This is the published version of a paper published in *Safety Science*.

Citation for the original published paper (version of record):

Boström, M. (2020)
Mind the Gap!: A quantitative comparison between ship-to-ship communication and intended communication protocol
*Safety Science*, 123: 104567
https://doi.org/10.1016/j.ssci.2019.104567

Access to the published version may require subscription.

N.B. When citing this work, cite the original published paper.

Permanent link to this version:
http://urn.kb.se/resolve?urn=urn:nbn:se:lnu:diva-90559
Mind the Gap! A quantitative comparison between ship-to-ship communication and intended communication protocol

Magnus Boström
Kalmar Maritime Academy, Linnaeus University, SE-391 82 Kalmar, Sweden

ARTICLE INFO

Keywords:
Communication
Icebreaking
Misunderstanding
Safety
Standard Marine Communication Phrases (SMCP)

ABSTRACT

Icebreaker operations, when an icebreaker assists other vessels through ice-packed fairways, are hazardous due to harsh environmental conditions and complexity of procedures. The severity of operations is further aggravated by the necessity for maintaining a small distance between the vessels, which consequently increases the risk of collision. Even though miscommunication is widely identified as a contributing factor to shipping accidents, previous research within winter navigation has focused largely on technical aspects of icebreaker operations to increase the operational safety. This study aimed to investigate to what extent closed-loop communication is used during icebreaker operations, and whether this practice deviates from stipulated communication protocols. A quantitative analysis was performed, coding 40 days of verbal radio communication. Subsequently, the data was compared to the stipulated communication protocol outlined in the Standard Marine Communication Phrases. The results show that closed-loop communication is not utilized to its full extent. Some message types are completely repeated at a higher rate, mainly instruction and question, while other message types, such as information and intention often receive a yes-no answer. A full closed-loop, i.e. a completely repeated message followed by a confirmation, was only observed in 16.4% of the messages initiated by an icebreaker and 14.0% for the assisted vessels. Thus, this study clearly shows that there is a gap between actual language use and stipulated communication protocol. Finally, since misunderstandings during icebreaker operations can have serious consequences, more research is needed into the underlying reasons for miscommunication in situations with little room for error.

1. Introduction

Misunderstandings during ship-to-ship communication have long been identified as an important contributing factor to shipping accidents (Bocanegra-Valle, 2011), and even though data is limited, winter navigation is no exception. Better communication is among the factors necessary for the development of such operations (Valdez Banda et al., 2016). However, even without language problems, winter navigation is a complex and hazardous operation. Previous research has shown that a voyage through ice adds a number of fundamentally precautionary aspects compared to shipping in open water, e.g. severe weather conditions and ice crushing pressure on the hull (Kujala and Arughadhoss, 2012). In addition, assisting a vessel that is stuck in ice also requires the icebreaker to operate in close vicinity to the assisted vessel (House et al., 2010), and since the distance between the vessels can be very small, so is also the margin of error. With little room for error, miscommunication could deteriorate the outcome of such a scenario. The effects of collisions are multifactorial, and include putting human lives at risk, severe damage to the environment, and costly operational disturbances to the shipping industry but also to the transport buyers (Chai et al., 2017; Karahalios, 2014).

Preceding research and development activities within the field of icebreaker operations have primarily focused on ice and weather conditions (e.g. Valdez Banda et al., 2015; Leppäranta and Hakala, 1992; Haapala and Leppäranta, 1997), and technical aspects and engineering principles (e.g. Cho and Lee, 2015; Juva and Riska, 2002). Human and organizational elements have to date largely been ignored, apart from a recent study by Boström (2018), who showed that successful icebreaker operations require a large amount of personal interaction and communication between the crews on board.

Even though maritime communication is an under-researched topic within the area of winter navigation and icebreaker operations, it has been studied by researchers in related fields. Vessel Traffic Service (VTS) operations have been investigated from an interactional perspective (Brodje et al., 2013). In a VTS area, vessel movements are monitored by VTS operators, and vital information is shared between individual vessels and VTS operators, to allow optimal situational awareness. Brodje et al. (2013) identified a number of factors, e.g.
hierarchy and trust, which determine the extent to which VTS operators would choose to share information with vessels. At times, operators deliberately refrain from communicating what they believe the other party already knows, to avoid being supercilious. Furthermore, the exchange of information does not necessarily follow proper communication protocol. Costa et al. (2018) reported that the closed-loop communication model, where a message is repeated and confirmed to verify that the intended message is received, is not always used, resulting in situations where VTS operators rely on the other vessel despite their use of open-loop communication, even though they acknowledged that such communication could potentially result in misunderstandings. Trust and power imbalance were also discussed by Sætrevik et al. (2018) in the context of safety-critical offshore operations. They identified a power relationship between offshore vessels and other units. This relationship has consequences for the way trust is established, and the extent to which justifications are offered for instructions. Furthermore, it potentially leads to communication problems such as receiving insufficient information or even no response whatsoever to radio calls.

There seems to be numerous similarities between VTS and icebreaker operations, e.g., the necessity of co-operation between two or more people with varying proficiency in English (Boström and Österman, 2017; Mansson et al., 2017). Nonetheless, there is a difference between the two operational contexts, and that is the available space for manoeuvring. Even though space might be limited in VTS areas, e.g., in a congested approach to a major harbour, there are few situations, if any, where there are equally small error margins as during icebreaker operations. The unpredictability of the ice thickness further aggravates icebreaker operations, making ice assessment a crucial skill for icebreaker operations (Boström, 2018). However, even with skilled operators, convoy operations where one or several merchant vessels follow close behind an icebreaker, are among the most perilous situations of winter navigation (Valdez Banda et al., 2015). To mitigate this risk, Goerlani et al. (2017) analysed convoy speed and ice thickness to provide empirical knowledge about distance between vessels in a convoy, to support decision making and increase the safety of ice navigation. However, even with a recommended safety distance, situations will occur which require action and co-operation between the icebreaker and the assisted vessel. In a study of maritime accidents, Sandhåland et al. (2015) report that in cases associated with human error, most cases also involve the loss of situational awareness and suggest that communication failure might have been a significant factor in some of them. Conversely, Grech et al. (2008) advocate closed-loop communication as a mean to support team situational awareness. Likewise, Hetherington et al. (2006) stress the centrality of communication for safe performance in any high-risk industry. Furthermore, they also report that there appears to be a discrepancy between one’s own self-perception of the effectiveness of communication and other’s interpretations of the same interaction. More precisely, when maritime pilots were asked whether they made sure their orders were understood and acknowledged by the rest of the bridge team, most of them agreed. The other officers on the bridge, however, viewed the pilot’s actions differently and agreed to the statement at a considerable lower degree. Finally, research on situational awareness in the military shows that less effective teams make more communication than more effective teams (Rafferty et al., 2012), and Salmon and Stanton (2013) state that more communication does not necessarily lead to better situational awareness; this suggests that quantity does not outperform quality. Consequently, Salmon and Stanton (2013) propose that safety research should study the influence that various factors have on situational awareness, e.g., communication.

The aim of the study presented in this paper is to describe verbal maritime communication in the context of icebreaker operations. This includes a quantification of what is being said, by whom it is being said, and what response it elicits; in other words, to what extent closed-loop communication is, or is not, used in this specific context. The study offers a thorough description of authentic maritime communication, from an area where such data is scarce. Even though the context of this study is icebreaker operations, it is believed that the findings are of value to other domains as well; any operation that, in a multicultural setting, relies on interpersonal interaction to maintain operational safety might benefit from the results presented here.

The remainder of the article is arranged as follows. Section 2 describes the Standard Marine Communication Phrases (SMCP), its intended usage and research on closed-loop communication from different domains. Section 3 presents the method for data collection and analysis, followed by a presentation of the results in Section 4. The results are presented sequentially following the closed-loop structure, presenting first the original message, then the subsequent response, and finally the confirmation of the intended meaning. In Section 5, the results are discussed in the light of maritime communication, as well as the effects of misunderstandings on icebreaker operations. Finally, Section 6 offers conclusions as well as recommendations for future research within the field of icebreaker operations and maritime communication.

2. Communication at sea and closed-loop communication

The United Nations agency for maritime affairs, the International Maritime Organization (IMO) has long recognized the necessity for precise and unambiguous communication at sea, and a need for a standardized language to reduce the risk of misunderstandings potentially causing harm to people, vessel or environment (IMO, 2001). However, in addition to setting a minimum standard for language proficiency, the purpose of the SMCP is also to persuade native or near-native speakers of English to refrain from using idioms and too eloquent language. Essentially, speakers of maritime English need to find common ground and adjustments are required by both novice and skilled English speakers (Johnson, 1999). Previous studies show that actual maritime communication deviates from the recommended standardized radio communication (Pritchard and Kalogjierr, 2000), and that the extent of this deviation needs to be researched further (Bocanegra-Valle, 2011).

The SMCP provides a large variety of phrases appropriate for situations requiring both external and on-board communication. Use of these phrases “should be made as often as possible in preference to other wording of similar meaning; as a minimum requirement, users should adhere as closely as possible to them in relevant situations” (IMO, 2001). In addition, there are general discursive features that shape language use, and specific discursive features that optimize the communicative performance. The former have governed the compilation of SMCP, and include general guidelines such as avoiding synonyms and contracted forms. The latter deal with organizational aspects of communication, e.g. the use of the phonetic alphabet for spelling of letters and the words over and out for clear turn taking (Bocanegra-Valle, 2011). Features with relevance to this study include:

- **Provide fully worded answers to yes-no questions.** The question “Are you currently on full ahead?” requires a full answer, e.g. “Yes, my engine is full ahead.” Replying “yes” or “no” is not enough.
- **Provide fully worded answers to instructions or pieces of advice.** The instruction “Rudder midships and slow ahead” requires a reply such as “Ok, rudder midships, slow ahead”. Replying “ok” or “understood” is not enough.
- **Provide one phrase for one event.** The communication should be made simple and precise by articulating only a single event in each sentence.
- **Make use of message markers.** A message marker is a word that precedes a message and indicates the nature of that message, e.g. instruction or warning. It is used in verbal interpersonal communication to increase the probability of the message being properly understood. The use of message markers is encouraged to reduce the
The first two features described above embody the essence of the concept called closed-loop communication, a mechanism that provides feedback on messages. Flin et al. (2008, p. 105) define closed-loop communication as “[a] three-step sequence whereby a message is sent by a team member, another team member provides feedback regarding the received message and the originating team member then verifies that the intended message was received”. Within the maritime domain, Froholm (2016) has studied how readbacks are used by speakers to verify information. For example, a nod or other nonverbal cues cannot replace the readback as it might go unnoticed. Furthermore, the readback enables the correction of an incorrectly repeated message.

Team situation awareness and communication have been thoroughly studied within the medical domain. Parush et al. (2011) quantified the various functions of speech acts in the operating room and showed that open communication loops can be susceptible to information loss. Furthermore, closed-loop communication reduces surgical mistakes (Schuueneyemeyer et al., 2017), as well as increases speed and efficiency of tasks in paediatric trauma care (El-Shafy et al., 2018). Brindley and Reynolds (2011) adopted strategies from the aviation industry to offer practical methods for improved communication in critical care medicine, proposing closed-loop communication, the repeat-back method and a restraint from using mitigating speech, i.e. deferential language, in pressing or non-routing situations. However, an awareness of the importance of communication is not sufficient; Hărgestam et al. (2013) observed a gap between theoretical knowledge of communication models and actual language use during trauma team training.

A significant difference between communication in the operating room and communication at sea is that in ship-to-ship communication the team members are not co-located, and cannot rely on non-verbal cues. This type of radio communication can be exemplified with Schramm’s communication model (Schramm, 1971). The model has a basic structure with a source, a message and a destination; the sender encodes a message, which is transmitted through a channel and received and decoded by the recipient. However, Schramm added the concept of feedback, from the receiver to the sender, which allowed for interaction. Where previous models had been linear, Schramm’s model had a cyclic structure where sender and receiver continuously alternated positions, and that is one reason Schramm’s model is suitable for describing Very High Frequency (VHF) radio communication. Schramm also incorporated the idea of overlapping fields of experience (Blythe, 2009). The coding and decoding processes are influenced by experience, and if there are no commonalities in the sender’s and receiver’s field of experience, then communication simply does not take place. In the case with ship-to-ship communication, a common language is a first step towards an overlap. Moreover, experience of icebreaker operations increases the overlap as it provides a common understanding, which can be verbalized through a specific vocabulary. This, in turn, increases the likelihood of successful communication.

3. Methods and procedures

3.1. Data collection on board the icebreaker

The data for this study consists of verbal communication between an icebreaker and vessels under icebreaker assistance. Since people tend to modify their behaviour when under observation, it was deemed necessary to utilize a non-reactive research method (Marrelli, 2007; Webb et al., 1966). Rather than having the researcher conducting observations on board, the conversations were recorded on board without the researcher present, thus reducing researcher interference. The recording equipment consisted of three main components: a VHF radio with its own antenna, a GPS, and a VHF recorder. The VHF recorder was the main unit, into which both VHF communication and data from the GPS were recorded onto an external storage unit. This set-up allowed for the recording of data to be performed independent from the icebreaker’s own onboard equipment. Furthermore, by utilizing a VHF that was not used by the icebreaker’s crew, the VHF could be set on the icebreaker’s working channel, hence only recording communication on that specific channel. That also reduced the risk of inadvertently forgetting switching back to the working channel after using another channel.

The data was collected on board one icebreaker for 40 days during the winter of 2017; the data amounted to 2825 communication loops (each consisting of a message, a response and a confirmation), and is a total population sample (Etikan et al., 2016) of the ship-to-ship communication between one icebreaker and the vessels receiving assistance during icebreaker operations. Although a case study does not guarantee room for generalization, there are no reasons to suspect that results from studies on other icebreakers would be diametrically different since international shipping adheres to the same regulations concerning language use and training of seafarers. The bridge team of the icebreaker normally consists of five nautical officers taking turns manning the bridge. During icebreaker operations, two officers are on duty at any time, and an additional lookout is available at the discretion of the bridge team. In addition, the master may also assist whenever necessary. The entire bridge team on the icebreaker were informed about the aim of the study, and consented to having the recording device on board. Furthermore, the crew were informed that participation was voluntary, and the recording device offered a simple way to temporarily disengage the recording if anyone decided to opt out from participating, without indicating who had done so; however, the records indicate no such disengagement.

3.2. Transcription and analysis of data

After the equipment had been retrieved, the recorded communication was transcribed into an intelligent or clean verbatim transcript, i.e. a word-for-word transcript, but without fillers, stutters, nonverbal cues and pauses. Powers (2005) compares transcription to translation; not even the best transcript mirrors the original activity entirely, and both the recording and subsequent transcription take the researcher further away from the original event. Transcription transforms speech, which is fleeting and heavily contextualized, into a static form, which is much more manipulable. As a written text, it can be analytically processed (Lapadat, 2000). Furthermore, the coding of the data rests on the interpretive epistemology and subjectivism. Knowledge in general and language in particular are constructed through interaction with humans, and both culturally and historically laden (Scotland, 2012). Knowledge is subjective, and therefore the transcript and the subsequent coding are not simply representations of talk, but an interpretive construction formed by the researcher him- or herself (Green et al., 1997). With that in mind, confirmation bias, the interpretation of data in ways that are skewed based on previous beliefs, is an omnipresent threat (Nickerson, 1998). People tend to see what they are looking for, and this poses a challenge for the researcher who must remain vigilant to avoid researcher bias. Kvale (1994) describes the same negative phenomenon as biased subjectivity, in contrast to perspective subjectivity. The latter appears when researchers adopt different perspectives, resulting in different interpretations. However, Kvale (1994) downplays the risks associated with perspectival subjectivity, stating that a multiplicity of meanings is not necessarily haphazardly, but “objective in the sense of reflecting the nature of the objects investigated”. According to Nickerson (1998), awareness of confirmation bias is a first step towards mitigating this risk. More specifically, a number of measures were undertaken during the analytical process to ensure a true representation of the communication. First, at an early stage of the study, a section of the data (ten days) was initially analysed to allow evaluation of the analytic process. After adjustments had been...
made, the complete data set was analysed. Second, it was deemed important to listen to the recorded communication multiple times, to notice nuances and capture aspects that otherwise might have gone unnoticed. Third, the analysis included a constant shift between the isolated communication turns and the data set as a whole, to get a holistic view.

The transcripts contained all ship-to-ship communication from the icebreaker’s working channel, i.e. all verbal communication between the icebreaker and the vessels under assistance. This study aimed at describing the transfer of messages through closed-loop communication. Other aspects of a VHF conversation, e.g. the call procedure where one vessel addresses the other and the subsequent response, as well as general pleasantries, were not included in the analysis. Since IMO strongly recommends the use of English in situations where language difficulties may arise (IMO, 2001), messages in other languages than English, e.g. Swedish and Finnish, were omitted from this study. Furthermore, closed-loop communication is an interactional communication style (in contrast to a linear style found in one-way mass communication), and as such requires both parties to be audible. As a result, messages where one part was inaudible, due to e.g. long distance or static, were also omitted. Out of 2825 communication loops, 247 loops (8.7%) were omitted due to being non-English and another 191 loops (6.8%) were excluded due to one part being inaudible. The remaining 2387 loops (84.5%) were further processed.

The data was split into segments conforming to the closed-loop format to include three parts: the original message, the feedback (response) provided by the receiver and the verification of whether the message was received as intended. Each segment of the transcript was analysed to identify the following parameters:

1. Initiator: An identification of the actor that initiated the message, e.g. the icebreaker, the assisted vessel, etc.
2. Message type: An identification of the type/s of message/s. Each message was classified in accordance with the indicators defined by IMO’s SMCP, also known as message markers (Table 1). Each message could consist of one or several different message types.
3. Response: How did the receiver respond to the message? For example, was the message repeated completely, partly, or simply acknowledged with a Yes/No/Ok? Table 2 shows the different types of responses, and the examples illustrate characteristics that distinguish one response from another. A complete response did not have to be repeated word-for-word but all essential information had to be repeated. When some information was missing, the response was coded as partly. A new message meant that no information from the original message was repeated, and the receiver started a new loop instead of responding to the previous one.
4. Did the sender acknowledge that the receiver’s response was correct in relation to the original message, i.e. was the loop closed?

### 4. Results

This section illustrates the communication between one icebreaker and the vessels receiving icebreaker assistance. The results are presented sequentially in the same order as the closed-loop sequence: the original message, the response, and the confirmation.

#### 4.1. WHO says WHAT?

The main actors in icebreaker operations are the icebreaker and the vessel or vessels receiving assistance, a fact that clearly is reflected in Table 3. Other actors, who occasionally initiate verbal communication, include shore-based entities such as VTS operators, and pilot boats. However, it needs to be emphasised that Table 3 only shows who initiates the communication, not the distribution of time talked. The amount of talk, or turns, is more or less evenly distributed between the icebreaker and assisted vessel in the sense that almost every message is met with a response. However, the icebreaker is the actor that initiates most of the communication. Since the communication initiated by shore entities or pilot boats comprises such a small percentage of the data, the remainder of the results presented in this study is only covering communication initiated by either an icebreaker or a vessel under assistance.

The distribution of types of messages used by icebreaker and assisted vessels is illustrated in Table 4. However, even though the message types have been categorized in accordance with the message markers, they are not message markers per se; a message marker is verbalized in spoken communication, while the message types in Tables 4 and 5 are merely based on message content. Nonetheless, some spoken message markers were observed throughout the data. Although very few, less than 20, they were almost exclusively information message markers and often interwoven with the subsequent message, i.e. not as distinctive as intended by the SMCP.

The single most common message type used by the icebreaker is instruction to the assisted vessel/s. These are often brief and explicit and can be executed with a single action, e.g. “Please go full ahead”, while other are more general and might require action over a prolonged period of time, e.g. “Just follow the icebreaker until we reach the ice edge” or “Do not come closer than two cables”. Information is the most common message type used by the assisted vessel and the second most common for the icebreaker as well. For both of these vessel types, information messages involve the exchange of factual statements; however, there is a difference. When used by the assisted vessel, it is usually a statement about one’s own vessel, e.g. “We are back on the track” or “Pilot is on board”. In addition to such statements, the icebreaker also briefs other vessels about forthcoming operations, e.g. “Yes you can see we coming with [vessel name] and we are going to [place] and will drop her off, and then we can come out and get you started again”. Questions are used in an interrogative manner to obtain information.

### Table 1

<table>
<thead>
<tr>
<th>Message type</th>
<th>Definition by the SMCP</th>
<th>Examples from icebreaker operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruction</td>
<td>…implies the intention of the sender to influence others by a Regulation.</td>
<td>“Please follow the icebreaker.”</td>
</tr>
<tr>
<td>Advice</td>
<td>…implies the intention of the sender to influence others by a Recommendation.</td>
<td>“I suggest you still go in the course zero four zero.”</td>
</tr>
<tr>
<td>Warning</td>
<td>…implies the intention of the sender to inform others about danger.</td>
<td>“Just ahead of you you have a ten metre shallow area so please go a bit more to the west.”</td>
</tr>
<tr>
<td>Information</td>
<td>…is restricted to observed facts, situations, etc.</td>
<td>“My engine is full ahead.”</td>
</tr>
<tr>
<td>Question</td>
<td>…is of interrogative character.</td>
<td>“What is your destination?”</td>
</tr>
<tr>
<td>Answer</td>
<td>…is the reply to a previous question.</td>
<td>No message was coded as answer. Answers were coded as responses to previous messages and thus coded according to Table 2.</td>
</tr>
<tr>
<td>Request</td>
<td>…is asking for action from others with respect to the vessel.</td>
<td>“Could you please arrange pilot ladder port side three metres above?”</td>
</tr>
<tr>
<td>Intention</td>
<td>…informs others about immediate navigational action intended to be taken.</td>
<td>“The icebreaker will soon turn to starboard.”</td>
</tr>
</tbody>
</table>
The five most common combinations of message markers used by icebreaker and assisted vessel are listed in Table 5. An instruction to the assisted vessel followed by the icebreaker’s intended movement is a frequent message, e.g. “You can have half ahead and I’m coming astern towards you” or “Keep your engine stopped, I will pass you and we will meet starboard – starboard, keep your engine stopped.” Similarly, general information about upcoming operations followed by an instruction is a recurrent combination, e.g. “And then icebreaker [vessel name] will assist you. But please stand by on this channel, seven seven.”

4.2. HOW is it repeated?

This section describes how the receiver responds to a message. A message that is repeated completely may be paraphrased as long as it carries essentially the same meaning. In contrast, a message only repeated partly lacks one or several elements from the original message. Table 6 shows the responses to messages initiated by the icebreaker; Table 7 provides a similar view of responses made to messages initiated by the assisted vessels. The tables show the overall distribution of responses as well as responses to specific message types. For both vessel categories, less than half of the messages are repeated completely, and a considerable number of messages are only responded to partly. Furthermore, a substantial part of the messages receive nothing more than a simple affirmative or negative response without the appropriate phrase in full, e.g. “Copy that” or “Ok thank you, that’s good to know”; that kind of response signals that the receiver indeed has heard something, but the response offers no reassurance about the understanding of the message. Occasionally, a message prompted a new message in response without responding to the initial message, e.g. “Are you going full ahead?/Ten point five now, speed ten point five”. Finally, in some situations the message did not receive any response whatsoever.

However, a breakdown of the response as a function of message type indicates a disparity. While instructions and questions fairly often prompt a complete response, information and intention do not. Instead, affirmative, single worded responses are much more common and used in response to roughly half of those messages. Finally, it should be noted that when the original message by an icebreaker includes more than one message type, a larger proportion of the responses include only partly repeated messages, compared to messages of single message types. However, a closer examination reveals that when several message types are used together, if one of them is an instruction, that instruction is very often repeated while nothing else is. For example, the message “Then you keep your speed and course [instruction] and I will alter to port a little bit [intention]” typically prompts the answer “We keep course and speed [response to instruction but not to intention].”

4.3. Is it confirmed?

This section describes the last phase of closed-loop communication, in which the correctness of the receiver’s reply is confirmed by the sender. There are numerous ways this confirmation can be done during icebreaker operations. One way to indicate the correctness of a message is to repeat the message once more, or conclude with a direct phrase.
like “Yeah, that’s right”. More subtle ways include responses such as “Very good” or “Thank you”. Table 8 shows that in the majority of the loops, the receiver’s response is left unconfirmed by the sender.

However, the confirmation rate in Table 8 shows the number of confirmed responses in the complete data set. This means that occasionally, messages that were partly repeated or only received an affirmative “ok” as a reply were confirmed as well. The number of instances where an ideal closed-loop cycle was used, i.e. a message was repeated completely and the correctness of that reply was confirmed, was substantially lower (Table 9).

### 5. Discussion

The aim of this study was to describe the use of verbal communication between the vessels involved in icebreaker operations. This was done by analysing 40 days of communication and quantifying the message elements according to the closed-loop communication structure.

It comes as no surprise that the distribution of message initiation is uneven, with more messages initiated by the icebreaker (72.1%) than the assisted vessels (26.7%). This does not necessarily mean that one party does most of the talking. It does mean, however, that the icebreaker is in charge of the operation and as such, takes a leading role in deciding appropriate actions and providing necessary information and instructions. The difference in message types used by different vessels (Table 4) illustrates this point. During the early stage of an operation, the icebreaker informs the assisted vessel about the task at hand, asks questions if additional information is needed and then gives direct instructions during the following operation. The assisted vessel offers information about its present situation and asks questions for clarification. When several message types are used in combination, most of the time that combination includes an instruction and either information or intention. Mixing several phrases into one message is contrary to theIMO (2001) recommendation of providing one phrase for one event. However, whether unintentional or not, this deviation might not be entirely negative. Supplementing an instruction with one’s own intention could be a way to validate the instruction; by providing a fuller picture, it is possible that the receiver is more likely to understand the instruction correctly, and adhere to it. This could also enhance team situational awareness (Grech et al., 2008) with the potential to increase maritime safety (Sandhåland et al., 2015).

### Table 8

<table>
<thead>
<tr>
<th>Amount of messages</th>
<th>Icebreaker</th>
<th>Assisted vessel</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Yes</td>
<td>507</td>
<td>29.5</td>
</tr>
<tr>
<td>No</td>
<td>1214</td>
<td>70.5</td>
</tr>
<tr>
<td>n = 1721</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 7

<table>
<thead>
<tr>
<th>How is the message repeated?</th>
<th>Total n (%)</th>
<th>Instruction</th>
<th>Advice</th>
<th>Warning</th>
<th>Information</th>
<th>Question</th>
<th>Answer</th>
<th>Request</th>
<th>Intention</th>
<th>Several types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completely</td>
<td>810</td>
<td>498</td>
<td>5</td>
<td>0</td>
<td>51</td>
<td>145</td>
<td>0</td>
<td>2</td>
<td>37</td>
<td>72</td>
</tr>
<tr>
<td>Partly</td>
<td>363</td>
<td>40</td>
<td>1</td>
<td>1</td>
<td>41</td>
<td>27</td>
<td>0</td>
<td>2</td>
<td>6</td>
<td>245</td>
</tr>
<tr>
<td>Yes/No/Ok</td>
<td>456</td>
<td>99</td>
<td>2</td>
<td>1</td>
<td>138</td>
<td>34</td>
<td>0</td>
<td>2</td>
<td>76</td>
<td>104</td>
</tr>
<tr>
<td>No answer</td>
<td>40</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>New message</td>
<td>52</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>6</td>
<td>0</td>
<td>6</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

*In 159 out of 245 responses to messages including several message types, only the instruction was repeated and not rest of the message.

### Table 9

<table>
<thead>
<tr>
<th>Initiator</th>
<th>Total number of messages sent</th>
<th>Amount of messages completely repeated...</th>
<th>...and confirmed</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Icebreaker</td>
<td>1721</td>
<td>810</td>
<td>47.1</td>
</tr>
<tr>
<td>Assisted vessel</td>
<td>637</td>
<td>277</td>
<td>43.5</td>
</tr>
</tbody>
</table>
interpretation include background noise and other disturbances. Finally, in some cases people simply speak incoherently. These issues are not the result of study design; people on board are likely to suffer from these consequences as well. These examples are similar to wrongful interpretation of intonation patterns as discussed by Bocanegra-Valle (2011), and the use of message markers could reduce this problem. Unfortunately, very few message markers were observed in the data material. During the 40 days that the communication was recorded, spoken message markers were used less than 20 times to emphasise the intent of a spoken message.

The SMCP mandates that when an instruction or an advice is given, the reply should be a fully worded response with the same meaning as the message. The same is applicable to yes-no question (IMO, 2001). The SMCP does not provide further guidance regarding appropriate responses to other types of messages. Nonetheless, since research suggests that closed-loop communication has positive benefits in both maritime (Proholdt, 2016; Grech et al., 2008) and medical contexts (El-Shafy et al., 2018; Schuenemeyer et al., 2017), it would be wise to make use of it even when not regulated. Still, the results of this study show a difference in the way responses are given. For example, when replying to a message initiated by the icebreaker, instructions (74.7%) and questions (67.8%) indeed prompt a complete response at a much greater rate than information (20.6%) or messages with several message types (16.5%). Nonetheless, even in the categories where response rates are relatively high, they are far from perfect and the fact remains; during icebreaker operations, it is not uncommon to receive only a partial response, a single yes or no, or even no response at all. Even though this study does not address underlying causes for this, a pragmatic explanation could be that the higher response rates for instructions and questions stem from the fact that those messages often are coupled with an action. The receiver of an instruction is being influenced to act, and ignoring an instruction is not an option since that will inevitably be apparent to the sender; thus, the compliance of closed-loop becomes higher. A similar pattern is observed when examining responses to messages containing several message types. When replying to a multi-type message from the icebreaker, more than half of the responses (56.2%) only repeat the message partly. Nonetheless, when one of several elements in such a message is an instruction, that instruction is indeed repeated at a much higher rate than the rest of the message. Therefore, in a compound message, the instruction is given more attention than other message elements. Worth noticing, however, is that there might be situations where closed-loop communication is too time consuming, and disregarding from using closed-loop communication might have a positive effect on safety. For example, SMCP stipulates that messages of certain types should be repeated fully. Perhaps a better requirement would be that the situation at hand, i.e. the risk level, should decide the appropriate response to a message. A flexible situation-based communication structure, rather than an inflexible one, might be suitable for any operation with fluctuating intensity, e.g. aviation, military, or emergency first response.

However, the results clearly show that there is a gap between the communication protocol set in SMCP and actual communication procedures, as discussed above. Findings from nearby maritime domains might explain this deviation. Manson et al. (2017) found that some VTS operators had been discouraged from using SMCP since, according to some pilots’ views, that was not considered correct maritime communication. Furthermore, Manson et al. (2017) also reported that previous experience from working together facilitated better coordination; conversely, Boström (2018) concluded that infrequent personal interactions potentially impede cooperation. Following that logic, being used to cooperate might allow some leeway regarding the compliance of communication protocol. Brodjé et al. (2013) reported that trust was an important element; when trusting the bridge team, VTS operators assumed that the other party had a clear understanding of the situation and sometimes chose not to share information to avoid being superfluous. As VTS and icebreaker operations share some operational aspects, it is possible that trust plays a similar role during the latter as well. After assisting a merchant vessel for several hours, the officers on both vessels get accustomed to each other, offering a good basis for trust.

With reference to Schramm’s model of communication (1971), the closed-loop can finally be assessed in its entirety. The VHF communication can be viewed as a circular flow of messages with verbal feedback. An outgoing message can be said to represent an idea that the sender wants to transmit to the receiver, e.g. to influence the behaviour of that person. If the original message is viewed as being completely undistorted, the subsequent steps in the closed-loop risk diluting the meaning of the message, or at least the assurance of the message being received properly. Ideally, the response mirrors the original message completely, but as Tables 6 and 7 show, that is not always the case. A weaker response, e.g. one that only partly confirms the original message or a simple yes–no answer, offers lower reassurance to the sender that the message has been properly received. Similarly, the absence of a final confirmation of the response (Table 8) makes the receiver less confident as to whether the message has been interpreted correctly or not. If the steps in the closed-loop are not followed, the message grows weaker. Following this logic and referring to Table 9, one could say that a message with an original strength of 100%, after the message has been repeated (or not) the strength has been reduced to 47.1% for messages initiated by an icebreaker, and after the response has been confirmed (or not), the strength is as low as 16.4%. Similar, but slightly lower values apply to messages initiated by assisted vessels. Here, it must be stressed that a substandard response or the absence of a confirmation is no absolute indication about whether the message has been interpreted according to the sender’s intention or not. It does, however, worsen the odds.

For a long time, it has been acknowledged that misunderstandings when speaking through a VHF radio have been the main, or contributing, cause to accidents. Consequently, effective use of maritime English is essential to ensure the safety of human life, vessel and environment (Bocanegra-Valle, 2011). Communication failure, leading to a loss of situational awareness, is frequently associated with human error accidents (Sandahländ et al., 2015), and effective use of closed-loop communication has been suggested to support team situational awareness (Grech et al., 2008).

6. Conclusions

The present study describes how closed-loop communication is used in communication within the context of icebreaker operations. While previous studies mainly have used qualitative measures to investigate interaction and communication, this study adds a new dimension to the joint knowledge of maritime communication: a quantitative description of a substantially large data set. While other studies have described how people perceive communication from different perspectives, this study illustrates what is observable, and together they complement each other. The results show that closed-loop communication is not used to its full extent, and that the extent to which it is being used varies with message types. However, the overall results clearly confirm the discrepancy between actual language use and recommended standardization that has been shown in previous research. The structure of safety related communication is important, and more communication does not necessarily lead to better communication, improved situational awareness or teams that are more effective. In a nutshell, the results indicate that people need to speak better, not more.

The study, as designed, offers a comprehensive description of communication practices centred around one icebreaker. However, the same design also poses a limitation that calls for future research. First, since only one icebreaker is studied the level of generalizability should be controlled for by studies on other icebreakers. Second, a thorough, qualitative analysis of the same or a similar data set could provide answers to whether certain phrases or terminology are more susceptible
to misunderstandings. Third, this study has described practices of closed-loop communication but has not addressed its effectiveness. Further studies could measure performance outcomes, for example linking communication procedures to accidents or operational delays. Finally, as shown by previous research, theoretical knowledge and practice does not always go hand in hand; simply knowing about the language protocol recommended by SMCP does not necessarily result in a suitable behaviour. Therefore, a fourth suggestion is to study the effects of maritime language training and how long-lasting language acquisition is achieved.

In this study, vessels involved in icebreaker operations have played an important role as study objects. However, the findings are not limited to those operations. On the contrary, they extend to other domains within the maritime business, as well as beyond. The scope of interest could be extended to any situation where interpersonal interaction is required, and there is limited leeway for irregular operations caused by verbal misunderstandings. Other domains within the transport sector, process manufacturing and control room operators, military personnel and medical staff are just a few operatives that could benefit from cross-fertilization of communication research. The icebreaker used in this study simply serves as an example. Nonetheless, during icebreaker operations, it is crucial to get the message across; when following an icebreaker, which unexpectedly comes to a halt just 500 m ahead, their instructions need to be transmitted, interpreted and executed without any delay.

References

Froholdt, L.L., 2016. I see you on my radar!: displays of the confirmatory form in maritime teleologically mediated interaction. Sociological Rev. 64, 468–494.