell me, because as I said from a very [inaudible] from outside to, it is like a zigzag, zigzag. I, if you will ask me to bring, I can bring but [inaudible] this level is more high and also when the pilot is there, because I can make out from his body language whether he's confident or he's sort of panic person or..., so then if I see that, okay, seems like he's not confident or, or he's like with chilling when.., So then it's it, It's my job to make a call. Well, well in time, not when we are, but I can see that pilot is well confident he's going as for what, what we have decided in the meeting. He's going as per that still sometimes like [someone else] in this situation from my end I could do only thing is my [inaudible] are working fine. If anytime, if I see anything, I will always ask pilot like...

And P4 is recognizing the questioning as a vital safety feature:

> I see them as an aid to me and I expect that if I do something wrong, they will question me, and I expect they will question whatever of my actions they do not understand.

There is however the fact that M2 and M3 are masters of rather big ships who would normally use tugboats on arrival/departure from a port. The use and coordination of tugboats is a challenging task and something that pilots needs special training in (International Maritime Organization & International Maritime Pilots Association, 2004), therefore pilotage will usually be compulsory when tugboats are in use. If we on the other hand look at our informants who are masters on smaller vessels, M5 and M6, the picture is somewhat different. They would normally be alone on the bridge, navigating without a pilot, during maneuvering and their statements reflects it:

> So, um, when we go into the Kiel Canal, this maneuver, I always make maneuvers by myself. I never let someone. (M5)

> I never can understand how you can, uh, let a pilot do a maneuver with your ship. (M5)

> Only just if something happened, he only like to give advice. What do you have to do? All responsibility only captain. Captain give some joke for pilot. The pilot can maneuver and can steer during a passage from pilot station to key. But a, usually pilot ask: "who will maneuver?" Captain in our case because yeah, we are not so big vessel. (M6)

The difference between small and big vessels are also mentioned by P3:

> On a lot of small vessels going to port x, port y and port z there is ... it's something different to go onboard. Then you have your hands on the controls of the ship and the master is only watching what's going on. The master/pilot exchange is very short on these ships.
>
> I think I am good at feeling what the master wants. Does he want to do the maneuvering himself or is it someone who just wants to go home on vacation. I feel it on the way they ask questions regarding the approach.

The reasons for the contrasting statements of P3, M5 & M6 looks initially odd, but our own experience tells us that on the small ships the master is used to do a lot of maneuvering by himself and for these small ships the tricky part can be to find the way in and out of the port and find the place they have to go alongside. Once they have arrived safely close to their berth the master can easily bring the ship alongside by himself assisted by his crew.

Another interesting observation from the small vessels is that the pilot is not always welcome onboard:

> A pilot is a guy nobody like to have on board. (M5)

M5 is bringing up this issue even though one of his family members used to be a pilot. As pilots we have been feeling this a few times especially on small vessels. We do not think it is because of a hostile mindset, but rather a reflection of the social and cognitive burden of the small crew when they have a stranger onboard. We will get back to this issue in the discussion.

The decision/agreement to whom is going to do the conning of the ship during the maneuvering close to the berth is vital, as if no agreement has been made, the ship will not be under command and will thereby be in a dangerous situation and hereby we can move into the next subject – common ground.

4.1.2 The Requirements for Joint Activity

According to Clark and Brennan (1991) the common ground, the understanding of the job that needs to be done, is perhaps the most important basis for interpredictability and consists of "the pertinent mutual knowledge, mutual beliefs, and mutual assumptions that support interdependent actions in some activity" (G. Klein et al., 2005, p. 146). Our masters and pilots easily understand the need to achieve a certain level of interpredictability however they use different terms for this:

> If we are talking about route planning, then I would like to see what he has planned and then I can comment on it and say what I will do and what I won't do and explain why. I am an advisor and the master can say he wants to follow his own route plan, so I will use it as a base, but I have never… I don't think I have experienced anybody not willing to follow my recommendations. If they don't have a route plan, they can see mine. (P1)
>
> I am telling them what my plan is, and they are welcome to add to it if they want it differently than my initial plan. Typically I will do 95% of the conning during the approach and when we reach the berth the master will take over for the maneuvering as he knows how the ship is reacting, leaving me to give directions as 'do this' or 'more that way'. It relieves me to coordinate with people ashore while he is maneuvering. (P2)
>
> We do have a folder regarding tugboats, mooring setup and such things. I use this to explain to the master the sequence of the mooring, how the current is running, the water depth in different areas, number of tugboats and their strength, where we are going alongside and how we will approach the berth. (P3)

We see here different examples on how the masters and pilots initially exchange information after the pilot arrives onboard. Two types of checklists are mentioned by the masters: The Pilot-card and the Master/Pilot Exchange checklist. Examples of these checklists can be seen in Appendix C. The Pilot-card is a form with static information

regarding the vessel (size, propulsion system, type of rudder etc.). The Master/Pilot Exchange checklist is a checklist that is supposed to be filled out by the master and pilot in cooperation. We have identified the pilot-card and master/pilot exchange checklist as coordination devices (G. Klein et al., 2005) and we will return to them in chapter 4.1.3. The masters on the big vessels, M3 and M4, see the checklist as important: "I also do the master pilot exchange. So at least I know that, so, whatever I'm discussing" (M4) makes sense to that master, however the rest of the masters does not seem to value this checklist much as M1 says when asked if he preferred talking instead of using the checklist: "Yeah. Yeah. Just, yeah, exactly. Exactly. Exactly. Exactly. Exactly. Yeah. Yeah. That's, but, but not that really any formal checklist".

This more informal way of conducting the master/pilot exchange is also described by the pilots:

> I use it mostly to check for defective equipment. It must be stated in the checklist. (P1)

> I experience a lot of difference in how the master/pilot exchange checklist is presented. Some is point by point and others are very loose, and you sense that it's just a matter of signing it and then you will work it out as you go. (P2)

> It's not the master who is presenting this paper – it's the officer – he needs to get a signature from you. On most ships you will get a quick introduction from the master, thereafter he disappears, and then the officer is standing with a cup of coffee and a piece of paper to sign. (P6)

When we asked the masters and pilots what kind of information, they needed from each other, the answers from the pilots were quite clear that they need information regarding the design and functioning of the vessel:

> In connection to a harbor pilotage it is the type of propeller and type of rudder and then whether the draught is corresponding with the information given to me and my own reading. And then the design of the bollards and mooring area if it's mentioned on the checklist. (P2)

The masters on the other hand were more interested in local conditions, route plan and the maneuvering:

> I do also try to make it always clear that I also like that we talk about, already from the start that how should we do it? Okay. You will do it now and then we do like this, we can keep the controls here until this stage and then if it's okay, then I, when do I move the controls I take over? Is it okay? But I think that should be agreed also. (M1)

> Then uh, we go through all the master/pilot exchange card and we explained to him that we CPP all important information about regarding, about bollard pulls, tug bollards pull. Then, also where the tugs will be pushing, the location where tugs should push, and they should not come in at what angle and everything we have discussed about that. Also, any are any tides also be discussed, what tides. Then also squat effect. Any UKC requirement, especially UKC requirement because our company policy a bit more stringent like 0.5 in all [inaudible]. (M4)

When asked if it would be beneficial to exchange information prior to embarkation of the pilot several of our respondents, both masters and pilots, agrees that it would be helpful to exchange information regarding for instance route, weather, local conditions, ship particulars, and mooring arrangements.

The agreement to a common route plan is also important to the pilots:

> If he has made a route plan, then I would like to see it. Then I can comment saying this is ok or not ok, or 'here we should do like this because this and that'. In that case I will use his plan as he is the master and I am an advisor. (P1)

The planning of a maneuver is a tricky thing. There are many parameters to be considered in order to maneuver a ship safely and these are changing during the maneuvering making adjustment to a plan a necessity or maybe even they can make the initial plan obsolete:

> For maneuvering you have to agree on who is calling the shots, who is deciding when and what. You need a strategy for the speed of the vessel at certain points as we will need to be at zero speed when we are alongside, whereas on a transit pilotage you will just go any speed you like. You will need to approach the berth softly and your strategy must do that, therefore you will need to have a firmer expression during harbor pilotage. (P1)

> But I try to explain what I am doing, and if I can see that they are uncertain and in doubt of the effectiveness of my maneuver, I will explain why I am doing it. (P5)

> Somebody called up on the VHF and he discussed with pilot and pilot told me: 'Okay, now that is a change in plan, we are going starboard side alongside'. (M4)

So, here we are realizing that it is a continuous process to keep the common ground up to date and that the adjustment and change of plans and strategies demands an increased level of communication. Whether it is one-way communication or two-way communication depends on the situation and we continue into the subject of choreography of the joint action.

4.1.3 The Choreography of Joint Activity

The use of pilot-card and master/pilot exchange checklist as coordination devices is as mentioned earlier not consistent. The design of these papers is a little different from each other. The pilot-card contains information intended for the pilot with details regarding the present state of the vessel and design of propulsion system and the checklist is meant as an aid for the master and pilot to guide them in their discussion regarding the job to be done. The International Chamber of Shipping has made an example of how they could be designed, and this design has been adopted by many ship owners who have made standard documentation to fulfill their quality management system. Regarding the checklist M4 is stating:

> But uh, because we are going as for the checklist, so mostly what all information is required we always cover through that. We have a company checklist, so we're just going to check, check, check, mostly everything. But things were only, which is not being, you know, very clear in our checklist.

The master is here telling us about his checklists, and he mentions that sometimes the checklists are not sufficient. The pilots are divided in their opinion regarding the usefulness of the checklist. The pilots however can agree that there are huge differences in how the checklist is used onboard and these different approaches to using the checklist might explain the different perception of its usefulness:

> I think that in 85% of the vessel it's more CMA, you know Cover My Ass from the ship's side rather than a handover. You will have to dig out the information yourself. You will be given a piece of paper in the dark at the same time you will be asked if you want a cup of coffee and requested to sign the paper. (P6)

> But they have, uhm, they do actually have general information to the pilot that the master goes through and usually, well it's been a while since I was onboard a vessel from BP, but I think he goes through the general first, all ship data first and then he proceeds to the actual condition they have with draught and speed and all that, and he leaves both of them on the table after he has signed them. He is not signing them until we are finished with the handover and that is rare. I think in almost all other vessels the master is probably signing when the paper leaves the printer. But in BP they will be signed by the master and pilot at the same time. In Neste, as long as they were existing, it was the same procedure, but otherwise the paper is pre-signed or will be signed when you leave the vessel. It's very rare I see a master signing a master/pilot exchange. (P5)

Signaling by use of verbal communication is of great importance in the joint activity between master and pilot and a common language is therefore a necessity. The common language in the maritime domain is English and it seems like lack of English skills in some cases is a constraint when the pilot and the master are trying to establish common ground.

In statements referring to the language skills of specific nationalities, the nationality has been hidden by the authors with xxxx.

> It may also have something to do with the language, often they can ask whether you want a cup of coffee and thereafter the communication is quite limited… it´s rather scanty. (P3)

> Therefore, with xxxx; short sentences and confirmation after each sentence that they understand what is said. (P4)

> And it is simply the language barrier, you know, they do understand when you give the heading in English or the other things but other than that, it is on an absolute minimum. (P6)

> But otherwise they are probably the least English speaking of all and it can be really difficult, you have to be very diplomatic and pedagogic as pilot, I think, you really have to make an effort to understand them, and let them know that you understand them and are not just leaving them bypassed, nothing good comes from that, I think. (P7)

> Sometimes the problem is xxxx, the xxxx now you speak English slowly from xxxx all people you don´t know very experienced with the English ok, the xxxx sometimes some ports coming the pilot, fast, talking very fast, different English, it is different English from England. (M2)

The significance of non-verbal communication is also recognized by our respondents, for instance P5 states:

> There are many ways to find out, if for instance the captain is standing close to the helmsman, watching him and giving rudder commands continuously, then you know the steering is not too good.

and M4 concerning body language:

> Because the body language you can understand very well, you know, and sometimes you know, they [the pilots] get panicked very fast, they give; "okay steady at one two two" and then my helmsman is bringing in because of the local condition, it is not easy…, "NO, NO I SAID ONE TWO TWO" and you can understand that he's been in a panic situation.

Considering themselves the driving force of the activity the interviewed pilots describe their aim of including the entire bridge team in the joint activity and of ensuring that the bridge team members remain active contributors throughout the activity. P4 stresses the importance of not only shaking hands with the master when entering the bridge, but with the entire bridge crew. This hand-shake ceremony sends the signal that the entire bridge crew is part of the team, not just the pilot and the master.

P2 describes how he is polite when the look-out or the officer of the watch report observed vessels, even when the vessels are far away and do not cause an immediate concern. If the pilot signals indifference or maybe even irritation in this situation, it might result in the reporting crewmember exiting the joint activity. The information flow can get too high though, as expressed by P6:

> Sometimes you get too much information, for instance when passing through the Langelandsbelt during the summer holidays where all the pleasure crafts available are on the water and both buoys and boats are reported, then I ask politely if we could please concentrate on the boats and yachts coming close to our route in order to focus on the targets relevant to us.

Summarizing on communication it seems like our respondents make an effort to create an environment that encourages the bridge team members to participate actively in the joint activity, but sometimes this effort is constrained by language problems.

When a team of people is navigating a ship, it is important that one person is in control of the ship. This person is said to be 'conducting the maneuvering' of the vessel, 'conning the ship' or 'having the con'. This coordination of who is having the con is mentioned by several of our respondents, M1 finds:

> I do also try to make it always clear that I also like that we talk about, already from the start that how should we do it? Okay. You will do it now and then we do like this, we can keep the controls here until this stage and then if it's okay, then I, when do I move the controls I take over? Is it okay? But I think that should be agreed also.

The master is explaining how he from the beginning of the pilotage wishes to make an agreement about who has the con where. This approach is backed by P3:

> Again it depends on the kind of ship and how the captain is, it differs from ship to ship, you kind of have to sense whether he wants to maneuver himself or if it is fine by him that you do it all. Sometimes I ask the captain "Do you want to maneuver alongside yourself – or should I do it?" if he says he would like to do the last 10 meters himself – then it´s all right. Many captains express a wish to control the handles on the final approach and then go alongside with my guidance, others couldn´t care less and sit by the computer until we are alongside.

The pilot is here describing how he to a great extend adapts to the wishes of the master, the cognitive workload associated with such an adaptation is dealt with below.

4.2 Cognitive Workload.

All of the pilots and some of the masters are in some way describing an increased cognitive workload when the pilot is onboard. It is hard to clearly distinguish and separate different categories of cognitive processes as they may overlap each other, but we have identified three categories of cognitive processes and we will describe these next.

4.2.1 Sensing and Adaptation

When a pilot boards a vessel, one can see this as being foremost a meeting between people. Everybody is assessing each other's personal appearance and personal relations are formed. P7 is stating:

> On my way to the bridge I will talk to the officer who went down to escort me to the bridge. I find it can give me a hint on the qualifications onboard. I ask questions like 'where are you coming from?', 'is the captain on the bridge?'. His language and answers will give you a hint of what you can expect on the bridge.
>
> On the way to the bridge I am looking at the general level of maintenance and cleaning. If the ship is dirty and the English skills of the officer are weak it could indicate a lack of maintenance on engine, steering gear and bridge equipment.
>
> It's also about how the crew is communicating. Is it only the captain speaking to me or is it also the officers and ratings on the bridge who speaks to me - I find it very important for the job we are going to do.

The master will be at the center of the pilot's attention when the pilot arrives at the bridge. However, the functioning of the entire bridge team is immediately assessed by the pilot:

> In my experience bad internal communication is a function of bad mood onboard, and then you have to squeeze information out of the crew. They will be less willing to talk. So, if there is a bad environment on the bridge it's probably because of internal problems onboard. It can be that the master is fired, or the ship is sold, then they

> don't want to work anymore – their suitcase is already packed. In that case it's a transportation job. Luckily most of the times they are happy to have us onboard and it is only rarely that we are onboard against the will of the captain. (P1)

On the other hand, the pilot is also assessed by the master:

> So, in the … in the meeting itself I just not ...., just casual way; 'So, pilot, how many years as a pilot?'. Like my Dan.., the sea pilot, he was like only one year. Then at least, for first half an hour I was like, you know, wondering how he's approaching and as I said, he was going very close to the buoys. I was asking; 'What is the reason?' I don't know because of the current and all, 'We are just trying to keep pretty close to this'. Okay. I agreed with. Okay, understood. Then after that I gained more confidence in that guy. (M4)

> Yeah. I don't know how it works, but it's, it's for me at least, I, uh, I feel very comfortable because, uh, when the pilot has a seafarer background, he knows that I have some other things also that I need to think about some, uh, some financial things and who is paying and then some other kind of things. So, he understands if I need to ask something that little bloody hell, and so he understands what I'm talking. I understand why you worry about this. So, uh, that, that makes it a good off course, So... (M1)

A few of the pilots also think about how much information they can push to the master without him losing any of it:

> According to my experience, if you give a lot of details, they will lose track after 3 or 4 details. (P2)

> It is nice to be able to draw the vessel, and then the mooring lines, and then we put a number on the lines according to the sequence in which they go ashore … because otherwise … if you just say it – nobody can remember… (P3)

The two statements above should maybe have been in cognitive category regarding memory, but we included them here in sensing as the pilot has expressed they are concerned and try to evaluate on the amount of details they can give and the best timing to pass on these details.

When asked if they experience differences in the cooperation between master and pilot due to nationality, apart from language differences, there is inconsistency between the replies from masters and the replies from pilots. Four masters do not experience any difference. M1 is only trading in Northwestern Europe and does not notice any difference there, he mentions differences experienced years ago early in his career when trading worldwide. M4 states he has noticed a difference in temper depending on where in the world he is trading. All the pilots however describe how the cooperation differs depending on the nationality of the masters and crews of the piloted vessels, for instance as expressed by P2:

> I make it a virtue to adapt to the conditions onboard and adjust to their ways and there is a big difference in how to act regarding authority depending on the crew being Filipino, Russian or Scandinavian, so I do act differently, I´d say.

Apart from recognizing the difference in cooperation as a result of different nationalities, the pilots also express how they make an effort to adapt to the environment they meet on the vessels under pilotage.

In our experience another thing for the pilot to work out is the design of the ship he is onboard. Of course, ships have the same basic outline but like cars are different in size and handling, so are ships. First of all, he will have to familiarize himself to the bridge instrumentation and although he is given information regarding the size of the vessel, propulsion system, type of rudder and maybe he is even presented for diagram showing how fast the vessel is able swing using maximum rudder, he is not certain how the vessel behaves when he starts to maneuver it. M6

is making an analogy to a car; if you step into an unfamiliar car you know basically how it should behave, but it can be a challenge to find the switch for the headlights and being given a turning diameter of 12 meters does not tell you how much you need to turn the wheel at the next corner. Likewise, you don't know how much you need to press the accelerator to obtain a certain speed. Touching on the same subject P4 is telling us:

> You know steering in the narrow fjords, we would all become crazy if they should steer, because first of all they probably cannot steer, and secondly you have a better feeling when your hand is on the rudder – you can feel the narrow part and the bank effects, you cannot feel anything if somebody else is doing the steering.

P4 is describing how he is easing his cognitive workload by controlling the rudder himself. Thereby he does not have to observe the rudders position as he already knows where he positioned it. By observing the rate by which the ship is turning he can then adjust the rudder as necessary without using excessive mental resources.

4.2.2 Trade-offs

When taking over the actual steering of a vessel in certain situations P4 is making a trade-off and he continues the above statement "But it has to be a damn good lawyer if one day it goes wrong and I have to explain that I thought it was better I was doing the steering than using a helmsman, but that's how it is… ". P4 is choosing to do the steering because he believes it is the best solution at the time and this is the opposite of what is being taught on BRM courses.

Another trade-off described by the pilots is choosing the route to be followed during the pilotage. The vessel has prepared a route plan, and it might not correspond to the plan the pilot has. Depending on the degree of discrepancy they will have to agree on one of the solutions or maybe just accept the small differences:

> We always review the route planning. I usually ask: 'Can I see the route on the ECDIS?'. It might not be the first thing when I come onboard, but as all is clear and soon as we are well underway, I will ask. I will usually point out if there are alternatives and I might do it later. (P5)

The trade-off by waiting to do a proper master/pilot exchange in favor of doing some immediate navigation or handling some traffic is described by several pilots:

> The last time, there was actually quite a lot of traffic when we came onboard, so I was quickly briefed by the master regarding the traffic situation, position and heading and later, when time permitted, we did a proper master/pilot exchange. (P6)

Sometimes during the master/pilot exchange the pilot needs to adapt his original plan due to information received from the master. If the speed is too low, he might not be able to complete his job within the working-hours available. Another situation could be that some equipment is not functioning making certain types of maneuver difficult:

> Uhm, on my last watch I had a transit pilotage from Skaw and southbound. It was a real slow-steamer and going against the wind it became even slower. I realized that my rest-hours wouldn't make it on the planned route, so I called our dispatch center and explained the situation. They said I could be relieved at buoy A4 instead of buoy T10. Then I told the master 'It's your choice – either you can speed up or we need to deviate and that is a longer passage'. Luckily, he took it nicely. I can easily imagine another master with more pressure on his back or another personality who would take it differently, but you just have to try to explain the situation with a little smile. (P7)

> … and then the master tells me that he wasn't sure that the engine would run astern. I said 'well, if you are not sure that your engine will run astern then we will have to proceed to the anchorage area. We cannot go in with an engine that cannot work astern!'. And then they were running down in the engine room and after 20 min or

so, they found a way to operate the engine safely through the emergency phone. Then I said 'If you are sure it will work then we can proceed in…' – and they were. I said 'Good, let's proceed.' – but, uhm, the atmosphere was a bit tense on the way in… (P3)

I need to know if there are any limitations on the bow-thruster. Sometimes if you are running the thruster to starboard it takes 8-9 seconds before you can run it to port. It is also nice to know if it can run at 100%, maybe only for a short time or maybe not at all as it will cause a black-out. It is not always as they tell it. Sometimes you need to squeeze it out of them, especially on a coaster in general poor condition. It's something they would rather not say, so I ask: 'Will it work ok on 100%?' and a typical answer will be: 'Don't do Mr. Pilot, don't do!', then I have a pretty good idea that I have to be careful. (P2)

In case of faulty equipment there is an increased pressure on the master as it can result in extra cost due to delay or the use of tugboats. Master M2 is describing:

If you ask… if you not agreement the vessel unmooring without tugboat, so the pilot can order with authority outside. Agent arrange to coming alongside the tugboat for assistance to unmooring or mooring, but the problem is; if I ask the pilot to proceed some tugboat, more expensive for charterers, and charterers and owners very angry with me. Maybe I lose my job, this is the system in some ports. Some other ports if you use one tugboat no problem, but without tugboat this vessel turning in the river, where the space is very small space, 10 m from the shore during the turning where is the safety in this? I explained to pilot here, before come here; 'Pilot this is .... my heart … 10 m to shore…, What you do now? What you do?' He, now moving the engine. If one time not working - finished, grounding. This is the problem some ports, in the rivers from this is the problem…, from the money…, from don't like the charterers to pay extra money, very expensive. (M2)

When confronted with a trade-off it naturally leads to making a decision.

4.2.3 Decision Making

The decision making is probably the easiest cognitive challenge to imagine when a ship is maneuvering. The constant positioning of rudder, use of engines and maybe even thrusters or tugboats results in a constant flow of commands through the ship from the master/pilot to the deck crew, engine department, tugboats and shore personnel and every command is the result of a series of decisions. However, even before reaching the last few meters to the berth the master and pilot have been making numerous decisions. As we have seen previously the master and pilot need to decide a plan for the maneuver. But even though a plan has been made, the conditions for the plan may change, and therefore they must be prepared to revise their plan often on short notice:

If there is a lot of wind and you have to make a tricky maneuver, then I say to the master that if plan A is not working then we have to use plan B, going another way. Because a lot of the times the master tells me that the wind will not affect the ship that much, but once we get started its another story… then we use plan B. I often experience that. (P4)

Um, as I said, the passage, we discuss what we applauded, whether he's going to follow the same passage or if there is any change. If he says there is any change in that, we also to make the change in our plan - if we agreed to it. If you have any… if we have any concern or something you always brought up and tell it… tell the pilot. (M4)

Even the decision about who is going to conduct the vessel during maneuvering as mentioned earlier is a decision:

But, uhm, usually pilot ask: "Who will maneuver?" - Captain in our case because yeah, we are not so big vessel. (M6)

> So, and I… I do also try to make it always clear, that I also like that we talk about, already from the start, that how should we do it? Okay. You will do it now and then we do like this, we can keep the controls here until this stage and then if it's okay, then I, when do I move the controls I take over? Is it okay? But I think that should be agreed also. You know, I, I've heard also horror stories... (M1)

And that the decisions have been going on from the very start of the pilotage is confirmed by these statements:

> The primary task is to know your position right now and where you are going. Can you keep the course?, What is the next course?, Are there other ships in the area imposing a threat? (P7)

> The immediate briefing from the master is regarding the traffic situation, maybe he had to swing the vessel to make a lee for the pilot-boat and sometimes you cannot go back to the original course due to the traffic situation, and then it is nice to be briefed regarding position, course and traffic in order to bring the vessel back to a safe course. (P6)

It is of no surprise that there are cognitive burdens associated with the maneuvering of a vessel. As we have no access to the internal functioning of the master and pilots' brains, we can only describe what they tell us and this description only we can relate to theories regarding cognition.

5. Discussion

5.1 The Criteria for Joint Activity

As we can see from the Results and Analysis section, there is a fundamental wish to do a good job. Both masters and pilots want the operation to be a success and they usually have an understanding that they can benefit from each other when they work as a team. The benefit of having an individual to fill your mental gaps and question your actions can be great. Therefore, if as reported by our informants, pilotage occasionally turns into a one-man show this benefit is often lost. This loss has already been described by Drouin (2008), but we would like to see this understanding plotted as the "A. Criteria for joint activity" in the triangle, Fig. 1, made by G. Klein et al. (2005).

As the point of the triangle is still that if one side is missing the activity will no longer qualify as a joint activity and turn into a one-man show, the benefits of contributions from multiple parties will be in danger (G. Klein et al., 2005). So, when the master and pilot decide to cooperate and realize they can benefit from each other's knowledge, the base for the basic compact and interdependence is established. It is likely that interpersonal relationships do not affect the cooperation. If they don't like each other they can still achieve this base by intending to cooperate and realizing that the other part has valuable knowledge from which they can benefit.

5.2 The Requirements for Joint Activity

The exchange of information and establishment of common ground is of vital importance for the joint activity. Our informants were able to express this in various ways, and they did mention how they sometimes used checklists to support the exchange of information. They also mention that these checklists are of different style and quality and often contain a lot of unnecessary information because they are standardized by the ship owners and are to be used in all circumstances when a pilot boards a vessel. This could be why the master and pilot sometimes skip the checklist and proceed in an informal information exchange. The observation that the master/pilot exchange checklist is most of the time handled by an officer could also be an obstacle as the officer would probably have less knowledge than the master regarding both the ship and the oncoming job. This could be seen as a recognition that the checklist is ill-suited for the joint activity. Both masters and pilots found that it could be a good idea with pre-arrival information exchange forwarded to the vessel and thereby limiting the information exchange onboard at the start of the joint activity. It would also be a benefit if the checklists and information flow addressed only the important information needed for the activity. An overload of information is a cognitive burden and the cognitive system at both master and pilot seems pretty occupied already (see below).

The decision to adapt the formal procedures regarding information exchange should be done based on the principle of local rationality (Dekker, 2014) If the tool (checklist) seems inappropriate, then it is more convenient for the master and pilot to work out another way of exchanging their information. The informal way of conducting a master/pilot exchange is an easy option. The master and pilot discuss the activity and ask for the information they need to establish common ground. It might be that a piece of information is missing later in the process, but it can be obtained by asking the other party. The downside of not using the checklist is that it is possible to make decisions leaving out information that could influence the result. Another downside is that documentation of information exchange is lost. On the other hand, it is also possible to lose/forget information that is obtained through a checklist.

All this information is used by the master and pilot to reach a level of interpredictability. The interpredictability is a function of the mutual knowledge and understanding of the activity. An example is the agreement regarding speed when entering into a port as mentioned earlier by P1. Once this agreement has been reached it is easy to predict when the propulsion system will be adjusted at certain positions during the approach. If this agreement has not been reached it will be difficult to understand why suddenly the propulsion system is adjusted by another participant in the activity. Some of the pilots describe how they try to understand the thinking of the other parties in the bridge team. According to G. Klein et al. (2005) this can lead to even more interpredictability than just relying on the same basic script.

We will use the same example regarding speed during approach to a harbor to explain the notion of directability. In case P1's agreed approach plan regarding speed is not followed it is possible for a participant (master or pilot) to address this problem by questioning the difference between plan and execution. If for example the vessel is doing 6 knots at a certain point where the speed should have been 4 knots according to the plan it is possible to address this issue and get back to the plan. It could also be that one party realizes that the activity is about to derail due to a condition that only he can see and then he has the possibility to have the other participants to redirect their efforts in order to sort out the situation.

The decision to direct another team member in case the execution does not follow a plan requires that a team member overcomes the cultural barriers described by H. Klein (2004). So, when a team member has decided to try overcome the cultural barriers and raise his voice to direct another participant it is a result of his evaluation of the present situation compared to a hopefully common plan and then the voice of personal experiences from the past tells him if this is a good idea or not. To raise his voice, he will need to use a certain way of communicating – the choreography.

5.3 The Choreography of Joint Activity

The right side of the triangle in fig.1, the choreography of joint activity, is about how the communication regarding the joint activity is taking place. There has been a long tradition of how to communicate on a ships bridge using closed loop communication(Flinn et al., 2008), and during the last decades training in these subjects has been intensified on BRM-courses.

The phases mentioned by Klein et al (2005) is as explained earlier small pieces of joint activity and to be sure that nobody has left the phase, the closed loop communication procedure is an effective tool. When a loop of communication has been accomplished, we can say that a phase is completed. An example could be that the pilot commands "half ahead!" and the master repeats "half ahead!" and shortly after when the engine has been adjusted the master informs the pilot: "the engine is running half ahead" and the pilot replies "half ahead, thank you!". Even though it is only the master and pilot speaking all other people on the bridge are now informed that the engine is now running 'half ahead'. This verbal way of signaling makes a common language very important and why a breakdown of communication can be critical. As most seafarers are not native English-speaking people, they have, in our experience, a tendency of reverting to their own native language in case of emergency. This is also described by P4 as he tells us that communication with tugboats has been found more effective and safer when done in the local language, because if it is done in English, communication will be more difficult in situations with high cognitive load. Besides the example of a pilot and a tugboat talking in a local language leaving the master outside of the communication loop, another example could be a ship's crew talking a local language leaving the pilot outside of the communication loop.

The coordination devices are the set of "highly diverse mechanisms of signaling" (G. Klein et al., 2005). By this they are referring to the agreements, tacit conventions, joint experience and salience. In our case, it is the way that master and pilot chose to do their communication, e. g. whether it is a formal way by using checklist or a less formal way by working it out as they go. Or maybe the master has done the passage before and therefore there is a kind of common knowledge, and this reflects how they keep the information flow running to keep each other updated.

5.4 Cognitive Workload

The idea of describing some of the cognitive workload was to visualize that there is sometimes a huge amount of load on the master and pilot. We have seen and we talk to our colleagues about the fact that sometimes people's cognitive resources deplete, and they stop responding. That the cognitive system has its limitations is described by Norman and Bobrow (1975) and it is important to keep it functioning. We identified three different cognitive tasks that the master and pilot used frequently. The sensing and adaption, the management of tradeoffs and decision-making were the tasks that we identified on multiple occasions in our transcripts.

As several of our masters and pilots describe how they adapt to each other, we believe this is a significant mental load for them. The sensing of another person's intensions and other persons' relations with each other, their state of mind, nationality and language issues combined with the sensing of a vessel's maneuverability can be a huge task. To do this task in a different language than your first language may add to the task and to overcome cultural barriers could also add to the task of establishing a good connection onboard.

As we stated in the Results and Analysis section there can be a significant difference in the cognitive workload when steering a small vessel. That the workload can be even higher for the master/pilot if he does not have his hands on the rudder control is clear. According to our experience the master or pilot steering the vessel will have an internal feedback from his muscular system so that he already knows the position of the rudder without looking at the rudder indicator. The benefit of steering with a helmsman could therefore be an ease of the cognitive workload but the problem of steering without a helmsman is that only one person is included in the control loop of the rudder making the cognitive burden for the rest of the team more difficult as they have to follow visually all maneuvers.

5.5 National Differences

When considering national differences in teamwork there are two aspects, we find relevant to discuss based on the answers provided by our respondents. First, the pilots recognize the national differences to a much greater extent than the masters. Of course, it is possible that the masters actually do not experience national differences, but their answers may also reflect politeness or political correctness i.e. it is acceptable to focus on individual differences but not acceptable to focus on national differences. An example is M6´s reply to the question, "So it varies from country to country?":

> No, it's a about some people it's, you know, some people friendly, some people not friendly… I just don't see any difference between the nationality.

It seems like some of our respondents felt uncomfortable talking about national differences, when asked to describe national differences P7 replied with a smile: "Where does this tape go?".

The reason why the pilots, though some felt uncomfortable doing so, described national differences and most of the masters did not might be that the pilots know us as colleagues and we therefore have some mutual trust. On the other hand, we were strangers to the masters and the masters apparently considered the question sensitive and therefore were reluctant to discuss it. During the interviews we noted a significant variation in language skills. All of the masters had different levels of difficulties in expressing themselves in English, whereas the pilots have been talking to us in their native language, Danish, and we have translated the important parts later. This could be another explanation of why our masters were reluctant to address issues regarding nationality.

The second question of interest concerning national differences in teamwork is how the data from our interviews correspond with the theories proposed by H. A. Klein and McHugh (2005). They conclude that descriptions of teamwork are based on competencies and mechanisms characterizing Western organizations. Competencies like shared mental models, closed loop communication and mutual trust mentioned by Salas et al. (2003) are concepts designed by Western researchers exploring Western domains using Western paradigms and cannot uncritically be generalized to non-Western teams (H. A. Klein & McHugh, 2005). Our data does not give us much information on how different nationalities deal with the cognitive challenges mentioned by H. A. Klein and McHugh (2005). However, their conclusion that:

> As a result, members of different groups may be continually surprised and disoriented when faced with the practices of other groups. This reduces predictability, which is a prime requirement for effective coordination. Differing Mental Models make it difficult for members of one national group to anticipate and understand the decisions and actions of other groups. Differences also prevent members of multinational teams from using abbreviated messages and other efficiencies that can cut coordination costs.(p. 240)

seems to correspond well with our observations from the pilots. This make the effort described by the pilots regarding their wish to understand the cognitive challenges of other members of the bridge team, and thereby increase interpredictability, even more important as described by Klein et al. (2005).

5.6 The Pilot as an Alien

In the start of the analysis we came across the statement: "A pilot is a guy nobody like to have on board" (P5). As we wrote in our analysis chapter, we do not believe this comes from a hostile mindset, but rather a reflection of the social and cognitive burden of the small crew when they have a stranger onboard. Taking the two statements from H. Klein (2004) and H. A. Klein and McHugh (2005) cited above, we find some of the explanation to support this claim. If we furthermore look at the last paragraph in '5.4 Cognitive Workload' we can see that the master very easily can be in an observer's role rather than in command of his own vessel when the pilot is steering the vessel. This of course can be uncomfortable and especially masters on small vessels can have this feeling. This is because the masters of the small vessels are normally used to handling the maneuvering of the vessel themselves, whereas the masters of the larger vessels are more used to working with a pilot, therefore there is a difference between large and small vessels having a pilot onboard.

5.7 Limitations

5.7.1 Validity and reliability

As mentioned above it was both an advantage and a disadvantage for us as researchers to have insider knowledge about the phenomenon we were studying. Knowing the terminology and the domain was an advantage as we knew what our respondents were talking about. On the other hand, the insider knowledge might have led us to think we knew the answers already (Blaxter et al., 2010). Furthermore, we were unavoidably influenced by the two closely related biases; expectation bias and confirmation bias i.e. hearing what we expected to hear and finding confirmation for our assumptions while discarding unexpected information. According to Grech et al. (2008) there is no cure for these biases, other than being aware of their existence. Though no cure exists there are means to alleviate the symptoms of the biases, Delamont (2007) found, "reflexivity is the way the qualitative researchers strive for reliability and validity" (p. 214). It is necessary to mention that many scholars within the qualitative paradigm dismiss the terms reliability and validity as meaning a search for "the truth" (Denzin & Lincoln, 2018; Seale, 2007). We were in no search for the truth, the point for us was that the reflexive process of *striving* for reliability and validity was our way of ensuring quality and credibility in the research taking advantage of being two researchers able to discuss and reflect on the research.

When doing the interviews one of us acted as primary interviewer while the other was shadowing, asking questions when deemed necessary. After each interview we reflected on the interview discussing possible improvements in our approach. The first cycle coding was done separately and then we compared and combined the codes. The rest of the thesis was done in sequences of writing and meeting (either physically or on phone/Skype) reflecting on the writing.

Of course, it can be argued that due to our shared background our preconceptions and biases were also shared and therefore hidden from both of us. We do however believe that being aware of the possible preconceptions and biases enabled us to act as, "friends willing to be enemies" (Ladkin, 2007) i.e. enabled us to identify the blind spots in the research.

We interviewed 6 masters and 7 pilots. If the number of interviews had been higher it might have increased the significance (Blaxter et al., 2010) of our results. The number of interviews was, as mentioned above, to a great extent determined by practical circumstances.

5.7.2 Generalizability

The qualitative approach is generally suitable to achieve depth in the data but not equally suited to produce generalizable information (Blaxter et al., 2010; Denzin & Lincoln, 2018). Since our study was inspired by narrative

research the obtained data was especially ill suited for generalization, Josselson (2012) found, "Narrative research is not generalizable to populations but rather highlights the particularities of experience" (p. 873).

Flyvbjerg (2007) argued that generalization is only one of several ways to accumulate knowledge and mentions "the force of example" as an underestimated source of reliable knowledge. In our study we focused on the lived experience of the respondents, therefore the contribution to the understanding of MPX is based on examples rather than generalization.

6. Conclusion

Our informants have told us their stories of their experiences regarding the cooperation between a master and a pilot. We have evaluated their stories by using the theories by G. Klein et al. (2005) regarding teamwork, studied their expression of cognitive burdens and touched upon the cultural differences using the theories of H. A. Klein and McHugh (2005). During this work we have been describing how the teamwork between master and pilot can be performed in multiple ways depending on the circumstances.

The question raised by Mansson et al. (2017) on how masters and pilot manage the trade-off between common ground and their ability to be adaptive, could maybe be answered by using G. Klein et al. (2005) terms regarding joint activity. As the master and pilot reach a sufficient level of common ground and thereby achieve interpredictability and directability they will gain an increased adaptive capacity. By knowing their initial common ground, their possibilities, their present state, and their common goal they will be able to alter their plan to mitigate unforeseen challenges and reach their goals by utilizing interpredictability and directability.

6.1 The support for the cooperation between the master and the pilot during the MPX

The teamwork is, in our view, supported in a number of ways. First, the intention of both the master and the pilot to do a good job makes a difference and gives them a base for a successful joint activity. By utilizing and sharing their knowledge regarding the present conditions and the activity, they reach a level of understanding, a common ground, that provides interpredictability and directability. The techniques of communicating, the choreography, trained on BRM-courses, helps them to find a common ground and to sustain it throughout the activity.

It has been recognized by the IMO that this teamwork is so valuable and fragile it needs a formalized start, hence the master/pilot exchange checklist. The IMO also stresses that the exchange is constantly ongoing and some of our informants described they tried to keep this common ground updated throughout the pilotage.

Our findings imply that it is the adaptive capacity of the masters and pilots, their wish to cooperate, their mutual understanding of the common ground and their way of communication, that makes the joint activity a success.

6.2 The challenges and constraints that masters and pilots experience conducting MPX

Some challenges in establishing and maintaining this joint activity have also been mentioned by our informants. First of all, the master/pilot exchange checklist and pilot-card can be identified as an important feature for establishing this cooperation. However, the design of these papers and their use seems to need some further investigation. To reduce the cognitive burden of both the master and pilot some of this exchange of information might even take place before the pilot comes onboard (vessel's data, weather forecast, tides, route suggestions etc.).

Another constraint in achieving a sufficient level of cooperation is the fact that seafarers are often using English as a second language to communicate. As shown in this thesis the level of English skills can vary and can indeed make successful cooperation difficult, however the more hidden national differences like those of relationship, mutual trust, tolerance for uncertainty and power distances as described by H. Klein (2004) seems to makes a difference too. These are difficult things to quickly assess when faced with another human being for the first time. They are also difficult to talk about in the light that everybody would like to appear as openminded and accommodating. It was our impression that there were also national differences in informant's openness to address particular issues. The masters and pilots describe how they try to assess one another however they were not able to express what exactly they were looking for other than nationality, language skills and body language. We think issues regarding nationality should have a more prominent place in BRM-training.

6.3 Next Step

We find that it could be beneficial to look further into the design use of checklist used during MPX. As they are rarely used as intended, they are obviously ill suited for the job. Bearing in mind the principle of local rationality (Dekker, 2014) if a procedure does not make sense to a person, he will try to find a better solution.

When designing checklist and procedures it is valuable to have knowledge regarding the topics of national differences as mentioned by H. Klein (2004). We see a constant shift of which nationality of seafarers are preferred by the ship owners. We think it would be beneficial to explore the national differences of seafarers further and distribute the knowledge regarding this subject on the BRM-courses.

On these BRM courses, we think the presentation of cooperation in joint activity as laid out by G. Klein et al. (2005), would make a good understanding for the participants on how a joint activity is constructed theoretically. By gaining this knowledge they can better mitigate a failure of a joint activity.

We think the possibility of sharing some pre-arrival information between ship and pilot station would ease the cognitive burden of both master and pilot and may make it easier for them to reach a common ground when starting up their joint activity.

We have only touched lightly on the cognitive workload for a master and a pilot. This workload deserves a further investigation.

6.4 MPX - A Highway to Human Error or a Stronghold Against System Variability?

In the introduction we mentioned that several accident investigations have concluded that a poor master/pilot exchange was a contributing factor leading to the accident. We hope in the future that incident investigation teams will ask themselves: Why was this master/pilot exchange a failure? – Was it something hardwired in the system?

By studying the MPX it is clear that there are many ways the joint activity can break down and history have shown us that. However, we must emphasize that most of the time (almost every) MPX is a success. The success originates from the knowledge, skills and adaptive capacity of the master, crew and pilot. Unfortunately, we have seen that when the joint activity fails it is easy to point at the MPX as being insufficient. As the MPX is done by humans it is also easy to see the human as a liability instead of a safeguard against the variability of everyday work.

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Appendix A

Letter of Concent

Research project title:
Master/Pilot Exchange - Common Ground and Adaptiveness.

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Purpose:
This interview is for the purpose of gathering empirical data regarding the daily work of masters and pilots.

The Master/Pilot Exchange is a focal point of attention for both maritime authorities and stakeholders in the maritime domain. In many accidents reports inadequate Master/Pilot Exchange has been identified as a contributing factor to the final outcome. We would like to explore the challenges experienced by masters and pilots when they are working together.

By conducting interviews, we hope to gain an understanding of how the practitioners are meeting the challenges of cooperating in a complex socio-technical system, where there is imperfect knowledge about the interactions within the system and individuals. The research will be conducted in fulfilment of the requirements for a master degree.

Risks and Rights:
There are no known risks in participating in this research. You are participating on a voluntary basis and have the right to withdraw from taking part in the study at any moment without stating a reason.
As a participant in the research you can select to receive a copy of the thesis.

Confidentiality:

Any contribution to the study will be treated confidentially and participants and their companies are ensured anonymity in the thesis. During the interview we will audio record the conversation and take notes. The information collected during the interview is available only to the researchers and for the purpose of the research. On completion of the research all notes and recordings will be erased.

Consent:

Your participation in this research is entirely voluntary. You may refuse to participate or withdraw from the research at any time. Your signature indicates that you have received a copy of this consent form for your own records and that you consent to participate in this research.

Date:

Place:

Participants signature

Researchers signature

Appendix B

List of informants:

This is a description of our informers. They have all volunteered to participate.

M1: Master of containership. Approximately 6400mt deadweight. Interviewed in Odense. Nationality: Finnish. More than 35 years of experience at sea whereof 16 years as master.

M2: Master of bulkcarrier. Approximately 74000mt deadweight. Interviewed in Aarhus. Nationality: Greek. 30 years of experience at sea whereof 16 years as master.

M3: Master of bulkcarrier. Approximately 95000mt Deadweight. Interviewed in Odense. Nationality: Indian. 19 years of experience at sea whereof 8 years as master.

M4: Master of product/chemical tanker. Approximately 50000mt deadweight. Interviewed in Odense. Nationality: Indian. 19 years of experience at sea whereof 2 years as master.

M5: Master of dry-cargo ship. Approximately 1350mt deadweight. Interviewed in Aarhus. Nationality: German. 15 years of experience at sea at sea whereof 2 years as master.

M6: Master of cement carrier. Approximately 4200mt deadweight. Interviewed in Randers. Nationality: Russian. 29 years of experience at sea whereof 14 years as master.

P1: Transit and harbor pilot. Nationality: Danish. 29 years of experience at sea whereof 7 years as pilot.

P2: Transit and harbor pilot. Nationality: Danish. 25 years of experience at sea whereof 7 years as master and 10 years as pilot.

P3: Transit and harbor pilot. Nationality: Danish. 29 years of experience at sea whereof 4 years as master and 13 years as pilot.

P4: Transit and harbor pilot. Nationality: Danish. 34 years of experience at sea whereof 7 years as master and 13 years as pilot.

P5: Transit pilot ex. Harbor pilot. Nationality: Danish. 33 years of experience at sea whereof 2 years as master and 23 years as pilot.

P6: Transit pilot ex. Harbor pilot. Nationality: Danish. 29 years of experience at sea whereof 15 years as pilot.

P7: Transit pilot. Nationality: Danish. 13 years of experience at sea whereof 7 years as master and 4 years as pilot.

Appendix C

Copy from Bridge Procedures Guide (International Chamber of Shipping, 2016).

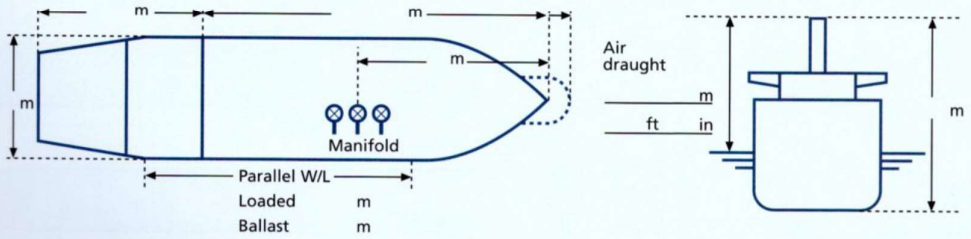
A1 MASTER/PILOT INFORMATION EXCHANGE

SHIP IDENTITY		
Name:	Call Sign:	Flag:
Agent:	Year Built:	IMO Number:
Cargo:	Ship Type:	Last Port:
ADDITIONAL SHIP'S CONTACT INFORMATION		
Telephone:	Email:	Other:
PILOT BOARDING INSTRUCTIONS		
ETA at Pilot Station:	Pilot ETA at Boarding Station:	Approach Course and Speed:
Embarkation Side:	Requested Boarding Arrangements:	
SHIP PARTICULARS		
Refer to the ship particulars in the Pilot Card (Checklist A2)		
ANCHORS (Length of Cable Available)		
Refer to the ship particulars in the Pilot Card (Checklist A2)		
MANOEUVRING DETAILS AT CURRENT CONDITION		
Refer to the steering information in the Pilot Card (Checklist A2)		
MAIN ENGINE DETAILS		
Refer to the main engine information in the Pilot Card (Checklist A2)		
BERTH AND TUG DETAILS		
Intended Berth and Berthing Plan:		
Side Alongside:	Estimated Transit Time to Berth:	Tug Rendezvous Position:
Number of Tugs:	Tug Arrangements:	Total Bollard Pull:
WEATHER AND SEA CONDITIONS (At Boarding Station and at Berth)		
Tidal Information (Heights and Times):		
Expected Currents:		
Weather Forecast:		

PILOTAGE PLAN
REGULATIONS (VTS Reporting, Anchor/Look-out Attendance, Maximum Allowable Draught)
OTHER IMPORTANT DETAILS (Including Navigation Hazards, Ship Movements, Berthing Restrictions, Manoeuvring Peculiarities)

A2 PILOT CARD

SHIP PARTICULARS		
Name:		Call Sign:
Displacement:	DWT:	Year Built:
Length:	Beam:	Bulbous Bow:
Draught Fwd:	Draught Aft:	Draught Amidships:
Air Draught:	Port Anchor: Shackles	Stbd Anchor: Shackles
		1 shackle = 27.4m/15 fathoms



MAIN ENGINE			
Type:	Max Power: kW		Max Power: HP
	RPM/Pitch	Loaded Speed (kts)	Ballast Speed (kts)
Full Ahead:			
Half Ahead:			
Slow Ahead:			
Dead Slow Ahead:			
Dead Slow Astern:			
Slow Astern:			
Half Astern:			
Full Astern:		% ahead power	
Engine Critical RPM:	Maximum Number of Consecutive Engine Starts:	Time from Full Ahead to Full Astern:	
Time Limit Astern:	Minimum Steering Speed:		

STEERING		
Number of Propellers:	Direction of Turn:	Propeller Arrangement:
Time from Hard-Over to Hard-Over:	Rudder Angle for Neutral Effects:	
Thrusters (Positions and Power):	Steering Characteristics:	

EQUIPMENT CHECKED AND READY FOR USE		
Anchors:		Cleared Away: YES/NO
Compasses:		
Compass Error:		
Speed Log:		Doppler: YES/NO Speed: Water/Ground Axis: Single/Dual
Echo Sounder:		
GNSS:		Type:
ECDIS:		
X-Band Radar:		ARPA: YES/NO
S-Band Radar:		ARPA: YES/NO
VHF (Including Handheld):		
Steering Gear:		Number of Power Units In Use:
Engine Telegraphs:		
Rudder/RPM/ROT Indicators:		
Mooring Winches and Lines:		
Navigation Lights:		
Whistles:		

EQUIPMENT OPERATIONAL DEFECTS

OTHER IMPORTANT DETAILS

Reference: IMO Resolution A.601(15) Provision and Display of Manoeuvring Information On Board Ships

Master:..... Date:.....