Meteorological and sea ice services in the Arctic: How fisheries and cruise actors address risk in their decision

Sarah Pötter

Faculty of Law School of Humanities and Social Sciences University of Akureyri 2018
Meteorological and sea ice services in the Arctic: How fisheries and cruise actors address risk in their decision

Sarah Pötter

30 ECTS thesis submitted in partial fulfilment of the degree of Master of Arts in Polar Law (MA)

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Faculty of Law
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Akureyri, 14 June 2018
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Abstract

This study works towards a wider understanding of the specific role of weather and sea ice information services in decision-making processes in Arctic navigation. It focusses on the cruise and fishing industry.

Due to climate change, the ice cover in the Arctic is retreating, creating opportunities and challenges for maritime operators.

The Arctic inhabits relatively uncertain conditions such as sea ice, fog, waves and wind which a captain needs to handle. The cruise tourism industry and the fishing industry have different approaches to address those challenges by means of available weather and sea ice information services in their planning of voyage itineraries and in the operational phase.

With limited electronic communication systems in the higher Arctic, reliable and up-to-date weather and sea ice information are rare, making navigating in the Arctic a safety concern.

There are public and private producers of weather and sea ice information services in the Arctic available, indicating little information on the expectations and needs of the end users onboard of cruise and fishing vessels. Interviews with captains from cruise and fishing vessels were conducted, addressing the role and handling of weather and sea ice information services and the need and requirements for such information services. The results showed that, for both industries, weather and sea ice information services play a crucial role in the decision-making processes while navigating in the Arctic. Better weather and sea ice information services are needed to minimise risks in navigation.

Furthermore, knowledge, experience and skills of a captain are crucial. The competences of the captain are closely connected to the risks taken and accordingly to guarantee safety at sea. Safety regulations and laws especially tailored to the Arctic need to be enforced. Enhanced training and knowledge transfers of captains, especially in the cruise tourism industry need to be solved.

Keywords: Arctic, Navigation, Cruise, Fishery, Climate Change, Decision
To the ones who motivate and inspire me
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AECO</td>
<td>Association of Arctic Expedition Cruise Operators</td>
</tr>
<tr>
<td>AHDR</td>
<td>The Arctic Human Development Report</td>
</tr>
<tr>
<td>AMAP</td>
<td>Arctic Monitoring and Assessment Programme</td>
</tr>
<tr>
<td>ASIP</td>
<td>Research on automated sea ice products</td>
</tr>
<tr>
<td>CIRFA</td>
<td>Centre for Integrated Remote Sensing and Forecasting for Arctic Operations</td>
</tr>
<tr>
<td>DMI</td>
<td>Danish Meteorological Institute</td>
</tr>
<tr>
<td>DNV-GL</td>
<td>Det Norske Veritas and Germanischer Lloyd</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross domestic product</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>HF</td>
<td>High frequency</td>
</tr>
<tr>
<td>IAATO</td>
<td>International Association of Antarctica Tour Operators</td>
</tr>
<tr>
<td>ICG</td>
<td>Icelandic Coast Guard</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organization</td>
</tr>
<tr>
<td>JRCC NN</td>
<td>Joint Rescue Coordination Centre of Northern Norway</td>
</tr>
<tr>
<td>LNG</td>
<td>Liquefied natural gas</td>
</tr>
<tr>
<td>MARPOL</td>
<td>International Convention for the Prevention of Pollution from Ships</td>
</tr>
<tr>
<td>MET NORWAY</td>
<td>Norwegian Meteorological Institute</td>
</tr>
<tr>
<td>NEP</td>
<td>Northeast Passage</td>
</tr>
<tr>
<td>NORDREG</td>
<td>Northern Canada Vessel Traffic Services</td>
</tr>
<tr>
<td>PAME</td>
<td>Protection of the Arctic Marine Environment Working Group</td>
</tr>
<tr>
<td>PAX</td>
<td>Passengers onboard a vessel</td>
</tr>
<tr>
<td>POLAR-TEP</td>
<td>Polar View Earth Observation Limited</td>
</tr>
<tr>
<td>PWOM</td>
<td>Polar Water Operation Manual</td>
</tr>
<tr>
<td>SALIENSEAS</td>
<td>Enhancing the saliency of climate services for marine mobility sectors in European Arctic seas</td>
</tr>
<tr>
<td>SAR</td>
<td>Search and Rescue</td>
</tr>
<tr>
<td>SEDNA</td>
<td>Safe maritime operations under extreme conditions Arctic</td>
</tr>
<tr>
<td>SOLAS</td>
<td>International Convention for the Safety of Life at Sea</td>
</tr>
<tr>
<td>STCW</td>
<td>The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers</td>
</tr>
<tr>
<td>TTX</td>
<td>Table Top Exercise</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
</tr>
<tr>
<td>UUV</td>
<td>Unmanned underwater vehicle</td>
</tr>
<tr>
<td>WMO</td>
<td>World Meteorological Organization</td>
</tr>
<tr>
<td>VHF</td>
<td>Very high frequency</td>
</tr>
</tbody>
</table>
Acknowledgements

I would like to acknowledge several people who are important for this research, helping me on my way, advising me and without whose help this work would not have been possible.

I am extremely grateful to Dr. Maaike Knol and Professor Gunhild Hoogensen Gjørv who supervised this master’s thesis. I owe Maaike and Gundhild great appreciation for their support, their ideas and the fact that their doors were always open for me. Both provided me with constructive feedback and comments which were helpful to modify the research, helping me on my way. I appreciate the effort and time you took to provide comments and to discuss my problems and concerns about this thesis.

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Especially, I want to thank all my interview respondents for making time and the provided trust, sharing their opinions, feelings and comments about weather and sea ice information services in the Arctic. Your contribution is highly appreciated- this study would not have been possible without you.

Furthermore, I want to express my big thanks to my friend Meike, who is always there for me when I need her the most. Thank you for your patience and friendship.

Eventually, I want to thank my parents who generously supported and financed my studies.
1 Introduction

This study works towards a wider understanding of the specific role of weather and sea ice information services for Arctic navigation in the cruise and fishing industry. It assesses the role those services play in governing the activities of fishing and cruise captains taking place in the Arctic environment.

The changes in environmental conditions impact economic activities in the Arctic. The increased accessibility of the Arctic provides opportunities as well as risks for maritime activities.

With limited electronic communication systems in the higher Arctic, complete and up-to-date weather and sea ice information are rare, making navigating in the Arctic a safety concern. This thesis is addressing this safety issue by exploring how the two different industries are using weather and sea ice information services in decision-making processes in their planning and operational phase and how it relates to the ships captain’s perception of risk.

The Arctic has been considered as one of the last frontiers, undergoing rapid changes particularly in the past two decades. The transformational changes that take place in the Arctic region are combining the effects of climate change and the technological progress. This allows the increase of commercial opportunities in various sectors and businesses such as the energy, shipping, tourism and fishing industry. However, the opportunities pose simultaneously substantial risks for the maritime actors planning to conduct activities of any kind in such latitudes.

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1 J Morison and others, ‘Recent environmental changes in the Arctic: A review’ (The Arctic Institute of North America 2000); JE Overland and others, ‘The Immediacy of Arctic Change: New 2016-17 Extremes’ (American Geophysical Union 2015).
Despite the many uncertainties about the future of the Arctic, it is certain that climate change is going to shape the future of the Arctic, environmentally and economically.³

The Arctic is sovereign to Canada, the USA, Russia, Norway and Denmark (Greenland). The Arctic itself is defined in numerous different ways.

One definition denotes the Arctic as both land and sea north of the Arctic Circle, above 66° 33’N.⁴ Alternatively, the Arctic Human Development Report (AHDR) defines the Arctic as an area of 40 million km², acknowledging Arctic societies, consisting of people sharing similar cultural and social habits and utilizing the same area for economic purposes.⁵ According to the AHDR, the Arctic includes the area above 60° N, which comprises northern Canada, Greenland, Iceland, The Faroe Islands, most of the Nordic states (Norway, Sweden, Finland), large parts of Russia and Alaska in the USA.⁶

The Arctic Monitoring and Assessment Programme (AMAP) covers in their definition on the Arctic the same geographical area as AHDR but includes marine areas. A combined map of the three definitions can be found in Figure 1.

³ Ibid., 8-19.
⁵ DK Müller, Issues in Arctic Tourism in B Evengård and others (eds), The New Arctic (Springer International Publishing Switzerland 2015).
Additionally, the term Arctic waters can be found in literature, especially when dealing with maritime activities. Arctic waters are defined by the International Maritime Organization (IMO) as the waters surrounding: Greenland, Svalbard, Jan Mayen, Bjørnøya, the northern shore of the North American and Asian continent as far south as latitude 60° N.\(^7\)\(^8\)

---

An illustration of the described area can be found under chapter 4.2 Risk mitigation-The introduction of the Polar Code.

The Arctic is changing and one major reason for this is climate change. Hence, the region is transformed. The Arctic is warming up approximately twice as fast as the rest of the world, causing melting of sea ice, snow covers and of glaciers. The effects of such rapid melting are felt around the globe as the melting of the Arctic is impacting and changing weather and climate patterns and is responsible for sea level rise.  

Further, the thickness of the sea ice in the central Arctic Oceans has declined by 65 percent since the 1970’s. Arctic sea ice can be distinguished from other types of ice because sea ice is defined as freezing ocean water that forms into floating ice, whereas ice shelves, glacier ice and ice sheets are formed out of freezing precipitation on land. The maximum amount of sea ice in the Arctic can be found in March, marking the end of an Arctic winter. Naturally, in the following summer months, the cover of sea ice will minimise, having its lowest amount in September. In the past years the overall extent of sea ice in the Arctic has drastically declined. In 2017, the Arctic sea ice extent was registered to be record low, since the beginning of satellite observations in 1979. This decline in sea ice primarily results from increased greenhouse gas emissions fostering climate change.

Further, the proportion of sea ice has changed its physical properties. In the winter months in the Arctic, much more sea ice is formed, called first year sea ice, which is melting in the summer months again. This process covers older sea ice with melting ponds. First year ice is to a far greater extent covered by melt ponds than multi-year ice, because the melted water spreads to larger areas. This process creates a feedback loop, resulting in the inability of sea ice and snow to reflect the solar energy (albedo), the melting process continues. The consequences of this changing sea ice are enormous. Thinner and less compact sea ice accelerates its transportation, fostered by wind and ocean currents and the general change of sea ice structure is altering the Arctic Ocean in respect of habitat characteristics. Further, the amount of sea ice in the winter months will decline too, but respectively slower than in the summer.14

Even if expectations and projections with climate models shows a practically ice-free summer by the middle of the 21st century, the Arctic Ocean will still have periods where it is covered by sea ice.15 However, the Arctic Ocean will eventually open and become more accessible to economic actors which could potentially and to some extent already are enhancing its economic exploitation. Climate and environmental changes will coinstantaneous entail socio-economic changes to the Arctic.

A major increase in Arctic maritime activity will be seen in the shipping industry, where shorter routes for trade will play a far greater role to optimise time and shipping costs. Furthermore, the tourism industry, especially the cruise industry is expected to grow.


Vessels without and light ice class\textsuperscript{16} will be limited to seasonal activities. Approximately until 2050, the Arctic Ocean is predicted to be inaccessible during the winter months.\textsuperscript{17}

A potential winner of the altered ecosystem could be the cruise industry which is thriving to expand their undertakings to new Arctic destinations.\textsuperscript{18} Like the cruise ships, fisheries could benefit from it. With shrinking ice cover and a general trend of warming of the oceans a shift in the ecosystem will occur, eventually presenting new fishing grounds.

With far more vessels operating in polar waters, the IMO has issued ‘The International Code for Ships Operating in Polar Waters’, hereinafter referred to as Polar Code, to react on the international concern of protecting the polar environment and the safety of seafarers and passengers. By introducing the Polar Code, all ships operating in those extreme and challenging polar waters must comply with the guidelines. The Polar Code entered into force on 1\textsuperscript{st} January 2017, setting mandatory standards (see chapter 4.2 Risk mitigation-The introduction of the Polar Code).

The ongoing opening of the Arctic Ocean to possible economic use poses numerous open questions that are not yet satisfactorily dealt with. Such concerns include the ecological impact of increased activities as well as aspects of safety and disaster management.

One major aspect of safety concerns the liability of weather and sea ice information services in the Arctic. Due to this rapidly changing environment, weather and sea ice information services, are currently uncertain and unreliable. The constantly changing conditions of weather and sea ice alter the risks in Arctic navigation. In the Arctic, the forecast systems are lacking, and improvement is necessary.\textsuperscript{19}

\textsuperscript{16} The ice class defines the vessels capability of navigating in sea ice. The ice class is defined based on technical aspects of a vessel as rudder strength and hull strength, enabling it to navigate in different types of ice. The ice class of a ship is assigned by a classification society.


\textsuperscript{18}DNV-GL, Exploring the Arctic (2017) Cruise Update 2017, 13

\textsuperscript{19}Alfred Wegener Institute, Climate researchers are pursuing better ice and weather predictions for improved safety in the Arctic and Antarctic (15 May 2017)
Currently, expensive equipment and automated weather stations transferring real time data on temperature, wind and barometric pressure are transmitted to weather stations around the world, though the weather services found in the Arctic are poor. Therefore, in order to minimise the level of risks occurring in the Arctic from human activity, better forecasts for weather and especially sea ice are required. This could be achieved by enhancing observation efforts and modelling.\textsuperscript{20}

Accordingly, this study aims to contribute to a better understanding of weather and sea ice information services in the Arctic and how those services are used by cruise and fishing captains in decision-making processes. Thereby, practice theory will enable me to analyse the three elements of meanings, competences and materials. Practice theory will be used to assess the operating in the Arctic and to evaluate how weather and sea ice information services are used onboard the different vessels (cruise and fishing). Hereby, practice theory is utilized to describe on what decision-making processes are based and how risk is handled by captains of vessels.

Overall, Beck’s risk society will be used as framework for defining risk. By analysing decision-making, it is possible to integrate uncertainties, characterize the hazards in the planning phase and during the voyage. Decision-making in risk situations presents a method to process a decision according to a fundamental understanding of safety, serviceability and durability when navigating in sea ice in the Arctic. More precisely, this study will emphasize how those two groups of stakeholders address the risks of navigating in the Arctic, with unreliable weather forecasts that are not regularly updated on an hourly, daily or even weekly basis.

\begin{table}
\caption{Comparison of decision-making approaches in the Arctic}
\begin{tabular}{|c|c|c|}
\hline
\textbf{Stakeholder Group} & \textbf{Decision-Making Approach} & \textbf{Risk Handling} \\
\hline
Cruise Captains & \multicolumn{2}{|c|}{\textit{Safeguarding}} \\
\hline
Fishing Captains & \multicolumn{2}{|c|}{\textit{Adapting}} \\
\hline
\end{tabular}
\end{table}

\begin{thebibliography}{9}
\bibitem{awi} Beck’s risk society will be used as framework for defining risk. By analysing decision-making, it is possible to integrate uncertainties, characterize the hazards in the planning phase and during the voyage. Decision-making in risk situations presents a method to process a decision according to a fundamental understanding of safety, serviceability and durability when navigating in sea ice in the Arctic. More precisely, this study will emphasize how those two groups of stakeholders address the risks of navigating in the Arctic, with unreliable weather forecasts that are not regularly updated on an hourly, daily or even weekly basis.

\end{thebibliography}
The resulting research question is as follows:

*How do industrial actors (fishing industry and cruise tourism industry) in the Arctic address the risks related to weather and sea ice conditions in a context of ongoing climate change?*

This question will be assessed by (i) identifying how cruise and fishing actors utilize weather and sea ice information services in their practice, (ii) which weather and sea ice information services are used and (iii) how risk in the Arctic affects decision-making practices onboard of cruise and fishing vessels.

The thesis is relevant in terms of creating an insight into risk and decision-making of captains operating in the Arctic. Captains of cruise and fishing vessels, operating in the Arctic must deal with uncertainties, inconsistent and irregular forecasts for certain regions in the Arctic, dealing with the overall present risk of their operations. This is of even greater importance for new players in the Arctic who are attracted by the new access.
2 Methodology

The objective of this study was to assess the decision-making processes of two maritime based actors, in this case the cruise and fishing industry, in the Arctic and how they address the risk related to weather and sea ice conditions. The main source for this study were qualitative interviews held with relevant people who are or were occupied in either Arctic fishing or cruise sector. In this chapter, my approach to this study and the interviews will be presented alongside with a description of further use of methodology and the use of secondary sources.

2.1 Justification of research approach

The thesis addresses the utilization and need for weather and sea ice information services among captains of cruise and fishing vessels in their decision-making processes, operating in the Arctic. I choose to study the fishing and cruise sector more intensively due to their assumed differences and inconsistencies. First, they exploit Arctic resources differently: the fishing sector actively removes resources whereas the cruise operators indirectly exploit the nature and uniqueness of the area. Further, they differ in size. Cruise ships carry thousands of people who, in a worst-case-scenario, would need to be rescued, while fishing vessels are often staffed with fishermen who know how to handle the risks themselves. Moreover, they have a different perception of risk and a different approach towards the decision-making processes. Hence, it is assumed that they also utilize weather and sea ice information services in a different way.

Both sectors will play an important role in using the Arctic economically in the future. Fishing has been conducted in Arctic waters during a long period of time, whereas the cruise sector is a respectively new player in the Arctic due to the opening of the region related to climate change. However, both activities are affected by external circumstances in the Arctic (e.g. climate change and consequently unpredictable weather conditions) which requires personal commitment and individual approaches to reduce risk and uncertainty.

To me, a qualitative research approach based on individual experience and opinions therefore seemed appropriate to understand the decision-making
processes in relation to the use of weather and sea ice information services by captains onboard fishing and cruise vessels in depth.

2.2 Empirical data collection

Several different approaches to the qualitative data collection were used, including interviews, secondary sources and personal observations.

Interviews

In the following, I will outline my approach to the interviews, by firstly describing the applied interview structure, ensued by a specification of the selection of the interview partners and my interaction with them. Further, I will outline the analysis of the interviews.

Qualitative semi-structured interviews

The research questions were explored by applying the technique of semi-structured interviewing, producing data in form of detailed answers of the respondents to the questions. Accordingly, in-depth qualitative interviews were conducted to collect the data, obtaining a complete picture of the current situation of weather and sea ice information services in the Arctic, to map problems and needs of end users and to understand how decision-making is practiced onboard fishing and cruise vessels in relation to risk.

For conducting the semi-structured interviews an interview guide, containing a list of 11 questions, was used by the researcher. The interview guide was prepared before the first interviews were conducted and can be found in Appendix A. Most interviews lasted between 30-50 minutes. The interviewing structure allowed me, the researcher, to guide the interview and cover the topics by the questions asked.
The flexible approach of the technique presented sufficient opportunities and leeway to the interviewee to elaborate on what he or she considers relevant as well as to give examples and views from their own experience, which is essential for this study.\textsuperscript{21} The flexible framing helps to understand how an interviewee emphasis on issues and events are important in understanding patterns and behaviour of the interview partners.\textsuperscript{22} Question may be asked in a different order than outlined in the interview guide but by and large, all questions will be asked. The wording of the interview questions is similar for all interviewees.\textsuperscript{23} Questions, which are not included in the interview guide, may be asked by the interviewer ‘to pick up on things said by the interviewee’.\textsuperscript{24}

Selection of the target groups

I chose to focus on two groups in this study to make a comparison of the different uses of weather forecasts and sea ice information services onboard vessels operating in the Arctic. I decided to research the cruise and fishing industry, because cruise tourism in the Arctic is increasing and the fishing industry is understudied in terms of their use of weather and sea ice information services and both are and will be important players in the Arctic. The cruise industry, especially the adventure cruise tourism sector, was studied earlier by Paula Duske in 2016, a former master student at the Wageningen University, one of the relevant documents used in this research. However, Duske’s study did not include interviews with cruise captains which I regarded as a limitation because, the captain is the person in command of the vessel, crew and passengers and has ultimate decisions-making power. Therefore, the interviewees for this study were selected based on their position onboard of cruise or fishing vessels that operate fulltime or seasonally in the Arctic. I made it as a requirement that the respondents had higher officers ranks onboard, preferably a captain’s patent or a chief mate, also called first officer.\textsuperscript{25}

\textsuperscript{21} E Drever. \textit{Using semi-structured interviews in small-scale research: a teacher's guide.} (Scottish Council for Research in Education SCRE Centre, 1995).
\textsuperscript{22} A Bryman, Social Research Methods (5\textsuperscript{th} edn, Oxford University Press 2016).
\textsuperscript{23} Ibid 471
\textsuperscript{24} Ibid 471
\textsuperscript{25} The person, second in command of the vessel after the captain.
The study made no requirements to the captains in regard to their years of experience in Arctic navigation. No special gender or age group was preferred for this study. However, the gender ratio was 1:8 (female: male). It would have been desirable to have a balanced ratio of 1:1 to additionally research on potential differences of female and male captains operating in the Arctic.

Approaching the interview respondents

The contact with practitioners was primarily established through my personal effort and network, but also via the supervisors of this master’s thesis, Dr. Knol and Professor Hoogensen Gjørv, who provided in total two interview contacts. I approached the potential interview participants either via email or reached them by phone. Based on their replies, an interview date was agreed on. The interviews were either conducted in person or by telephone. All interview participants from the fishing industry were primarily approached by telephone, because I was lacking their email addresses. All other contacts were approached by email.

In total nine semi-structured interviews were conducted. In Table 1, which can be found below, an anonymised list is presented to examine the interviewed participants. The table states the position of the interviewee, the type of company they work for and their total years of experience in navigation. Two of the interviewed captains (number 4 and 5) had nothing or only limited contact with the cruise or fishing industry but it was chosen to include them in the study because of their long-term experience as captains sailing worldwide and being specialists in ice navigation at the poles. One of them has long term experiences in being a captain of an icebreaking vessel, owned by a Federal Government. The nine interview respondents were from Germany, Norway, the Faroe Islands, Denmark, France, New Zealand and Canada.
Table 1: Overview of interview respondents

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Position</th>
<th>Type of company</th>
<th>Years of experience (as captain*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Captain</td>
<td>Fishing</td>
<td>more than 30 years*</td>
</tr>
<tr>
<td>2</td>
<td>Captain</td>
<td>Fishing</td>
<td>27 years*</td>
</tr>
<tr>
<td>3</td>
<td>Captain</td>
<td>Fishing</td>
<td>25 years*</td>
</tr>
<tr>
<td>4</td>
<td>Master Mariner</td>
<td>Naval, Merchant Shipping, Coast Guard</td>
<td>40 years*</td>
</tr>
<tr>
<td>5</td>
<td>Icebreaker captain</td>
<td>Merchant shipping, State owned research vessel</td>
<td>31 years*</td>
</tr>
<tr>
<td>6</td>
<td>Chief officer/Chief mate</td>
<td>Cruise</td>
<td>5 years</td>
</tr>
<tr>
<td>7</td>
<td>Captain</td>
<td>Cruise</td>
<td>more than 13 years*</td>
</tr>
<tr>
<td>8</td>
<td>Captain</td>
<td>Cruise</td>
<td>18 years*</td>
</tr>
<tr>
<td>9</td>
<td>Captain</td>
<td>Cruise</td>
<td>2 years*</td>
</tr>
</tbody>
</table>

All interviewees were informed about the topic and purpose of the study prior to the interview. On request, the interview guide was emailed to two participants beforehand. The respondents were asked, prior to the interview, if the researcher was allowed to record the conversation with a mobile phone.

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26 A master mariner is a qualification, generally considered to denote an individual who has obtained a Certificate of Competency as “Master Mariner” that qualifies them to command ships of unlimited tonnage anywhere in the world. Email from David Snider to author (5 May 2018).
Analysis of the interviews

All nine semi-structured interviews were fully transcribed. Out of the nine semi-structured interviews, five were carried out in person while the remaining four interviews were conducted via telephone.

Firstly, the interviews were transcribed in Norwegian, English or German, depending on the language that was used during conducting an interview. Direct quotes were used in the presentation and analysis of the results. The quotes from interviews presented in this thesis that were not hold in English, were translated by the researcher. The direct quote of the interviewee is referred to in a number in parentheses in the thesis.

The information of the interviews was collected and coded. The coding of answers conducted by semi-structured interviews requires the reading and rereading of the interview transcript to distinct codes and themes of the interviewee’s response.27 Going through the answers several times, helps to employ a basis for coding and to feed it into an excel spreadsheet to get a better overview of the obtained data. By consciously reviewing the transcribed results, a form of categories was developed. The themes of this study were developed based on recurring topics in the transcript. Categories that identified the use-, needs- and problems with weather and sea ice information services, practice theory, operational decision-making practices, etc. were established. Further, the categories were placed into context to each other, trying to identify the connections among the different themes as suggested by several authors.28 The retrieval for similarities and differences in response was applied which requires a systematic approach and is called the ‘constant comparison method’ by Glaser and Strauss.29 Further, the results of the data analysis of the interviews was supplemented by secondary sources.

Secondary sources

To supplement the collected primary data of interviews, secondary information sources were consulted. Those sources were also examined for the corroboration of statements, events and issues mentioned by the interviewees.

Information were gathered from reviewing literature including material such as online publications of papers, books and reports as well as unpublished papers and book chapters and confidential documents which were kindly made accessible to me. The most relevant documents and books that informed this research empirically were the following:

- Lloyds 2012. Arctic Opening: Opportunity and Risk in the High North
- Paula Duske 2016. The role of biophysical information in Arctic Expedition Cruising.

Further, I was able to gain information on the utilization of weather and sea ice information services at the Arctic Frontiers Conference in Tromsø, Norway. The conference took place from the 21\textsuperscript{st} - 26\textsuperscript{th} of January 2018 addressing the topic of Connecting the Arctic. At the conference I collected valuable background information for the thesis based on workshops, presentations and personal conversations with people from the industry and science community. I especially benefited from the stakeholder workshop on ‘Arctic Sea Ice Prediction’. It helped me to understand the challenges future sea ice conditions and accurate weather forecasts display for the industry and policy makers.
Observations

Normally, observations refer to the direct investigation of a phenomenon in the field. I was not able to make direct observations onboard a cruise or fishing vessel. I was only able to make observations at the Third Joint Arctic Search and Rescue (SAR) Workshop & Table Top Exercise (TTX) in Reykjavik, Iceland. From April 10-11, 2018, I was granted an observer status at the workshop and TTX. The event is a co-operation project between the Association of Arctic Expedition Cruise Operators (AECO), the Icelandic Coast Guard (ICG) and the Joint Rescue Coordination Centre in Northern Norway (JRCC NN). A broad group of representatives from cruise industry, experts of the Search and Rescue community and academia were gathered. At the TTX, all participants of the conference contributed to the solution finding process of a specific maritime scenario in the Arctic with a cruise ship involved. At the workshop I was able to make observations about the different aspects of Arctic navigation from the perspective of cruise operators, SAR responders and MET services which was very informative for this research. Further, two spontaneous interviews with cruise captains were conducted at the conference.

Data Triangulation

The different approaches of data collection resulted in data triangulation. Data triangulation denotes the use of multiple methods to collect data on the same topic to examine the research question and to ‘enhance confidence in the ensuing findings’. Bryman argues that a social research may suffer from limitations if only one research method is applied, and that using data triangulation offers an enhanced confidence in the research results.

31 Ibid.
To gain understanding of the different perspectives of the research topic (the use of weather and sea ice information services, the material, competences and meanings involved, decision-making processes, etc.) and to validate the research through utilizing different methods of data collection, data triangulation seemed appropriate for this research. Silverman argues that in combination with positivism, interview data can be examined with a realistic approach.\textsuperscript{32}

I used data triangulation to assure the quality and validity of the research by using different methods to collect data: interviews, secondary sources such as literature review and a conference and my own observations (Fig. 2). By utilizing data triangulation, I could build up and increase my knowledge on the topic and explore it from various perspectives.

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\textsuperscript{32} D Silverman, \textit{Doing Qualitative Research} (3rd edn, Sage Publication Inc. 2009).
Methodological issues

As a novice researcher with limited knowledge in conducting research, especially in performing semi-structured interviews, it may be that I encounter various problems during the research.

For interviews conducted via the telephone, problems such as a bad connection or the missing facial expression of the interviewee, leading to different interpretations of the response, could be encountered by the researcher. This enhances the importance of an audio record which enables me to audit the interviews if required.

Further, it may occur that interviewees digress from the actual research question where it is important for the quality of the data to guide the interviewee back to the posed question. It may be challenging for me to interrupt the interviewee, especially via phone where no mimic and gesture can be encountered. Accidentally interrupting the interviewee during the conversation via telephone can also easily occur and possibly understood by the interviewee as rudeness. This would not only breach the flow of conversation but would also offend the interview partner. Accordingly, I need to be patient but also able to guide the interview.

Also, it could occur that in some interviews I will not be flexible enough to react on responses immediately asking follow-up questions which might limit the research. In general, it is important to be non-judgemental and objective towards the response of the interviewee which is a challenge to every researcher.33

When applying coding, I might encounter difficulties in organising the different themes into the appropriate category which can lead to a different interpretation of results. Due to the nonexistence fixed method of how to analyse interview data it may happen that the results affect the quality of this study which may differ to other researches in this field.34

Ethical consideration

Ethical considerations must be expected when undertaking qualitative studies in order to provide trustworthy results.\textsuperscript{35} I faced ethical challenges at all stages of the thesis, from the planning phase to the reporting of the results. Issues such as confidentiality, anonymity and the potential of the researcher of impacting the respondents and \textit{vice versa} were considered.\textsuperscript{36}

I explained to every interview respondent the purpose for this study and offered to send them the report after approval. I asked each interviewee for their consent to record the interview with my mobile phone. All my interview respondents agreed to the recording. Furthermore, I explained to each interviewee that their response will be transcribed but anonymised in the study. Most of my interviewees did not wanted to be anonymised but for convenience all have been. The recordings on my mobile phone and computer will be deleted when completing the study. The recordings were transferred to my computer for transcribing purposes only.

I preferred no special gender or age group in this study and no ethnical group was discriminated or excluded from the study.

Limitation and weaknesses in the methodology

The study has limitations and weaknesses in several aspects. As I outlined earlier, being a novice researcher is partially a limitation to the study, because I encountered the common problem of what Silverman outlines as the ‘[...] the problem of failing to explicate to the reader what is [...] obvious [to the researcher]’.\textsuperscript{37} I was an outside researcher, entering a field that I have not worked with in prior studies. I gained more inside knowledge during the time of conducting research. In course of writing this thesis, however, I was consumed by the topic and its information flows. Consequently, I might have missed to explain some information that seemed logic and obvious to me.

\textsuperscript{36} Ibid.
\textsuperscript{37} D Silverman, \textit{Doing Qualitative Research} (3rd edn, Sage Publication Inc. 2009).
Alasuutari frames this limitation more detailed: ‘Researchers always become more or less blind to their texts and thoughts, so that they do not notice that they have failed in spelling out certain premises or starting points […]’.

Additionally, this can have influenced or even flawed my data analysis.

Further, this research has a data constrain. Due to a lack of contacts to the cruise industry and time constraints, only a small group of cruise captains were interviewed. This resulted into a restricted access of information which needs to be overcome on further studies. Additionally, more captains of fishing vessels could have been interviewed to make the results more valid and reliable. It was possible for me to identify patterns for both interview groups of cruise and captains of fishing vessels, but the research group was too small to study behaviour and different personality types to make assumptions on how these correlates to certain decision-making practices.

The study was not restricted to a specific region in the Arctic, which might limit the possibility of presenting a trend in the cruise and fishing sector for a particular region.

The live observation of practices and decision-making processes of the captain onboard fishing and cruise vessels would have been optimal in order to study practices and use of weather and sea ice information services effectively by applying Davide Nicolini’s zooming technique to study a practice. However, due to a lack of contacts, financial support and mostly due to time constraints live observation was not possible. Moreover, in correspondence to my expectations, conducting interviews by phone was challenging. In some cases, a bad phone connection complicated the understanding and equally required clarification from my side of the given answers of the interviewee.

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3 Theoretical framework

In this study, I apply a combination of concepts and approaches. The concept of Ulrich Beck’s risk society is used as overall theoretical condition for analysing the role of weather and sea ice information services for cruise and fishing industries operating in the Arctic. Further, I will explore the role of risk and uncertainty in the decision-making context. Practice theory will be applied to analyse the use of weather and sea ice information services in planning and operational practices of the cruise and fishing industry in the Arctic. Especially the practice theory of Elizabeth Shove will be used to explore the elements of ‘meanings, methods and competences’ in weather and sea ice information services which are used onboard. This framework will create an understanding of weather and sea ice information services used onboard, the role of those information and systems for navigation and how information is used in decision-making processes in both industries. In the following chapter, I will first introduce different perceptions of risk and accordingly define risk for this study. Further, I will present Beck’s risk society theory, followed by an introduction to Practice Theory. Lastly, I will introduce decision-making and its relevant theories ensued by a description of the conceptual use of all theories in this thesis.
3.1 Introduction

In today’s world of globalised trade and travel, the maritime industry in the Arctic is subject to a wide range of different risks, uncertainties, vulnerabilities and threats. The seafarers of cruise and fishing vessels can be affected by risks in many ways.\(^{39}\) In literature, various definitions of risk are available.\(^{40}\)

A clear definition of risk cannot be presented due to a lack of agreement on one definition by the research community. The lack of agreement makes it a rather complex process to gain adequate understanding of the concept. Therefore, a more detailed discussion on risk will be take place at the beginning of the chapter.

Defining Risk

The different definitions of the term ‘risk’ in literature and dictionaries vary and are ambiguous.\(^{41}\) Due to the maritime context of this study, the definition of the IMO provides a departure point. The IMO characterizes risk as ‘the combination of the frequency and the severity of the consequences’.\(^{42}\) However, this is a very broad definition, and ‘the frequency of consequences’ may be manifold in the Arctic due to the challenging conditions that can be encountered in this changing environment.


Thus, in the interest of presenting a more adjusted and semi-complex definition of risk that is relevant for the Arctic, the definition provided by the United Nations Environment Programme (UNEP) will be preferred. The UNEP defines risk as:

[T]he probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable conditions.\(^3\)

Regarding navigation in the Arctic, both cruise and fishing vessels encounter risks, which can result in consequences such as collision, fire, loss of power or grounding of a vessel due to an iceberg or an uncharted rock.\(^4\) Those hazards can ultimately lead to a worst-case scenario with the loss of life(s) onboard fishing or cruise vessels. In the Arctic, every human operation and being is naturally exposed to risk, due to the harsh climate.

### 3.2 The Risk Society by Ulrich Beck

The risk society concept developed by sociologist Ulrich Beck describes the appreciation of risks in the modern Western society and how society encounters and manages risks.

Beck argued that the modern Western societies of the 20th and 21st century are increasingly constructed around and affected by new qualities of risk, which have not existed before. Society is at a transition from an industrial society towards a risk society. This transition developed as ‘an inescapable structural condition of advanced industrialization’. Beck argues that the process of modernisation and transition initiated the development of man-made risks. Those risks and their effects are not restricted by national and geographical boundaries.

\(^3\) UNEP, Disaster risk management for coastal tourism destinations responding to climate change (UNEP 2009).

\(^4\) Y Bai, ‘Formal safety assessment applied to shipping industry’ in Marine Structural Design (Elsevier Ltd. 2016).
The increasing uncertainty and unpredictability of risks makes it difficult for science and technology to calculate, assess and effectively respond to the effects of such risks. The risk society is the product of the technological progress and acts just like a double-edged sword: people thrive for progress and reduction of uncertainty by developing new technologies but at the same time the new technology creates new risks which requires scientific solutions to limit and manage the negative side effects of those novel risks.\(^4^5\)

Beck states that the industrial society believed in technological development which embraced progress while in the risk society, technological development does not only mean progress. Technologies replace development with concerns of risks that emerge from those processes.\(^4^6\) In other words, society is in a new phase of modernity, where technologies not only present solutions but also create new problems.

Beck argues that risks are universal and stretch globally. Society cannot escape from risks. During industrialisation times, the wealthy part of society could avoid risks better due to their financial situation. For example, the wealthy people would not live close to the industrial plant but rather move away to not get affected by the smoke and other pollutants of the plant. In a risk society it is not possible to escape from those risks. Everybody is exposed to risks, independent of social class and wealth.

In the risk society, most risks that are present are human generated and likewise the risk and its effect are more significant. Beck argues that those human generated risks cannot be identified easily without the use of science as risks can be undetectable. For instance, climate change would not have been detectable and comprehensible for the for society. Solely by using everyday senses it might have been possible to understand that a change in weather patterns occurs but to sense its full extent requires a lot of complex technical equipment in order to assess the global changing climate and assess the human influence.

Another aspect of risks is that their results are irreversible. Once the effects emerge, suitable solutions are rarely found. Further, the risks in the modern society cannot be directly perceived.

The risks are too complex for an individual to be comprehended. Science and technology can help to reveal risks. It is too complex for an individual to perceive certain risks such as the full extent of climate change and science is needed to reveal the risks.

People who encounter risks due to technology advancement do no longer trust institutions to be able to handle these risks that arise from the technological progress. However, risk the society is continuously searching for new technological methods to assess risks.

Further, Beck claims that scientific experts and institutions are unable to cope with the variety of risks arising from technological development. He furthermore elaborates that the risk society is the ‘development of modern society in which the social, political, ecological and individual risks created by the momentum of innovation increasingly allude the control and protective institutions of industrial society’.47

Additional, institutions and experts are failing to present effective approaches to risk problems, which is leading to a decline of trust into those institutions by the risk society. Institutions, which are supposed to control and manage risks, lack the ability to predict those risks properly and do not have appropriate solutions to address the new risks. Society becomes disaffected by experts and institutions, which were supposed to give trust and legitimacy. The new risks have qualities that are not as controllable as those previously encountered by the society.

With the uncertainties of the modern world, when rationality and security cannot be guaranteed by key institutions any longer, other actors start to feed new knowledge and information to society. Accordingly, today’s society is oversaturated with an abundance of information, much more than society is able to cope with.48

48 T Aven and O Renn, Risk Management and Governance (Springer-Verlag Berlin Heidelberg 2010).
Moreover and importantly, the availability of scientific information increases, but there is a gap between the knowledge produced and its relevance.\textsuperscript{49} Thus, the society is constantly confronted with risks with little effective knowledge regarding how to address them.

According to Beck, science always plays an important role for the development in society. Through scientific experts and institutions, risks are communicated to the public. Therefore, Beck is arguing that science is not only defining risks but is also part of the debate of risk in the society. He states that scientific experts and institutions manufacture risks and are ‘no longer seen only as instruments of risk management, but also as a source of risk.’\textsuperscript{50}

The modern society is generating a new form of debate about the definition of risks and their evidence. This can be encountered nearly every day in newspaper headlines on any issues society can think of. Climate change is just one example of many kinds (genetically modified crops, nuclear power, etc.)

The risk society reacts differently to constantly being at risk through either apathy, denial or transformation of the present risks. The risks in the Western civilisation, if observed from the outside, are characterized as a kind of luxury risk in comparison with Africa or the Middle East. This indicates that risk is, to some extent, a socially constructed phenomenon. Further, risks cannot be reduced to only the probability of occurrences as described by the UNEP.

### 3.3 Practice theory

The utilisation of practice theory enables me to examine how the use of weather and sea ice information services are embedded in the cruise and fishing activities in the Arctic. By applying practice theory, it is possible to research the different elements that define a practice. My approach to the use of weather and sea ice information services through practice theory, gives an insight on how the data is utilized by the captains, and actions are shaped by their use of the material.

By analysing the use of weather and sea ice information services onboard fishing and cruise vessels the material context is highlighted.

\textsuperscript{49} CJ Kirchhoff and others, Actionable Knowledge for Environmental Decision Making: Broadening the Usability of Climate Science (Annual review 2013)

\textsuperscript{50} U Beck, ‘Living in the world risk society’ (2006) 35(3) Economy and Society

<https://doi.org/10.1080/03085140600844902> accessed 12 February 2018
Practice theory explained

Practice theory is studying human behaviour. It discusses the constellation of material utilized activities. Further, the approach foregrounds humans use of materials, how humans make sense of materials, and posits that the routinized and habitual nature of human actions are important.

In sum, the approach of practice theory is describing important features of a practice made by humans utilizing tools and routine in a discourse.\(^{51}\)

Originally, the key concepts of practice theory derived from Pierre Bourdieu and Anthony Giddens. A unified practice theory does not exist.\(^{52}\) The term practice theory rather umbrellas numerous theories, views and approaches developed by theorists such as: Davide Nicolini, Elisabeth Shove, Theodore Schatzki and Andreas Reckwitz, to only name a few.\(^{53}\)

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\(^{51}\) D Nicolini, Practice Theory, Work & Organization (1\(^{st}\) edn, Oxford University Press 2012).

\(^{52}\) Ibid.

What are practices

Practices are structured actions, implying a pattern in behaviour of an actor. Such a pattern can be seen in the way of experiencing, thinking, knowing or in executing a practice. Further, practices can be described as ‘organized regimes of activity and knowledge that provide a particular way of interpreting the world’.

Within practice theory, the focus is not based on studying the individual and its motives for behaviour and activities. It rather analyses how people behave in particular situations and moments. Reckwitz defines practice as:

[R]outinized type of behaviour which consist of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, things and their use, the background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge.

Practices become routinised for a human when they have been successfully performed over time. Normally, humans tend to switch to an “automatic pilot“ system when they are routinised in a practice, feeling confident about the execution of a practice. This limits the cognitive mobility, meaning a loss of mental flexibility in handling a situation.

If a practice is then disturbed, de-routinised or collapses due to shifting or changing conditions, the ability of acting routinised in a situation is no longer taken-for granted. Further, when new ideas or objects are brought into a practice, de-routinisation of a practice occurs.

Deviating from routinised processes requires experience and creativity. Such a creativity of a captain is required when the circumstances change, such as in the Arctic environment.

**Zooming in and out of practices**

Davide Nicolini applied the notion of the ‘zooming’ practice. Basically, the practice of zooming can also be considered a method. In this study, both types of zooming in and out were utilized. Nicolini suggested to ‘zoomed in’ on details which are indispensable to perform a practice, to get engaged and to take a closer look at social practices.\(^6\) Through interviews with captains, I could have zoomed in on their practices regarding the utilization of weather and sea ice information services. A more detailed zooming into the practice of captains would only have been possible by being onboard a cruise and fishing vessels for observation purposes. This would require much more ethnographic work. By zooming out the practice of using weather and sea ice information services, it allows me to place the practice of captains into a broader context. By using zooming, a comparison can be drawn of the utilization of weather and sea ice information services for the two groups. Further, differences and similarities of the practice in utilizing weather and sea ice information services for cruise and fishing vessels can be analysed. Zooming allows me to understand the practice more detailed and enables me to connect it to the broader context of this study, by means of the risk society. Furthermore, a more in-depth view on the practices two maritime actors in the Arctic is gained.

**The concept of elements**

For this study, the approach of practice theorist Elisabeth Shove will be used. Shove identifies three elements that are relevant to practice theory: material, meanings and competences. I considered it to be beneficial for this study since it combines three elements which are vital and interrelate in a practice. The dimension of materials encompasses technologies and materialistic objects, supporting the practice of a captain.\(^7\) Examples of materials would include the vessel itself and navigational devices such as computers, radar and satellite systems and other equipment used onboard.

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\(^7\) G Spaargaren and others, ‘Practice Theory and Research’ (1st edn, Routledge 2016).
Obviously, with the absence of the material element, the execution of a practice, especially in terms of safe navigation at the sea, would be much more challenging. The captain relies on the devices and equipment used onboard for navigation and manoeuvring the vessel. However, material elements might not always fully function, influencing the performance of a practice by de-routinising the practice.

The element of meanings stands for ideas, aspirations and emotions. The captain is in that sense the carrier of a practice. It is significant how and why certain information, systems and services are used and how this connects and influences the decision-making process.

The element of competence refers to the knowledge, skills, technique and know-how of an individual. For instance, how much practice a captain has in navigating in the Arctic, the practice of using weather and sea ice information services and the approach on how to deal with navigational challenges is part of the competences.

This study intends to understand elements of material, meanings and competence more nuanced with regard to how weather and sea ice data are connected to the actor’s actions. By utilizing the three elements and analysing their interrelationship, information can be obtained about the use of weather and sea ice information services. It is therefore interesting how this information is used onboard for planning and operational decisions-making processes. Further, the importance of this information for a captain navigating in the Arctic will be understood more in depth.

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The practice theory in time and space

Another approach used in this study was developed by Theodore Schatzki. He introduced the concept of ‘timespace’. Schatzki argues that timespace is a key concept that elaborates on the idea that human action has a history, which means that it happens in a setting and at the same time is future oriented.\(^\text{59}\) Further, adhering to rules and safety measures in time and space are outlined by Schatzki as ‘explicit formulations, principles, precepts and instructions that enjoin, direct or remonstrate people to perform specific actions’.\(^\text{60}\) In the following it was chosen to illustrate the concept of timespace for the two maritime actors.

If a captain of a cruise or fishing vessel receives a weather forecast information indicating strong winds, likely to bring multi-year ice towards the vessels, the decision must be flexible in time and in space. The captain must evaluate the future conditions (the time until the sea ice will reach the vessel) from the present information and assess the possible actions (do I need to navigate to a different place because my ship cannot tolerate the approaching type of sea ice). Hereby, the action of the captain should consolidate what is considered to be most appropriate in terms of a practice, risk mitigation as well as safety practices and standards in the fishing or cruise sector. The action of a captain takes place and is future oriented.

Rules and safety measures are vital in order to mitigate risky situations, especially in the Arctic environment.

Application for this study

For this thesis it is essential to understand how practices onboard cruise and fishing vessels precondition, develop and affect each other and what role interdependencies between material (weather and sea ice information) and activities (navigation in Arctic areas) play in constituting a practice.\(^\text{61}\)


The weather in the Arctic is a medium that has the power to change the practice of an actor by limiting or enabling a practice. Within a practice, the need to react to sudden weather and sea ice conditions are crucial and requires the modification and adoption of new practices. Through rapid changing weather and sea ice conditions in the Arctic due to climate change, the importance of material arrangements is emphasized. The meanings of a material entity are derived from its use in practice.

Further, practices compromise a routinization, indicating a certain way of how humans deal with the material element. Navigation in the Arctic represents a shift in practice and structures onboard of cruise and fishing vessels. Both captains of cruise and fishing vessels are confronted with navigational challenges. For example, a captain who has navigational skills in the Caribbean Seas cannot be compared with the navigational requirements of a captain who is operating in the Arctic, although both have the patent to navigate. Background knowledge, know-how and understanding are crucial elements, described by Anthony Giddens. He describes those competences as the ‘practical consciousness, deliberately cultivated skill, or as shared understandings of good or appropriate performance’.  

In terms of navigating in the Arctic, the know-how and practical knowledge are essential as well as the ability to read, interpret and use weather and sea ice schemes to make appropriate decisions. The ability to interpret and understand the weather, is considered a lifetime skill.63

Moreover, the perception of weather and sea ice is different by the actors, as they might perceive weather events differently. Different weather conditions such as ice, snow, rain, fog, etc. can be perceived differently by the cruise and fishing actors. The different perceptions influence, alters and guides the practice. Especially in cruising, different perceptions and interests can occur and clash with the adopted practice as the following example illustrates.

The captain of a cruise vessel decides to avoid the ice in a particular situation, whereas the expedition leader would have liked the idea of bringing the passengers of the cruise closer to the ice. Human beings are part of the biggest asset in the practice, due the ability of logical thinking, leading to a decision-making process, albeit, knowledge and experience cannot be only obtained by training in other environments.

This knowledge and ability to interpret weather is formed by experience, skills and the nautical education that every captain obtained. However, no practice in interpreting Arctic weather and sea ice charts is included in the nautical education. Overall, the consistent training in the use of weather and sea ice information data is considered beneficial towards the practice of navigating in the Arctic.

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64 P Duske, ‘The role of biophysical information in Arctic Expedition Cruising’ (Masterthesis, Wageningen University 2016).
3.4 Decision-making

In the following, examples of maritime accidents will be given to illustrate the importance of decision-making and the human factor influencing a decision. Further, decision-making theory will be explained and its relevance for the research will be emphasised on.

Zero risk does not exist

Within the maritime industry, most participants are continuously faced with making difficult decisions. Hazards such the presence of sea ice make the situation of navigating in the Arctic a demanding undertaking for every captain. Accidents such as the descent of the Titanic, Deepwater Horizon (Macondo), Piper Alpha or Exxon Valdez can be outlined as the catastrophic examples of human failures with extensive consequences. Approximately 65 percent of all catastrophic marine related accidents are the result of errors and mistakes by human(s) during an operation. Therefore, it is important to assess the risks of decision-making practices in order to overcome catastrophic accidents in the marine environment of the Arctic.

Decision-making theory

There are various theories and views found on decision-making. Decision-making theories are analytical tools to guide choices. Generally, decision-making processes depend on environmentally conditions, quality of available information and the knowledge and understanding of the decision maker. Numerous aspects define decision-making, such as the decision maker is influenced by his or her aims, values and believes. Hence, the better the latter factors, the more optimal the decision and the uncertainty decreases.

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To reduce uncertainty, tools are needed to collect, analyses and sample the information available to make a decision. Within decision-making, different or alternative decision can be taken. When an action offers two or more alternatives, decision-making takes place. However, the choice between the different alternatives does not characterize the quality of the alternatives offered. Those alternatives basically can be divided into two main categories. For one type of decision, the consequences are known. Those decisions are called deterministic. Consequently, if decisions are made in uncertainty, the decision maker only knows part of the potential consequences that can occur, the decision is defined as probabilistic. In most cases decisions are made under uncertainty of the outcome of a decision.

One theory of decision-making is about rational decision-making. The central principle of rational decision-making is the logical consistency of the decisions regardless of how available choices are offered. Rational decision-making is prescriptive, aiming to develop methods and models, aiming for the optimal decision. Bazerman describes the rational decision-making process as ‘logically expected to lead to the optimal result, given an accurate assessment of the decision makers’ values and risk preference.68 Further, the tactic taken towards a decision are made on a step-by-step approach, with all relevant objectives taken into account. All aspects and their interrelationship towards a problem must be considered. This process presupposes the ability of the decision maker to be able to rank the different aspects and interrelations influencing the decision, in order to choose the optimal decision. However, no decision can ever be made fully rational as emotions influence the individual. The study by De Matino and others claim that emotional processes are of importance in human choice processes.69

The decision process is influenced by the risk preference of the decision maker. De Martino and others argues that ‘intuitive or emotional responses can play a key role in human decision-making’.70

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70 Ibid.
Consequently, the human factor is of importance in the decision-making process. Hence, the rational decision process is affected by the individual and depends on the individual understanding of the situation connected to the different knowledge, skill and competence of a person. A more experienced individual is able to make rational decisions faster compared to a novice in a certain environment. This is based on the obtained knowledge, skills and experience during time.\textsuperscript{71}

When decisions must be taken in a complex situation with incomplete available data, the “rule of thumb” or different alternative approaches must be taken. Here the naturalistic decision-making approach is applicable. When making a decision, the individual follows different strategies, depending on their personality. One individual might be risk aversive while others are aiming to encounter the risk. Within those two types, it is either chosen to avoid risks that could potentially harm or have negative consequences or the risks that are taken are identified by the individual as being positive and worth the risks.

To a certain extent, naturalistic decision-making, hence experience-based decision-making, is completed by a captain.\textsuperscript{72} Contrary to rational decision-making, the naturalistic approach concentrates on the decision maker, faced with limited resources and time in a complex situation.\textsuperscript{73}

The naturalistic theory takes a descriptive approach, aiming to understand how decision are made in an environment.\textsuperscript{74}


\textsuperscript{72} CE Zsambok and G Klein, \textit{Naturalistic Decision Making} (1st edn, Lawrence Erlbaum Associates 1997).

\textsuperscript{73} MA Rosen and others, Expertise and Naturalistic Decision Making in Organizations: Mechanisms of Effective Decision Making In: The Oxford handbook of organizational decision making (1\textsuperscript{st} edn, Oxford University Press 2008); A Intezari ‘Wisdom and Decision-making: Grounding Theory in Management Practice’ (DPhil thesis, Massey University 2014)

\textsuperscript{74} MH Bazerman and DA Moore, Judgment in Managerial Decision Making (8\textsuperscript{th} edn, John Wiley & Sons 2012); A Intezari ‘Wisdom and Decision-making: Grounding Theory in Management Practice’ (DPhil thesis, Massey University 2014).
Further, the theory seeks to describe how time and space are important for the decision-making process in an environment.\textsuperscript{75} In a descriptive approach, decisions are partly made based on the decision makers intuition and perception of a situation.

In this thesis rational and non-rational decision-making are combined. Contrary, intuitive decisions require flexibility and creativity of the decision maker. Klein and Weiss argue that intuitive decision-making is appropriate for unconventional situations and environments, such as the Arctic, whereas purely rational decisions require the accurate data.\textsuperscript{76} However, Simon argues that purely rational decisions, in a complex world of modernity, are impossible due to the human influence that can never be completely rational and without any emotions, values, believes and desires.\textsuperscript{77}

\textsuperscript{75} LR Beach and T Connolly, \textit{The Psychology of Decision Making: People in Organizations} (2\textsuperscript{nd} edn, Sage Publications 2005).
3.5 Conceptual model

A structural outline of the general theoretical approach is illustrated in Figure 3.

The framework of this thesis is Beck’s risk society, is presented in the upper section of the figure. Within Beck’s risk society, the risks will be examined and analysed more in depth by applying practice theory. The practice in connection to the utilization of weather and sea ice information services by captains of fishing and cruise vessels will be explored. Further, the role of weather and sea ice information services in planning and operational decision-making will be examined, as visualized on the right-hand side of the figure. Accordingly, by using decision-making theory, the aspect of understanding the practice in a risk society, in the context of the two maritime industries (fisheries and cruise actors) in the Arctic, will be assessed.
The Fishery and Cruise sector in the Arctic: a background

The activities ongoing in the Arctic waters, such as fishing, cruising, cargo shipping and scientific research, are as diverse and complex as the region itself. The diminishing sea ice and decreasing ice coverage means in no terms easier voyages. For all maritime operators in the Arctic, the risks are complex and amplify another, making it difficult to manage. The huge variation in geography and conditions such as different kinds of floating ice and ice cover pose various challenges in the remote Arctic to both the fishing and cruise industry. Incomplete or lacking weather forecasts and accurate sea ice data for parts of the Arctic enhance the risks that must be expected when navigating in the Arctic. With more extreme weather events, the occurrence of higher waves as well as floating icebergs and sea ice ridges must be studied and understood carefully by any maritime industry, authority and society wishing to operate in the Arctic. I chose the fishing industry and the cruise tourism industry as actors for this research due to their current and potential future importance as economic stakeholder. This chapter will give background information about the two groups to provide general knowledge about both industries as well about the risks of shipping in the Arctic and to enhance the understanding of this thesis.

4.1 Risks of shipping in the Arctic

The risks of shipping in the Arctic is manifold and mostly related to the cold and harsh climate. Besides the weather conditions itself causing problems with safe navigation, sea ice is a major threat for vessels. Further, the low temperatures have a high impact on the material mounted to a vessel such as radars or antennas which can be covered by ice. Marine icing can also dangerously impair safety equipment such as rescue boats and influence stability. To avoid problems such as icing, most cruises take place during the summer months of June, July, August and September. There, the mild temperature prevents or diminishes the risk of icing.
Nonetheless, the extension of seasons for all actors could extend and vessel might go further north which likewise enhances the chance of encountering risks not yet fully understood.

Risks in the Arctic for the cruise industry is affected by different factors. Technology, the physical structure of the vessel and the material used as well as the environment and the humans, both the crew and the passengers have indispensable roles in risk handling and decision-making. Especially weather forecasts and sea ice data are enormously important. The crew and the captain onboard a cruise vessel need the best available data to safely navigate their ship and the passengers through the ice, but the route always also depend on the skills of the crew as well as the desires of the passengers. The customer onboard a cruise vessel wants to experience the Arctic as presented in magazines and brochures advertising cruises, without considering the danger it inherits. The level of satisfaction of passenger’s onboard cruise vessels is depending on ‘the consumer’s overall assessment of the utility of the product based on the perceptions of what is received and what is given’. This definition emphasises on what is sold to the cruise passenger in advance, based on brochures, pictures, etc. and how the cruise meets the perceptions of the passengers during the voyage. This puts pressure on the captain and crew to manoeuvre the vessel safely, through sea ice conditions to satisfy the passengers.

Further, the Arctic Council argues that climate change might increase the uncertainty of decision-making processes by maritime operators. Accordingly, accurate and consistent information on weather and sea ice conditions is needed to avoid navigational risks in the Arctic. Both industries require that information for their activities but especially in the cruise sector the information of sea ice and weather forecasts are crucial, because the cruise industry has scheduled routes and wants to encounter sea ice, whereas the fishing industry is much more flexible in terms of planning and adhering to a schedule. However, not only the quantity and quality of information has to be adequate, but also the skills of crew and captain to understand the information is vital.

The World Meteorological Organization (WMO) outlined that the improving quality of weather and sea ice information services in remote and changing marine environments is highly necessary for maritime operators to operate safely.\textsuperscript{80} However, availability of weather forecast, and sea ice data is limited and incomplete in some Arctic areas, due to reduced satellite coverage and the general lack of observations. The reduced satellite coverage limits not only the possibility to make accurate forecasts, especially for sea ice, it also challenges communication media such as internet or phone coverage above 72° North. This is caused by limited observing capacities of satellites covering the Arctic area. Better satellite coverage would lead to better observations, which can be useful for running better models to develop better forecasts in the Arctic. For now, less efficient systems are used causing further risks.\textsuperscript{81} Furthermore, the risks connected to navigating in the Arctic is increased due to incomplete hydrographic charts, presenting a huge safety issue. Even with the technology in 2018 like satellites, unmanned underwater vehicles (UUV), buoys, etc. it seems paradoxical that the surface of Mars and the moon are better mapped than the seafloor of the ocean.\textsuperscript{82} The reduced coverage combined with the lack SAR forces and assets in the Arctic is influencing the decision-making process onboard. Every operational decision-making process of the captain is hereby influenced by the thought of the consequences an incorrect decision in remote Arctic areas might result in, where SAR response forces or another vessel might be far away. Hence both actors operate in areas where risks are a part of their daily working business.

\textsuperscript{81} Email from Rachael Lorna Johnstone to author (13 March 2018).
4.2 Risk mitigation- The introduction of the Polar Code

Maritime activities in the Arctic are expected to grow in the years to come, especially with the exceeding sea ice opening. To manage these activities and the increase in vessels operating in the polar waters the IMO, enforced the Polar Code to protect the life of seafarers, workers, passengers and inhabitants of the polar environments. It is especially important for the cruise industry which is why I will give an introduction to the Polar Code in the following section.

The Polar Code is applicable to both the Arctic and Antarctic, two polar areas with different characteristics. The Polar Code recognises those differences and notes: ‘measures to be applied in Antarctic waters need not necessarily be required in Arctic waters and vice versa’.83

The Polar Code was developed by the utilization of a number of non-mandatory guidelines and recommendations, such as:

- The International Code of Safety for Ships in Polar Waters
- IMO Guidelines for Ships Operating in Arctic Ice Covered Waters
- Enhanced Contingency Planning Guidance for Passenger Ships Operating in Areas Remote from SAR Facilities
- IMO Guide for Cold Water Survival
- Guidelines on Voyage Planning for Passenger Ships Operating in Remote Areas.84

Those latter documents set a standard for polar operations to increase the safety of the ship, people and the environment. On 1 January 2017, the Polar Code entered into force through amendments under International Convention for the Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL), which are the most relevant international documents setting international rules and regulations.85

83 IMO ‘Report of the Maritime Safety Committee on its Eighty-Sixth Session’ (12 June 2009) MSC 86/26 para. 23.32.
The Polar Code covers only passenger and cargo vessels and does not apply to fishing vessels. Special requirements for fishing vessels are intended to be developed, but at a later stage.\textsuperscript{86}

The IMO defines Arctic waters and the applicability of the Polar Code as indicated in Figure 4.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure4.png}
\caption{Application for Polar Code in Arctic waters\textsuperscript{87}}
\end{figure}

The Polar Code sets mandatory standards as, for instance, the technical minimum standards for design, construction and capability of vessel going to Arctic and Antarctic areas.

\begin{itemize}
\item Regulations of Polar Shipping In: The Law of the Sea and Polar Regions (Martinus Nijhoff Publishers 2013)
\item International Maritime Organization ‘International Code for Ships Operating in Polar Water (2017) MEPC 68/21/Add.1 Annex 1012 p9
\end{itemize}
Further, it promotes maritime safety through minimum standards for the training of crew, SAR capabilities and equipment used onboard, albeit there are doubts if adequate lifesaving equipment exists. Additionally, gear and equipment must be approved for the use in cold temperatures, ensuring that the crew is able to operate the gear, even when wearing cold weather gear. By applying the minimum standards of the Polar Code, the ship gets roughly 200 tonnes heavier, costing the industry space and raises financial costs. To relate to the risks of operating in Arctic areas and to the capabilities of the vessel in ice conditions, the Polar Code requires a clear indication of awareness by the captains and officers of the limitations of the vessel. It is mandatory for every vessel to carry a Polar Operational Manual (PWOM) onboard, which contains detailed information of the vessel operational capabilities and capacity. This PWOM is intended to support the crew in their decision-making process when operating in polar waters.

Chapter 12 of the Polar Code is of special interest for my thesis. It addresses the training and manning of ‘adequately qualified, trained and experienced personnel’. The experience and knowledge of the captains and officers is a key asset, standardized by the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) and the Polar Code which tailors the training to polar conditions.

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90 DNV-GL, Ready to face the extremes (2017) 2 Cruise Update 2017, 22
92 Ibid 12.
4.3 Arctic marine communication and forecast – from past until today

The communication of weather forecast has followed the technical development from signal flags, via telegram, to radio and TV.\textsuperscript{93} In the following part of the development of weather forecasts will be explained. Meteorology always played an important role in the life of fishing people, determining if the weather would allow them to take out the vessel to fish. Albeit, strong economic reasons and fishing for food security forced fishing people to sail out in stormy weather, taking higher risks to secure their livelihood. Historically seen, the traditional forecasting model developed in the second half of the 19\textsuperscript{th} century.\textsuperscript{94} In the beginning of meteorology at sea, there was mainly a one-way communication between the users and the producers of the weather forecast taking place.

The Norwegian author Narve Fulsås describes this period detailed in his book ‘Havet, døden og vêret’ (engl. title ‘The Sea, death and weather’). He characterizes how the weather forecasts in particular in the North were a deficient service. Firstly, this was the case due to a lack of weather observations especially for the vast ocean areas of the Norwegian coast, Greenland, Iceland and Svalbard. Secondly, within those forecasts an error margin was mostly present, shaping the identity of forecasts.\textsuperscript{95} The opportunity of being able to forecast certain weather events had a high practical significance for fishing people in the North. Ultimately, this led to the fact that also the relation between forecast users, the fishing people and the providers of those weather information services changed. Back in the 19\textsuperscript{th} century fishing people depended on themselves, forced to use their own observations and knowledge on weather phenomena and to make their own forecasts. Hence fishermen were given information but had to interpret them themselves. However, this self-created forecast was based on limited or inefficient weather observation information.

\textsuperscript{93} MET Norway, Været til sjøs (Brukerundersøkelse om maritime værtjenester, MET Norway 2015)
\textsuperscript{95} Ibid.
The situation changed after weather forecast service in the North were established due to a pressure from the supply side (meteorology). It was not demanded by fishing people. In his book, Fulsås mentions that all interest and initiative originated from researchers, driving the development of forecast models. When storm warnings were first established, the fisheries management (Fiskeriforvaltning) in Norway wished to expand the service to the areas at sea. In the beginning of the 1930’s, the radio became the most important wireless medium for the fishing fleet. However, it was problematic to communicate weather forecasts over a larger area, the sound quality was poor, and problems were observed in understanding forecast message.\footnote{Ibid.}

Much has changed in technology since the 19th century in terms of weather and sea ice information services. Nowadays, weather and sea ice information services can be downloaded by the bridge crew onboard a vessel, changing the nature of risk for the vessel being out at sea all year around dependent on catching fish due to economic reasons. However, even if technology has come far in recent years and satellite technology is developing, fishing people, as all other maritime operators, still have to deal with electronic communication challenges, while operating above 70-72° North. The High Frequency (HF) radio and Global Positioning System (GPS) which is a satellite-based radio navigation system, is degraded in those latitudes and further North. This creates issues and limitations not only for electronic communication, but also navigation and SAR capacities. Within the Iridium\footnote{Iridium is a global satellite communication system.} constellation of several communication satellites, communication service in the Arctic is possible but only with a limited bandwidth. Another constraint of Iridium is that it is primarily meant for the communication in emergency situations, but frequently used by both the cruise and fishing vessels to download weather and sea ice information services. Due to sparse weather stations, and satellite constraints, weather forecasts and sea ice data are limited and incomplete.\footnote{M Knol and others, ‘Arctic weather and sea ice information structures: dynamics and drivers’ (2018) FramCentre < https://issuu.com/framcentre/docs/framforum-2018-issuu> p 50-54 accessed}


4.4 The Arctic players: Fishery and Cruise

Humans have been fascinated by the sea. They set sails to explore new parts of the world and to make use of the vast amount of resources the ocean has to offer.99 The human-sea relationship can be arguably described as a love-hate relationship. The sea cannot be controlled by any one and the test on man against the elements was rarely successful in history. Many humans lost their lives at sea but at the same time, the ocean still amazes people, either for pleasure or work purposes such as in the maritime industries of cruise or fishery.

Fisheries in the Arctic

Fisheries in the Arctic are very important and the ecosystem in terms of fisheries is described as ‘one of the most productive ocean areas worldwide’.100 In the Arctic, a high fishing activity is taking place (Fig. 5) but commercial fishing is only regionally concentrated. Historically seen, the Norwegian and Russian fleet were the most active fishing nations.101 These activities vary in size, from large industrial trawlers to smaller vessels.102 Commercial fisheries target 59 marine fish species.103

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Particularly the regions around Greenland, the Barents Sea, Bering Strait as well as Iceland and the Faroe Islands are key areas.\textsuperscript{104} Fishing vessel operating in those waters constitute a large portion of all vessel activity.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5.png}
\caption{Fishing intensity by vessel activity\textsuperscript{105}}
\end{figure}


\textsuperscript{105} Ibid
However, even if Figure 5 displays areas of high fishing vessel intensity (dark purple) the amount of actual activity taking place is most certainly underestimated, due to missing data.\textsuperscript{106}

For example, in the Canadian Arctic the number of fishing vessels represents the largest number of the total vessel traffic as shown in a statistic from Northern Canada Vessel Traffic Services Zone (NORDREG).\textsuperscript{107}

In most Arctic States, the fishing industry was and, in some states, still is an important industry. Historically seen, the fishing industry was the key employer in the Arctic as fishing has a long tradition in Arctic States as a source of food and income. Economically seen, it is crucial for some states. For instance, in Greenland the fishing industry represented a large share of 90 percent of the total export earnings of the Gross Domestic Product (GDP) in 2013.\textsuperscript{108} The development of the Greenlandic shrimp fishery for example did not only have a large impact on the national economy, but also on the coastal communities in terms of jobs and infrastructure development. Likewise, fisheries have a large economic relevance for other Arctic States such as Norway, Iceland and the Faroe Islands which are represented under the Kingdom of Denmark. However, the economic relevance differs for the countries and has changed within recent years, also resulting from a growth in other industries, such as the tourism industry as for example in Iceland. Despite its importance to individual states, Arctic fisheries contributed with less than one percent to the global fisheries in 2016.\textsuperscript{109} This might change in the future when the diminishing sea ice will reveal greater areas of ice free waters which will be available for fisheries. To prevent a drastic increase in commercial Arctic fisheries, in particular in the Arctic Ocean, the central part of the Arctic Ocean was therefore closed to commercial fishing in December 2017. Nine nations and the European Union agreed to ban fishing in the Arctic Ocean for the coming 16 years, at least.

\textsuperscript{106} Ibid.
The area will be subject to various ecological assessments, which will benefit the understanding on how to manage Arctic fisheries in the future. The present fishery in the Arctic is a challenging venture. Depending on the area and season, some Arctic fisheries take place in icy waters or near ice edges which poses a direct risk in the operation caused by ice. Arctic fishers are nonetheless willing to take such risks as part of their work. Overall, both industries are willing to take up the risks inherent in weather and sea ice information data for navigation in the Arctic.

**An introduction to cruise tourism in the Arctic**

In the following, a description of the cruise industry sector will be given. It is focused on how the industry evolved and why especially Arctic cruise tourism is booming.

Experts in the field of tourism have studied the global phenomenon of cruise tourism from multiple angles. Within cruising, aspects of curiosity, freedom and security converge, mirroring the feelings and political context of societies, and led to the creation of a new paradigm. The sea has been and still is fascinating people, being a symbol of power, eternity, and the adventure of the unknown. The modern cruise industry as it is known today, with the huge ships and large number of passengers is roughly 50 years old, however, the tradition goes back more than 100 years when people started sailing with mail ships across the Atlantic.

Modern cruise ships are floating hotels, offering and satisfying the customer with every standards, luxury extras and diverse entertainment offers.

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The numbers of cruise ships sailing to the Arctic or planning to do so in the near future increases drastically.\textsuperscript{113} The Arctic, promoted as one of the last remaining frontiers on earth, attracts an increasing number of cruise passengers. During the last decades cruise tourism boomed and was requested often especially since drawbacks in other tourism industries happened. On the one hand the ‘customers’ appetite’ to cruise grew because of security uncertainty and terror threads in tourism locations such as the Middle East and worries about the flight industries because of incidences such as 9/11. Certainly, the degree of vulnerability within cruising is higher than in other forms of transportation, as the case of the sinking of the Costa Concordia close to the Italian coast illustrates.\textsuperscript{114} Still, people go on cruise as it offers great luxury and a relaxing and active way to travel.

The motivation of cruise passenger traveling to places is a potpourri of different gazes.\textsuperscript{115} Nowadays, the Arctic is considered to be an exotic place and traveling there inherits the prospect of seeing unique places and sites. Additionally, the gaze of the ‘ordinary’ lives of people who live in this different environment from one’s own, seems to fascinate the cruise passenger.\textsuperscript{116} The particular situation in the Arctic, the melting of sea ice and change in nature, attracts cruise passenger wanting to obtain memories for the future of a geographic region, currently undergoing significant changes. A cruise trip to the Arctic is a journey, advertised by tour operators and travel agents as adventure to experience unique and pristine landscape as well as to see local fauna such as the polar bears. The cruise ship operators are competing in visiting wild, undisturbed and remote places in the Arctic where not many tourists have been before them and might never be. Furthermore, it is the ‘the exclusiveness among friends that have similar stories to tell’, as Rachael Lorna Johnstone describes one of the reasons for tourists to go to the Arctic, an expensive destination not able to visit for everyone.\textsuperscript{117}

\textsuperscript{116} Ibid.; Email from Rachael Lorna Johnstone to author (13 March 2018).
\textsuperscript{117} Email from Rachael Lorna Johnstone to author (13 March 2018).
Year by year, the willingness of cruise customers to pay high prices for an exclusive voyage to the Arctic rises which also leads to competition on the market resulting in the new constructions of more and modern vessels that will go to the Arctic.\textsuperscript{118}

The Canadian scholar Michael Byers even refers to Arctic marine tourism as ‘extinction tourism’, contrary to the other definitions naming it ‘adventure tourism’\textsuperscript{119}. The cruising market is trying to satisfy the increasing demand of the paying customers which desire to travel to the Arctic, a place that might be lost sooner than expected. To meet this demand, the cruise industry is issuing more than 20 new ice classed cruise ships that will come on the market within the next years until 2025.\textsuperscript{120}

A decade ago, polar cruising was limited to a small amount of ships, carrying a maximum of 100 passengers.\textsuperscript{121} Due to the increasing demand and the development of the cruise industry sector, the size and type of Arctic cruise tourism vessels are different. It compromises small expedition ships of less than 200 people, to large mainstream cruise liners holding up to 6000 people, passengers (PAX) and crew or more.\textsuperscript{122}


\textsuperscript{121} M Lück and others, \textit{Cruise Tourism in Polar Regions, Promoting Environmental and Social Sustainability} (1\textsuperscript{st} edn, Routledge 2016) ISBN 978-1-84407-848-6 p. 57

An increasing trend of passenger traveling to Svalbard, Greenland, Jan Mayen, Canada and the Russian Arctic can be observed as the statistic shows (Fig. 6). By 2019, close to 35 000 passengers are expected to cruise in the Arctic. In summer 2016 and 2017, two years in a row, a trip to the Arctic with the giant luxury cruise vessel Crystal Serenity, carrying 1070 passengers and 655 crew members each time, was sold out.123 It was the largest cruise passenger vessel ever transiting the North West passage until that day. However, despite all the appealing extras and luxury cruise operators are offering, large vessels going to the Arctic are mostly build for warmer waters as the Mediterranean and lack ice strengthened hulls. In order to satisfy the demanding Arctic cruise market, cruise companies remove those vessels from areas further South and offer sailings to Arctic destinations such as Svalbard or Greenland.124

![Passengers trend and prognostic for the Arctic](ftp://sidads.colorado.edu/pub/projects/noaa/iicwg/IICWG-2017/presentations/Kelley_Polar_Tourism.pdf) accessed 17 May 2018

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123 Email from Rachael Lorna Johnstone to author (13 March 2018).
124 M Lück and others, *Cruise Tourism in Polar Regions, Promoting Environmental and Social Sustainability* (1st edn, Routledge 2016) p. 57
Even if the disaster of the Titanic serves as a rare exception, for now, cruise passengers are rarely worried about the risks an Arctic cruise inherits. It is argued that Arctic cruise passengers maybe choose to ignore the risks they are taking when undertaking a cruise in the Arctic. This might result from the fact that most cruise passengers have an incident free cruise, however, incidents such as ships who ran aground or similar in the Arctic symbolise the risks attached to it. In case a severe cruise accident occurs in the Arctic, it will have a devastating impact on the cruise tourism sector.\textsuperscript{126}

Nonetheless, cruise companies are investing. The French luxury expedition cruise operator Ponant, has ordered the first non-nuclear luxury icebreaker that is supposed to go beyond the ‘known’ areas of the Arctic such as Svalbard. The icebreaker will be the first electric hybrid cruise icebreaker with Natural Liquified Gas (LNG) propulsion and is supposed to be delivered in 2020 and entering the market in 2021. Such a vessel with those features epitomises the exclusiveness of the cruise which is only surpassed by being one of a few people that will reach the 90° north latitude as it advertised on the official Ponant website.\textsuperscript{127}

Yet, the trend of cruise vessels going to the Arctic will continue and some operators might start the cruise season earlier than other operators. Only the non-ice-strengthened vessels will be seasonal, cruising through the Arctic in summer time. This means that many cruise vessels go to the Arctic, carrying thousands of passengers, without being ice strengthened.\textsuperscript{128} Insurance companies such the international classification company Det Norske Veritas and Germanischer Lloyd (DNV-GL) are thriving to make strict standards and conditions for vessels that needs to be insured, in order to minimise their own risks.\textsuperscript{129}

\begin{itemize}
\item \textsuperscript{126} M Lück and others, \textit{Cruise Tourism in Polar Regions, Promoting Environmental and Social Sustainability} (1\textsuperscript{st} edn, Routledge 2016) p. 70
\item \textsuperscript{127} Ponant, ‘Icebreaker Ultimate Expedition’ \texttt{<https://en.ponant.com/ponant-icebreaker/>} accessed 10 April 2018
\item \textsuperscript{128} Email from Rachael Lorna Johnstone to author (13 March 2018)
\item \textsuperscript{129} Ibid.; DNV-GL, ‘Arctic the next risk from Frontier’ \texttt{<https://www.dnvgl.co.uk/technology-innovation/broader-view/arctic/the-new-Arctic-reality.html>} accessed 12 May 2018
\end{itemize}
With the increase in expedition cruises in the Arctic, the Association of Arctic Expedition Cruise Operators (AECO) was established in 2003. AECO is the counterpart to the International Association of Antarctica Tour Operators (IAATO), setting standards in terms of safety and environmental protection measurements. AECO is a voluntary membership association, implementing its own safety and environmental protection measurements which are applicable only to their members. As of June 2018, none of the five largest cruise operators is currently a member of AECO. It remains unknown why this is the case, but it is hardly believed that membership fees and a passenger fees that needs to be paid to AECO are an issue for those big companies. It can rather be assumed that the companies fear a limitation in their self-control and constraints in possible route itineraries or activities when being part of AECO. Additionally, these big companies cannot be classified as expedition cruise operators, which would imply that they would need to operate smaller vessels with a limited number of passengers onboard. However, no parallel development in the emergency prevention, preparedness and response accident is observed, despite the development of some international regulations and agreements, such as the Polar Code and the Arctic Search and Rescue agreement.

The cruise tourism vs the fishing industry

Fisheries is certainly different to the cruise industry not only in terms of planning and the relation to ice. Fishermen have a very different relationship to sea ice then cruise ships; while cruise vessels want to be close to the ice, fishermen want to avoid ice if they can. Especially for the shrimp fishery in Greenland, which operates close to the ice edge, it is challenging to completely avoid the ice. Arctic fisheries can be characterised as opportunistic in nature, trying to immediately exploit the opportunity of catching fish. Additionally, the skipper has only responsibility for the crew, the vessel and the catch when operating at sea.

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130 Email from Rachael Lorna Johnstone to author (13 March 2018); F Jørgensen, Personal communication (10 April 2018).
131 M Knol, Personal communication (4 June 2018)
132 Email from Rachael Lorna Johnstone to author (13 March 2018).
Contrariwise, a cruise ship captain also is responsible for the welfare of several hundred to thousand passengers and must adhere to their wishes. The success of the cruise is depending on the satisfaction of the customer since with decreasing satisfaction also the demand is decreasing. It is unlikely that an unsatisfied cruise passenger would recommend the operator. Consequently, the cruise vessel might go into ice on purpose or as close to the ice as possible. Hence there is a crucial necessity for accurate weather forecast and sea ice data to reduce those risks, which are used for different purposes by both actors.
5 Evaluation of interviews

As I described in the previous chapter, the two target groups have different intentions in the Arctic. Accordingly, their use of weather forecasts and sea ice differs, alongside their decision-making practices. In the following, I will present the results of the interviews, structured thematically into sections. First, I explore the role of weather and sea ice information services in the planning phase from the perspective of both actors, followed by an insight into operational planning and decision-making practices onboard the vessels. Subsequently, I examine uncertainties and gaps of forecasting and sea ice data in the Arctic. Conclusively, I inspect the role of experience in Arctic navigation and the wishes and needs expressed by the two target groups. Ultimately, my goal is to understand how weather forecast and sea ice charts are used onboard of cruise and fishing vessels in different stages and what role experience and knowledges plays when navigating in the Arctic.

5.1 The role of weather and sea ice information services in the planning phase

The cruise and fishing industry have different intentions when going to the Arctic, but with the common aim of an economic motivation. Consequently, the approach towards planning of a cruise voyage is different than a fishing trip. I will explore the differences in this section by unfolding the results of the interviews.

Cruise industry

Most Arctic cruises take place in the summer months of June, July, August and September with the intention to encounter sea ice. The range of Arctic destinations and voyages is diverse at that time of the year, taking the customers to places such as Svalbard, Greenland, Canada or Alaska or through the Northeast Passage (NEP).
The weather and sea ice conditions can change rapidly within different areas in the Arctic, which requires a thorough planning of the itinerary to safeguard safe manoeuvring in the Arctic. In the planning phase, factors including where in the Arctic the vessel is intended to navigate, the content of the voyage and what is intended to be done in the area, for instance expeditions to shore or other arrangements, are influencing the planning phase.

The itinerary plan of cruise operators is made at least of 1,5 years in advance, before the cruise is intended to take place (7) (8). During the planning phase the captains (5) (7) (8) outline that having a planning strategy on how to approach the different uncertainties, such as the uncertainty of sea ice conditions that can influence the flexibility of the voyage, is important to consider (5) (6) (7). First, the areas and places in the Arctic, intended to encounter and visit, need to be defined before any weather and sea ice information services from different providers can be consulted. Hereafter, it is part of the planning strategy to collect and consider all available meteorological recordings and historical data on the presence of sea ice for the area in question. Those recordings and weather forecasts are used as material elements, supplementing the planning process. Since forecasts on sea ice data does not exist, a material gap is encountered in the planning phase. Depending on the familiarity of the operator with the material and competence of undertaking cruise operations in the Arctic, the planning is either done in-house, or taken to companies offering assistance and expertise in Arctic voyage planning (4) (8). These external competences are consulted when own experience is lacking and comes as a form of voyage planning and feasibility studies (4) (8).

After an evaluation of past cruise seasons (if the company has been in the area before) and the consideration of historical weather and sea ice data, a definite planning is undertaken. With approaching the start date of the cruise, the itinerary planning is updated regularly (first monthly, then weekly) by either the operator itself or by an external company. Up to four weeks before the cruise takes place, a very detailed assessment of weather forecasts and sea ice charts, displaying the current situation in the area, are undertaken.

Historical weather and sea ice data and weather forecasts are important materials used in the planning process.
Additionally, the competence of the planner plays a significant role in evaluating the material, taking into account whether the intended route is feasible based on, for instance, the vessels design and tolerance towards different sea ice types.

Within the planning phase, changes might occur at any time and it is therefore important that a route is not absolutely fixed, but instead it is rather flexible to changes (5) (6). In the Arctic ‘there is hardly a year which is just like the other’ (5). Certainly, in some years there is more sea ice of various types and thickness present in the Arctic (4) (5), and ‘exceptions confirm the rule’ (5) since there were always peaks in certain years where stronger sea ice in Arctic was encountered than expected (5). Overall, it was observed by both cruise and fishing respondents that especially the perennial ice\textsuperscript{133} in the Arctic has become rare.

**Fishing industry**

Fishing in the Arctic is a seasonal activity, targeting different species at various locations. Contrary to the cruise industry, fishing actors have a different intentions and approaches towards itinerary planning. In fisheries, it is not aimed to encounter sea ice, as it is in cruise tourism, but to catch the intended quota of fish.

A planning phase, as encountered in cruising, is absent in the Arctic fishing industry. The fishing activities of the interviewed respondents takes place nearly all year-around (1) (2) (3), leaving no time to undertake an intensive itinerary planning several years ahead as practiced in the cruise industry. Due to the uncertainty of weather, sea ice and more importantly the exact location of the fish stocks, weather and sea ice information services are not used to plan more than two to three days ahead of time. However, the planning already takes place in the operational phase while being at sea. ‘Our planning is determined by the fishing season and where the stocks stand’ (1), indicating the high flexibility of the industry towards changes in their itinerary of fishing places and organisation of catches. The only pre-planning is roughly taking place in terms of seasons and the corresponding places where the desired fish stocks can be encountered.

\textsuperscript{133} Perennial ice is a type of old, very thick, strong and melt resistant sea ice, sometimes also referred to as multi-year ice.
The long periods spend at sea and fishing operations taking place year-round, enable the captains to observe the weather and sea ice conditions thoroughly. Due to long-term experience of navigation and fishing in the Arctic, interview respondents would rather make use of their competences (interpreting weather events) and skill (to turn this observation into a decision) connected to the practice instead of consulting historical data for planning purposes. The captains would rather make use of their own knowledge (competence) of weather and sea ice conditions encountered in the past to make assumptions for the next season. However, those assumptions are only theoretical and do not influencing the planning process.

**Operational planning and decision-making**

In the previous section, I described how planning of Arctic ventures differs between the two target groups. It became clear that the fishing sector in the Arctic does not plan trips the way the cruise industry does. The planning of fishing operations rather relies on the direct operational decision-making. On the contrary, Arctic cruise operators use both approaches: the long-term itinerary planning, taking place minimum one year in advance, and the operational decision-making taking during the voyage. How the actors cope with weather conditions that can change within an hour is different due to their different intentions in the Arctic. For a cruise, the weather is of utmost importance. The power of the weather is hereby threefold. First, it has influence on the itinerary. Smaller deviations and flexibility in route alternatives within the limited time schedule are possible, but not desirable. Second, the weather influences the planned activities and landings and third, it has an impact on the passenger’s satisfaction.

For fishing actors such power in weather changes has an effect, on either their navigating or in restricting their fishing activity. Fishing vessels are presented with a significant flexibility in route planning and operational decision-making since they do not need to satisfy passengers, only catch the intended fish quota. As the skills and experience of actors in the Arctic vary, so does the weather. In the following, the different weather and sea ice providers and services used by the two target groups will be introduced.
A detailed evaluation of the operational planning and decision-making practices used onboard will be given for both the cruise and fishing sector.

Weather and sea ice information services used by both actors

While being at sea, captains of both cruise and fishing vessels collect all information available on weather forecasts and sea ice services. They use a variety of sources, depending on the area they are sailing in, the enormous variety of providers and the availability of information due to limited bandwidth in higher northern latitudes. Both target groups mentioned that a high flexibility towards changes when navigating in Arctic waters is essential.

In the following, two lists of providers are presented. The cruise and fishing industry uses weather forecasting providers such as:

- The Danish Meteorological Institute (DMI) for Greenland (www.dmi.dk),
- The Norwegian Meteorological Institute (MET) for the areas around Svalbard (www.yr.no),
- zyGrib (a free software for visualizing weather data),
- Canadian weather service for the Canadian Arctic (www.ec.gc.ca)
- CATSAT, a private actor providing oceanographic and marine weather data, mostly used by the fishing fleet
- Storm Geo’s Bon Voyage (BVSTM) system and
- Navigational Telex, better known as NAVTEX, which is a direct printing service of meteorological forecasts and warnings onboard the vessel.

Especially for ice charts, services from providers such as:
- Yr.no, the service of MET Norway,
- Ice charts from DMI,
- ArcticWeb,
- Kongsberg satellite service,
- Canadian ice service for Canadian Arctic (www.ec.gc.ca),
- Drift & Noise (private actor, producing near real time sea ice information),
- Seaice (from the University of Bremen, Germany) (www.seaice.uni-bremen.de),
- Polar View and Storm Geo are used by the cruise and fishing industry.
Cruise

For every captain operating a vessel, the entity ‘competence’ of having skills and knowledge on the specifics of the vessel he or she operates is essential, as it is strongly connected to the performance of a practice. Additionally, it is important that every captain, to navigate the vessel safely, have experience and knowledge in navigating the Arctic with reference to weather and sea ice conditions (5). The use of knowledge from previously encountered conditions regarding weather and sea ice supports the decision-making process of a captain.

For operational planning and decision-making processes, the availability of weather and sea ice information services influences the practice. Various weather conditions, as for instance the presence of sea ice, wind speed and direction, wave height, snow, etc., influence the practice of navigating in the Arctic. The condition of weather and sea ice combined, make the situation of navigating in the Arctic complex. The latter conditions define the decision-making process of the captain and can have influence on the itinerary of a cruise. Sea ice is intended to be encountered in Arctic cruises, which requires the availability and accurateness of sea ice data to locate the ice.

The availability of material entities is connected to many practices onboard cruise vessels and has a high relevance for determining the practice and decision-making process. Devices, for instance computers, to receive data (material) on weather and sea ice information services onboard cruise vessel are vital. A tool to access data is for instance the internet, next to satellite phones and the radio, but these only having a limited function in higher latitudes of the Arctic. Such devices and tools have an impact on the operational practices of the captain that is connected to it. The availability of the internet is influencing not only the amount of data that can be exchanged, but also the quality of information. The key role of the internet is therefore influencing the data which can be used for operational planning and the decision-making process by the captain. The use of Iridium\textsuperscript{134} is practiced in the operational phase and is not only limited to emergency communication, but it can also be used for receiving and sending data. However, the connection when using Iridium to download a small size or compact data file, such as a PDF document, is described as ‘insanely slow’ (6) and connected to high financial costs.

\textsuperscript{134} A global satellite network possible to use in polar regions.
Consulting weather and sea ice information services displays a routine in Arctic cruising. Various weather services and ice chart providers, as listed under ‘Weather and sea ice services used by both actors’, are consulted depending on the location. How often weather and sea ice services are updated depends on time and space. Again, weather and especially sea ice data are not always available or up to date. Depending on the data and services available, the captain assesses the situation and uses it for the decision-making process. The received data is not solely relevant for the same day, but also for the coming day(s) in order to execute the cruise based on safety standards. In cruising, the weather plays a dominant role. Unpredicted changes, caused by climate change, and ‘bad weather’ as fog, high waves and the presence of too much sea ice can have an influence on the itinerary and might require a correction of the intended navigation route. Further, the weather present at an Arctic cruise, can result in a change in itinerary planning. Such changes in actual routing can emerge for example due to more significant ice melt in a particular area than forecasted or the unexpected calving of an iceberg, which leads to the appearance of more growlers\textsuperscript{135} (6) (8). With the absence of data, a common practice in the cruise industry is it to cruise to the location in question. Many operational decisions are then made on the spot (6) (8) (9). Further, changes in the itinerary can influence the passengers’ satisfaction and pressure the captain and the crew to adhere to what was sold to the passengers (6). To abide to the time schedule and route, the itinerary seems essential due to the expectation of the passengers towards planned activities in certain Arctic areas e.g. for shore leaves. A high flexibility of the captain and crew is required, so having knowledge on the area to present alternatives in routing and landing sites is essential. However, safety is the overall deciding factor for decision-making processes. At any time navigating a vessel through unknown or challenging areas in the Arctic should take place in a ‘conscious and careful manner’, which can be ‘difficult to balance between what the customer wants and a safety-first policy’ (5).

Ice charts display an important material entity for navigation in the Arctic. The cruise operator wishes to encounter ice, making it a requirement to have ice data available not only to satisfy the passengers who desire to see ice, but also due to safety reasons since not all types of ice can be encountered if the vessel has only a limited ice class.

\textsuperscript{135} Small icebergs
Ice charts are downloaded, via the internet, by the captain and bridge crew. At the MET services, sea ice experts review the raw data images of satellites and edit the data to make it easier for the captain to read the charts. Raw satellite images are consulted by captains on weekends, as the Norwegian MET service does not produce sea ice charts on Saturdays and Sundays. Those satellite images require advanced skills and knowledge of the captain to read the data correctly due to the difficulty in reading the raw satellite images, and the uncertainty and incompleteness of the images, as for instance a cloud cover of the satellite might alter the image.

The use of private providers is common in the cruise industry, but mostly used in emergency situations where detailed data on, for instance sea ice data on local scale, is required but not available or insufficient. Private companies offer tailor made information correlating in particularly to the itinerary of cruise vessels. Those private companies make use of weather and sea ice sources worldwide. For instance, one cruise operator cooperates with the provider Kongsberg satellite service, when in need of updated weather forecasts or sea ice data. Kongsberg satellite service then provides the cruise vessel with satellite images of the area in question. One captain outlines that such a cooperation is helpful but new possibilities of producing and receiving up to date meteorological data needs to be developed (7).

Sharing of information on weather and sea ice should be considered by all operators in the Arctic since it presents a huge advantage for the safety of the vessel, crew and passengers (5). Especially when the access to data is lacking, sharing of information is appreciated by every vessels. One captain mentioned that the bridge team regularly is contacted by cruise vessels in the vicinity, asking for weather and sea ice updates and recent on site/in situ observations (5). Further, they emphasise that they regularly and gladly share weather and ice information with other vessels, as it is a concern of safety and therefore is in the interest of every vessels (5). All interviewed captains of cruise vessels (6) (7) (8) (9) share information; however, some companies are more limited than others. Information sharing between users of weather and sea ice conditions takes place through various media.

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Fishery

In the fishing industry the biggest material asset is the vessel itself. The fishing vessel is the basic tangible material, directly connected to fishery activities in the Arctic. The design of the vessel and its tolerance towards sea ice defines to what extent the fishing practice can be executed by the captain without making compromises towards risk and safety. ‘The ice decides where we are going or until the ship cannot handle the amount of ice anymore’ (2). The utilisation of various services of providers depends on the location, accessibility, and preference of the captain to use such services and sources. Checking and collecting weather and sea ice data is performed on a daily basis by the captain, indicating a routinised process. However, the routinisation is only limited to the actual activity of consulting the weather and sea ice information services. It is not always possible to download data, either due to limited internet connection or due to the absence of updated data. It is a routine for a captain to utilize the same providers and services to check and collect weather and sea ice data for every area and location. Every morning weather and sea ice services are checked via the internet (1) (2) (3). The use of the internet displays another important material element, the ability to send, receive or download data. The utilization of the internet by the fishing industry is comparable to the cruise industry. Iridium, same as for the cruise industry, is not solely used for emergency communication but also for data exchange. If the position of the vessel allows and the need for updated weather or sea ice information services is urgent, the services of different providers are consulted on more frequently, as for instance on an hourly basis. However, in most cases this is not a common practice in fisheries, since services for the locations where the respondents operate, as for instance off the Greenlandic coast, are not updated, and accurate weather and sea ice information services are not available. The competence of captains is therefore closely connected to their knowledge of the area and the specific condition present. By consulting different services and providers, the decision-making process of the captain is solely based on his/her competence to assess the situation correctly. Hereby, the considerations about the uncertainty inherent in weather and sea ice data, the risks involved, safety rules and standard practices are essential and determine the decision-making process.
Fishing captains constantly evaluate the weather and sea ice situation while being at sea and try to use every possible opportunity to catch fish. For instance, openings in the ice cover constitute an opportunity in time and space. These conditions in a specific Arctic location (space) represent the possibility of shortcuts or the opportunity for the captain to let the vessel move with the ice, which can save traveling time instead of sailing around the ice (time). Simultaneously, such actions present a significant risk to the operation but are outlined by the captain as ‘being part of the work-related risk’ (1). All interviewed captains demonstrated scant concerns about the vessels operationality in certain types of sea ice ‘we will fish here anyways, so ice must be ice’ (1) and raised no concerns about their ability to navigate the vessel in icy waters, demonstrating their competence of being certain how to pursue a certain practice and indication their technical and navigational knowledge on the material element (1) (2) (3).

Captains are making use of private providers such as CATSAT, which is a French fishing software. The software can display various information such as salinity, plankton abundance, temperature, etc., but also it provides meteorological information services (2) (3). The software is mostly used for pelagic fisheries136, however, one captain of a shrimp fishing137 vessel outlined that he uses the software onboard especially because of the access to weather information. All the other information provided by the programme are an asset for him when navigating in the Arctic, but not necessary (3). Making use of private providers is costly, but for the interviewed captains of fishing vessels operating in the Arctic is it ‘not about money as long as the system provides everything we need’ (1). In the case of limited or no data available for the location, weather data from the devices used onboard fishing vessels is collected and supplemented with the captains own observations of weather and sea ice conditions to assess the situation.

136 Pelagic fishery is taking place near the water surface, at the upper layer of the open ocean
137 Shrimp fishery in contrast to pelagic is a demersal fishery, meaning fish that live close or near the sea bottom
The longstanding experience of Arctic navigation and observations- ‘you know how it looks like at certain areas at sea’ (2) - is hereby an asset for the element of competence. Observations include the assessment of wind speed and direction, the temperature and the characteristics of the region in terms of what types of ice can be encountered through earlier made experiences.

The captains mentioned that wind warrants special concern because it affects their operations. The wind direction and speed are of special importance when make assumptions about the moving direction and speed of ice floes. Further, the wind speed and direction influence the wave height, which can make it difficult to spot bigger ice floes as they might be covered by water. Both the flowing direction and the type of sea ice is difficult to predict even with long experience and competences. Accordingly, their decision-making process on route planning for the next two to three days are directly influenced by the data, their observation and knowledge on weather and sea ice. Captains refer to their competences in navigating in the Arctic as having ‘having seen, know or experienced’ (1) (2) (3) certain weather and sea ice conditions in the past. Further, the competence of captains is not only connected to the material entity of weather and sea ice information services, but also to the knowledge of how the vessel behaves, as for instance how manoeuvrability changes in sea ice.

Since forecasts on sea ice do not exist and sometimes weather forecasts are limited or inaccessible, information can be obtained by contacting fishing colleagues, provided that any colleagues are present at or near the location in question. To do so, the imponent tools for sharing data on weather and sea ice are communication devices (material entities). Those devices used for exchanging data include: the Very High Frequency (VHF) and High Frequency (HF) radio used for ship to ship communication, satellite phones and, again, the internet. However, all services have limitations in their use.

Among interviewed captains, no limitations in information sharing for both meteorological and sea ice data was mentioned. The good contact with personnel at various meteorological weather institutes were mentioned as an advantage (3). In some incidences the captain contacted DMI to receive additional information about the ice situation at a local scale.
Forecasting uncertainties and difficulties

In the previous section, I described how services such as weather and sea ice information services are used during the planning phase as well as in for operational-decision-making during the itinerary. The approach towards this data differs somewhat between the cruise and fishing sectors.

This section focuses on the limitations and gaps of weather and sea ice data as outlined during the interviews and includes specific geographical areas that were mentioned during interviews as particularly challenging. Additionally, needs and wishes for enhanced weather and sea ice services are presented.

Gaps in forecast services

The notion on the state and gaps of weather and sea ice information services varies widely among the interviewed captains:

[W]e have come so far in technology, we are even able to drive a car up on planet Mars, but when it comes to our oceans we should have far more information by now (1).

‘[E]verybody thinks how great it is that the ice is melting [but] we know that there are more (ice)bergs coming down […] because of the ice melt and it just creates bigger problems (8).

‘The available amount of information of state and private providers is sufficient for the time being, we take the information available’ (2).

[F]or now, we got all we need from different providers and depending on where we are going it is like a puzzle- we puzzle the available information together (9).

Internet access is vital for both cruise and fishing vessels to download weather and sea ice information services from multiple different sources. However, data transmission is limited by the geographical range of services.
For instance, the transmission of data is not possible through Inmarsat\textsuperscript{138} to vessels operating above 72° North. Data transmission is still possible with using Iridium, but the transmission is slow and expensive as outlined by the captains (1) (3) (5) (6). The small bandwidth of Iridium results in an internet connection that breaks off several times during one session of sending or receiving data (6).

The limited connectivity influences the decision-making process of the captain operating in the prevailing conditions of the Arctic environment. Depending on the captain, the decision maker, a situation is evaluated and eventually handled differently, where again, experience and the role of the elements is closely connected to the decision-making process onboard.

Besides the access of data through means of communication devices and tools, captains criticise the non-existing continuity and actuality of the information available. The time gap in ice charts and the challenge of interpreting satellite data present challenges to both actors. For instance, ice charts can be already outdated by the time they are downloaded, displaying information that does not reflect the actual situation. Data on sea ice, older than six hours, is considered as ‘old’. This is a consequence of the fast-changing weather conditions in the Arctic, and the time that is required to process sea ice data before it is made available to the end-user onboard. Therefore, the error margin and uncertainties in ice charts derive from the fact that the ice charts are outdated by the time they are used onboard, not reflecting the actual situation. This makes the information unreliable and creates trust issues. Several captains express those trust issues which was backed by the statement that ‘you can never trust the data to 100 percent because of the error margins’ (2). Oftentimes only large-scale maps of a vast area, with an insufficient resolution are available, making it impossible to zoom in and exacerbating the accuracy issues when evaluating the situation. The use of a large-scale images with an insufficient resolution can lead to ‘unpleasant surprises’ (6) (8). The on-spot evaluation therefore seems to be a common practice for both actors, but oftentimes also leads to frustration if a situation is encountered that was not expected.

\textsuperscript{138} A global satellite network offering communication services
Satellite images can be downloaded, but require the experience, skill and knowledge of the captain to interpret the image correctly. On the one hand, the difficulty of interpreting satellite imagery exists and on the other hand, the chart inherits uncertainties as they might display a certain type of ice at a particular location, where there is open water or vice versa.

In nearly all interviews with cruise and fishing captains, the area around Greenland, especially North-Eastern and East Greenland was mentioned as a particularly difficult area to navigate due to a lack of meteorological forecasts and available sea ice charts. Factors such as sea ice formations, regardless of the season and powerful swells amplify the difficulty of navigation. This can have an influence on the itinerary, which is especially important to cruises that need to abide to a fixed time schedule. It can hardly be foreseen how the situation develops in a few hours’ time if no adequate or sufficiently detailed weather forecast and sea ice charts are available. At that point of the voyage, important decisions need to be made based on the captains’ experiences, knowledge and skills, as for instance: does he or she expects katabatic winds and fog or a calm sea and clear view. One captain mentioned that when the vessels cruise around Greenland, especially in the Baffin Bay, it is always faster for them to sail around the ice. The cruise operator tactically avoids crossing through Baffin Bay if no data or forecasts are available at that time, which is often the case (9).

The role of experience

As stated earlier, captains of cruise and fishing vessels rely on the competence entity, having skills, knowledge and experience of navigation in Arctic waters. The diverse levels of competences of the interviewed captains and their navigational skills of manoeuvring different types of vessels with or without ice class or even icebreakers through the Arctic indicate different levels of experience and skills. This experience is divided into categories such as map evaluation, knowledge of the ship and ice-navigation as such. In the following, I will outline the difficulties in ice navigation in relation to experience.
Experience with forecast data and sea ice charts

As I described earlier, there are different materials used in the practice of the planning phase and for operational decision making in Arctic navigation. The various providers of such material apply display information differently which makes it challenging for the captains to interpret the material accordingly. Certainly, there is a lack of understanding the provided material, especially for captains, new to Arctic navigation. The evaluation of satellite imagery is complicated for captains, especially novices, as it requires experience and knowledge on how to read the image presented. Satellite images are often times difficult to read, even for experienced captains.

One captain outlines that he sometimes has difficulties distinguishing between whether the white covered area on a satellite image shows a cloud cover or sea ice (1). Even if captains have a nautical education with meteorology courses taught during their studies, basis theoretical knowledge is not sufficient. Captains outlined that understanding and experiencing the importance of interpreting the data correctly in a real situation onboard is key. The direct experience onboard a vessel navigating in the Arctic is most important and cannot be replaced by solely training on land in a vessel simulator. Most interviewees learned their skills on how to interpret radar and satellite images from experienced captains or crew onboard a vessel. Underestimating situations and making mistakes in interpreting ice charts occurred to several interviewees and had a high impact on safety and efficiency for both actors of cruise and fishing. Even if sufficient experience is given, some areas require especially trained ice pilots as for instance Greenland and Svalbard.

Learning from experience

Sea ice navigation is a complex field, and even if the available information is correctly interpreted and of adequate quality, experience in Arctic navigation is the key. For decision-making processes in navigation, safety should be the overall deciding factor, but that requires experience and knowledge, not only theoretical understanding of the term safety, as outlined by several interviewees.
Captains, navigating in Arctic waters need to have knowledge on the available material (the technical aspects of the vessel, its tolerance of sea ice, weather and sea ice material, etc.) to execute a practice according to safety rules and standards.

The captains stated, apart from using weather and sea ice information services, that they rely on their visual perception and skills developed during several years of experience at sea, especially in Arctic navigation. Additionally, the behaviour of the navigator and his or her perception towards risky and challenging situations have influence on navigating in the Arctic as outlined by a captain. According to him, Arctic navigation is a ‘matter of serenity and patience. You cannot force the ice to move after your wishes, you have to deal with the situation’ (5). In order to deal with the situation, competences for the practice are indispensable. The training of navigation in Arctic conditions is a precondition for the adequate execution of practice.

In most practices, learning from mistakes is considered beneficial. However, in Arctic navigation it should be avoided at all times. This is due to the special conditions in the Arctic since SAR forces might be far away. All interviewees are experienced captains, confident in stating that their voyages in ice are always a learning experience. All stated that first-hand experience onboard a vessel is the key for securing a safe and smooth manoeuvring through Arctic waters. ‘In Arctic navigation you never stop learning’ as outlined by a captain with longstanding experience in navigation (5). Solely reading manuals, handbooks and developing skills in a simulator that can model different ice situations is not sufficient and does not replace on spot experience (6). ‘No simulator on land can teach navigators the ‘real’ Arctic conditions, nor create an understanding of the unique weather and sea ice conditions that occur in the Arctic’ (6), as outlined by an officer who had recently visited such a simulator.

The required knowledge and skills for Arctic navigation are often gained through learning from more experienced navigators as several captains outlined. Two captains mentioned that they sometimes leave the bridge deck, to stand outside listening to how the ice sounds when the bow of the vessel goes through. It presents them with a more thoroughly understanding of the current ice situation.
Another captain of a cruise, without prior ice experience before entering the Arctic, mentioned the use of hiring Norwegian ice navigators/pilots when sailing through unknown Norwegian waters, years ago (8). He recalled that he partially learned from the experience and insight of the Norwegian pilots.

A novice captain in Arctic navigation stated that an additional captain is attending the cruise for the first couple of weeks, months or even years until the novice is familiar with the Arctic conditions and trained in interpreting ice charts and weather condition. The ‘rest’ is considered as learning by doing.

However, captain of both industries outlined that they are not sure how the increasing demand for experienced captains for Arctic navigation should be met. They suspect an increase in novices in Arctic navigation, operating cruise vessels of all sizes. Further, the interviewees criticise that there is no standard for ice navigation training requirements in the IMO Polar Code or STCW. Further, all captains of fishing vessels expressed their concern of novices operating large cruise vessels in the Arctic. The captains of fishing vessels fear an incident with a cruise vessel where their fishing vessel could be called in as first responder in a SAR operation.

The major concern of the interviewed captains of fishing vessels is the limited capacity they have onboard to take on additional hundreds to thousands of cruise passengers and how those people should be entering the fishing vessel due to limited rescue equipment.

Cruise captains also voiced their concern about novice companies entering the Arctic cruise market without prior experience in polar operations. The interviewed captains mentioned their concerns about being the first responder in a SAR mission for a large-scale cruise incident. Hereby, captains of cruise vessels mentioned concerns on how to rescue those people, as there are mostly passengers of higher age groups (50+) with potentially limited mobility (6) (8), limited medical care facilities and how an additional number of passengers influences the stability of the vessel. Concerns by the cruise captains were raised on how they should then safeguard the safety of their own vessel and passengers.
Behaviour in uncertain situations related to risk

Interviewing the cruise captain of a private residential cruise vessel where residents live on the ship revealed how different repercussions from gaps in forecasts are dealt with by different cruise operators. The private residential cruise vessel is an exception in the cruise industry because the passengers are deciding where the vessel is going to sail next (8). He described one situation where the residential cruise vessel was intended to sail to Svalbard, but the sea ice extent was too extensive, and the trip got cancelled when the vessel arrived in the northern part of Norway. The captain described that the residents were disappointed but as he also outlines that even if it is a private residential cruise vessel, the residents would not want to damage the ship, because they have invested money in the vessel by buying a residence. In that sense, cruise vessels, the captain of the residential vessel outlines, ‘might be under more pressure to take a chance’ (8) and to deliver what the passenger paid for.

For instance, all interviews from the fishing industry clearly outlined that they know they are not navigating an icebreaker, but they still would try to push through the ice.

Needs and wishes of the end users

During the interview, a great deal of needs and wishes of the end users onboard cruise and fishing vessels was mentioned. Both interview groups outlined a great deal of limitations in weather and sea ice information services which need to be addresses and improved, even if most interviewees were basically satisfied with the current situation. In the following, the mentioned need and wishes will be listed. Overall most interview respondents were satisfied but mention great needs for improvement and development in technology.

Data availability, actuality and accessibility: Captains of both industries favour a continuity of data availability. The data should be easily accessible and free of charge. It was indicated that forecasting data once per day would be sufficient if the data is accurate and complete, but two to three times per day would be preferred due to fast changing conditions in the Arctic. Further, the wish to receive updated ice charts from MET Norway also on Saturdays and Sundays was mentioned.
Connection: When navigating in higher latitudes, the bandwidths is very limited; thus, the internet connectivity is limited. Downloading or receiving weather and sea ice information services is restricted due to limited coverage of satellites in the Arctic. Ideally, the format of meteorological and sea ice data would not be compromise the way it currently is by not interfering with the limited bandwidth, making it also possible to use a range of different communication mediums. Hence, connectivity needs to be enhanced.

Ice: The wish to receive near-real time data on ice charts was expressed. Improvements must be made on providing information on a local scale, and a consistent availability of the product is favoured. Further, sea ice forecasts in addition to sea ice charts would be favourable for operational planning. In particular, the flowing directions of ice floes, the speed of those floes and the determination of the type of sea ice would be of huge advantage in ice navigation.

Unity in design: For the interpretation of ice charts, the standard colour scheme, established by the World Meteorological Organization, should be applied by all providers to make interpretation user friendly and uniform. I was argued that formats like the egg code\textsuperscript{139} should be uniform.

Overall, the interview respondents elaborated on their willingness to invest in new, advanced meteorological services and ice charts if it would be advantageous for their operations in the Arctic. It is of no financial concern for the captains to buy services from private providers as long as those services cover exactly their needs. However, captains, especially of the fishing industry, are not willing to take the risk of making investments into systems that are not proven by other actors, favourably from their industry. The captains expressed their optimism towards further development in satellite technology and supporting user needs in receiving data and images in the Arctic which would make their business less risky.

\textsuperscript{139} The egg code contains information on ice concentrations, stages of development (age) and form (floe size) which is presented in an oval (egg) shape, Personal communication Bjela König (20 May 2018).
6 Discussion

This thesis focusses on the role of weather and sea ice services in the decision-making processes of cruise and fishing vessels in the Arctic and how these influence risk and risk perceptions. In chapter 3, I outlined that Beck’s risk society is used to frame risk and uncertainty. Beck describes our culture as a risk society which thrives for safety but likewise creates risks itself. By the introduction of Beck’s risk society, I aim to understand how decision-making in difficult conditions, based on available weather and sea ice information services, are utilized in maritime context in the Arctic and shape risk and perceptions of risks.

In that sense, weather forecasts and sea ice charts allow for addressing uncertainties and reasonable calculation of risks. However, due to the uncertainties inherent in those weather and sea ice services, described in chapter 5, safety is of increasing concern. Uncertainties in the services eventually force the decision maker to take risks in certain situations.

However, the application of Beck’s concept of the risk society shows that risks and uncertainties in Arctic navigation is not only based on forecast systems and sea ice services in need of improvement but also on other factors, which I will describe later in this chapter.

‘Zooming in’ on the performance onboard of the cruise and fishing vessels regarding their use of weather and sea ice data, enabled me to understand the planning process and operational decision-making practices practiced onboard. Further, it allowed me to map the role of weather and sea ice data used by the two groups and provided a better overview of the current availability and problems with weather and sea ice data. Understanding the different practices and processes of planning and operational decision making enabled me to identify gaps in weather and sea ice data as well as mapping the end users wishes and needs for future data.

Practices are established by a combination of the three elements: material, meaning, competence. Those three elements describe the materials that encompass and support a practice. With the absence of the material element, the execution of a practice would be much more challenging. Secondly, meanings stand for ideas, aspirations and emotions connected to a practice.
The dimension of meaning is important because it explains how and why certain information, systems and services are used and how this connects and influences the decision-making process. Thirdly, the element of competence refers to the knowledge, skills, technique and know-how of an individual.

Within Arctic navigation the interrelation of the elements differs and the dependence on materials and competences is significantly connected. The meanings and use of materials are similar in both industries, with regard to the weather and sea ice information services used. When it comes to means of transportation, both actors utilize different types of vessels (material). The material element describes the tangible part a practice is connected to. Both actors are using weather and sea ice information services, the technology needed and the ship itself as material elements which are connected to the execution of their practice. The meaning of a practice, for instance the use weather and sea ice information, is for both a captain onboard a cruise vessel and the captain of a fishing vessel important for the operational navigation. The utilisation of weather and sea ice data is related to the captain’s intention of a practice. For instance, the captain of a fishing vessel uses ice charts to safeguard that he or she will not manoeuvre the vessel into a dangerous ice situation that could possibly harm the vessel. Further, the proportion of uncertainty in weather and sea ice information can partly be overcome by using the captains’ knowledge and experience in Arctic navigation.
6.1 Uncertainties within Arctic activities

In this section, several types of uncertainties, as presented in chapter 5, will be discussed. First, I will explain the uncertainty of weather and sea ice data within the operational decision-making processes, followed by the uncertainty of experience. Third, the planning phase in relation to the practice theory will be elaborated. Hereafter, I will concentrate on potential human errors within the operational decision-making and on uncertainties in vessels operating in the Arctic. Lastly, I will explore uncertainties related to data providers.

Weather and sea ice services

The need of accurate and complete weather and sea ice information service is vital for operational decision-making processes especially in such a changing environment as the Arctic.

However, the access to weather and sea ice information systems is lacking due to a limited connectivity in higher Arctic latitudes. The access and quality of the weather and sea ice information services needs to be improved because relevant information is vital to mobile maritime actors such as the cruise and fishing industry. Thoman et al. endorses a need for more reliable and relevant information which would diminish the vulnerability of the maritime sector, operating in the Arctic.¹⁴⁰

Further, the ongoing and predicted activities in the Arctic, as for instance the increases in economic exploitation, urge for more specialized information services towards the end user needs. This would limit the uncertainties inherent in Arctic navigation. Consequently, tailor-made services reduce the risks of casualties while the environment is better protected (fewer oil spills due to naval accidents), easing the SAR apparatus and reducing costs of rescue missions.¹⁴¹

The users of those weather and sea ice services need to be much more engaged in the development of new technologies and services, because of their dependency on those systems. The commentary of Hajo Eicken on better forecasts confirms the results of my study that users must identify and voice their needs for data.\textsuperscript{142}

Additionally, decision-making in the operational planning of any vessels is to some extent flexible and not predetermined. Decisions must be made on-spot, both, in fishing and in cruise activities. Consequently, time is a factor. More timely data must be provided to flexibly and safely change the routes. This is important for both sectors as the cruise ships have to serve their customers and the fishermen must catch their quotas. The Polar Code, issued by the IMO and hence an international recognized authority, insists on steady supply of those forecast and sea ice services, which makes the enhancement of weather and sea ice information services also a matter of international authorities. Currently, a list of projects to develop new products and services are undertaken such as research on automated sea ice products (ASIP), Safe maritime operations under extreme conditions: the Arctic case (SEDNA), Enhancing the saliency of climate services for marine mobility sectors in European Arctic seas (SALIENSEAS), Centre for Integrated Remote Sensing and Forecasting for Arctic Operations (CIRFA) and Polar View Earth Observation Limited (Polar-TEP), to name a few. Additionally, new services in ice charting agencies are provided by the following companies: Polar View, Drift & Noise, ICEye.\textsuperscript{143}

Better satellites are needed to enhance the internet connection displaying an important material in Arctic navigation. If there are weather and sea ice information services available, it is in some areas not possible to download data in time (due to connectivity issues and a lack of broadband) or it is outdated. Accordingly, the double-edge sword “technology” as Beck describes displays a high dependency of humans of the technological development. Consequently, experience in navigating under such circumstances is crucial.

\textsuperscript{143} Email from Nick Hughes to author (11 April 2018).
Experience in Arctic navigation is limited, the pool of people with sufficient experience and competence is small. With the increasing number of ships, especially cruise vessels, targeting the Arctic, not enough experienced captains might be able to navigate in the Arctic to meet the needs of the industry.¹⁴⁴

This could lead to captains navigating almost blindly through the high latitudes due to missing experience in Arctic navigation. An example for the increased pressure in Arctic navigation is the case of the MSC cruise vessel intended to cruise to Svalbard in July 2018. The MSC cruise vessel is one of the larger types carrying up to 6000 people. The MSC is not a member to AECO, as it is not an expedition cruise vessel, and the operator has no prior experience in Arctic navigation which worried several of my interview respondents who will be navigating in the Arctic at the same time. The concerns are not purely related to the vessel size and amount of PAX itself but rather to the inexperience of the crew and captain. Further, it raises the concern that due to the rapid development of the Arctic cruise sector and a high need for skilled captains, promotions of officers might be executed much earlier, limiting the onboard experience and mentoring of the novice by an experienced captain.

The decision process is always influenced by how the captain understands the situation, his/her knowledge, competence and skill to make an optimal decision in a performing a practice. Accordingly, an expert in a certain environment, such as a captain who has long-term experience of navigating in the Arctic has more adapted skills and knows how to identify and interpret relevant information and the current situation than a novice.

Further, decision-making is influenced not solely by the decision maker but also depends on the environment wherein a decision takes place. The rapid changing weather and sea ice conditions in the Arctic are influencing the decision-making process and are considered by the two maritime actors.

A captain’s decision in both industries is influenced by the quality of weather and sea ice information and services and his/her knowledge and understanding of the environment. If the knowledge of the environment and information services on weather and sea ice are poorly developed, the quality of a decision decreases. If the circumstances and information for an environment are understood by a captain, the uncertainty in the decision declines, as well as risks.

Onboard fishing and cruise vessels, adhering to safety rules and standards has a high priority. Safety of onboard has the highest priority and determines the approaches towards a decision.

Captains are taking a step-by-step approach, to make optimal decisions corresponding to the situation, indicating a routine.

Further, captains are behaving in a routinised way when operating a vessel, knowing how to handle the technology onboard to manoeuvre the vessel. Oftentimes the routine is connected to a captain’s continuous awareness and analytical skills to assess a situation. However, such analytical skills are connected to the personal experience of a captain. Therefore, it can be argued that decision-making onboard cruise and fishing vessels operating in the Arctic is only partly rational. For instance, if there are no weather or sea ice services and information available, due to limited connectivity or lacking data, purely rational decision-making is limited. Often, captains stated during the interviews how much they are making use of their experience in Arctic navigation when they are experiencing problems in the utilisation of data material on weather and sea ice.

With the local absence of internet connectivity and weather and sea ice information services, as for instance due to the latitude and lack of satellite systems, the situation of adequate decision-making is aggravated. Hence, the captains need to make use of out-dated data (if possible) and trust on their own assessment of the situation and experience to make an optimal decision. Especially in cruising, ice should be encountered, as it is desired by the costumers, and the time schedule is bound to strict planning. Often a cruise has predetermined stops, appointments on land or additionally bookable adventures which are planned in advance. Hence, sea ice charts are prior consulted to scheduling those activities or to modify the cruise itinerary accordingly. However, MET Norway, for instance, issues weather forecasts 24/7, but sea ice charts are provided only during weekdays.
Accordingly, other information of potentially less quality must be used such as satellite images. Reading and interpreting those satellite images requires training since they are not easy to understand, and human errors can occur when an untrained eye is trying to locate ice. The interview with a captain of a research icebreaker confirms my findings that constant training in reading and interpreting satellite images is required to mitigate risks in Arctic navigation.\textsuperscript{145} Basically, satellite images display a multitude of information that can be of high value to the captain of both cruise and fishing vessels when understood and interpreted correctly.

Not all captains, even with long term experience in navigating at sea, are able to interpret those images correctly which poses a risk to safe navigation. In accordance to Beck’s risk society, the technical component promises safety. This illustrates how dependent the society is on knowledge and information. This information is produced through complex techno-scientific processes, making it difficult for humans to make calculations of risk based on such information. Adversity of possible interpretations about risk and safety are possible, and thus a variety of possible decisions can be made based on satellite images.

In practice theory, the combination of the three elements of material, meaning and competence are influenced by the individual. For instance, the captain decides which material to use and how to execute a practice based on the meanings he or she attributes towards it. The choice of different providers of weather and sea ice services, based on the location and preference of the captain, influences the decision making-process.

Correspondingly, I observed that different use of material and competences of the captain influences the practice. This different utilization is owed to the opposing interest of the actors as cruise captains want to meet the ice eventually and fishing captains are trying to possibly avoid the ice.

The captain itself can be displayed as an important medium for the decision-making process. The captain is responsible to guarantee safety to the crew, and passengers on cruises when navigating in the Arctic. Further flexibility in decision making is required of a captain since the condition in the Arctic can change rapidly, presenting the need for a flexible approach and mindset.

In the fishing industry, captains seem to be mainly concerned about their own skills of locating the fish stocks. It seems that navigating in the Arctic is a routinised process for them. Captains of fishing vessels tend to cope better with inadequacies of accessible weather and sea ice services, due to a high routine in operating in the Arctic environment year around.

The recognition of special skills and experience required for navigation in icy waters was already encountered in 1820:

[T]he navigation of the Polar seas, which is peculiar, requires in a particular manner, an extensive knowledge of the nature, properties, and usual motions of the ice; and it can only be performed to the best advantage, by those who have had long experience in working a ship in icy situations\footnote{W Scoresby, An Account of the Arctic Regions: With a History and Description of the Northern Whale-Fishery (Volume 1, Archibald and Constable & Co. Edinburgh) ISBN : 1-139-09706-7 P. 28}.

However, the limited access to meteorological weather and sea ice information services combined with not catching the desired amount of fish in a trip is leading to higher risks taken by the captain. The human factor of desire and need exceeds the notion of the risks. The routinized practice is interrupted, and irrational decisions could be made eventually leading to an increased potential of naval accidents. Even if the captain is certain of his/her own skills, experience and knowledge about operating in the Arctic, the risks would be limited with more qualitative and tailormade forecast data and sea ice charts available.
Data providers

The choice of a provider depends on the vessels location. The most commonly consulted providers are MET Norway or DMI, which are state-funded and offers some free of charge services.

Additionally, a broad range of information systems and services are used by both the cruise and fishing actors. I found out that the most common tool used to access information is via the Internet. The MET Norway maritime user survey of 2015 concluded also the Internet is the most used tool to access information.¹⁴⁷ Further, it was also concluded that the users of weather information also consult other data providers and services, depending on the location and quality of data available. Additionally, the study acknowledges the importance of including end users in the process of collecting data.¹⁴⁸

However, there is a large supply of private systems and services (4). The private market of providers for sea ice data is booming.

However, the product quality of many private providers cannot be assured due to missing standards, which creates a mistrust for the end user of the accuracy and reliability of the product. The increase in maritime activities will lead to longer seasons where cruise vessels will operate in Arctic waters, requesting more detailed and accurate data that is standardised to make interpretation uniform and user-friendly. Until now, the Polar Code does set such a standard even if it requires vessels to obtain data on a regular basis, especially data on sea ice. As by June 2018, only a few providers comply with the standard colour scheme for sea ice, established by the WMO. This scheme is a global standard widely known among seafarers but not universally used by sea ice charts providers. Using the global standard colour scheme would enhance the correct interpretation by its users.

Cruise and fishing captains seem to be satisfied with the current situation. That was confounding since all expressed their wishes for improvement and explained that expenses for investment did not matter. If more tailor-made services would be offered, it would not be a matter of money, to invest in such systems.

¹⁴⁷ MET Norway, Værer til sjøs (Brukerundersøkelse om maritime værtjenester, MET Norway 2015).
¹⁴⁸ Ibid.
Consequently, service providers do not fully comply to the user needs and developing advanced systems which incorporates these needs requires information and knowledge from different maritime players.\textsuperscript{149} It seems, that they cannot bother to express their needs to the providers or do not know what they need. In case of the fishing people, it seems they are continuing to do what they have been doing for ever, using their known and proven systems without thinking outside the box. Cruise vessel captains on the other hand might not know what to expect from the Arctic. This needs to be enhanced and improved to safeguard the adequate production of tailor made products according to user standards.

6.2 Safety in the Arctic

The potential economic development in the Arctic alarms the captains of fishing vessels. As the number of Arctic cruises are promoted and increased, the SAR capacities are stagnating. This is worrisome for the captains, as the current capabilities are not adequate.

The adequate response to safeguard SAR capabilities are not at the same level as the industry develops. Due to the remote environment of the Arctic, the activities of both the cruise and fishing industries are followed by a high operational risks and high cost of potential search and rescue operations.\textsuperscript{150} Further, safety in the Arctic is an international concern and accordingly, the activities by the two actors will be discussed in relation to international regulations such as the Polar Code. Further, I will examine the special role of tourism in the Arctic with regard to safety. Lastly, safety and SAR measures in regard of fisheries and cruise will be discussed.


The Polar Code and international regulations

There is an abundance of international laws and regulations on the seas, for navigation and other activities as well as control measures to regulate the impacts on ocean ecosystems. However, there are few specific regulations and little information to be found for the Arctic context. One exception is the Polar Code which aims to control and reduce risks by setting international guidelines and standards. Under the code, certain requirements are statutory for vessels operating in high latitudes.

For both cruise and fishing vessels, the captain and crew need to be fully aware of the risks of operating in the Arctic and the limitations of the vessel. However, the Polar Code’s safety components are only applicable to large vessels such as passenger and cargo vessels. Excluded are smaller vessels such as fishing vessels and yachts.

Since January 2017 the Polar Code requires that all applicable vessels operating in the Arctic have a PWOM onboard that should supply the captain and crew with sufficient information regarding the vessels operational capabilities and limitations to support the decision-making process.\(^{151}\) Further, the captain should be able receive sea ice data onboard and trainings for sea ice navigation should be met.

Hitherto, no standards on training and requirements for skills, competences or actual operating time in ice to receive the certificate of ice navigators is expressed in the Polar Code. Currently, a gap exists between the Polar Code and the previously mentioned STCW regarding the specific requirements and competences, required for the polar water trainings. Consequently, different actors offer different ice navigation training courses to receive a certificate as an ice navigator.\(^{152}\) As of June 2018, no independently verified training courses on ice navigation were present.


\(^{152}\) Email from David Snider to author (5 May 2018)
Hence, there is no comparison possibility of skills and knowledge of the personnel who have undertaken training courses according to the Polar Code.\textsuperscript{153} The additional use of an ice navigator\textsuperscript{154} should be considered by the captain of a vessel if no sufficient knowledge on Arctic navigating is present onboard. However, the Polar Code does not outline the competences required of an ice navigator. Therefore, the Polar Code is considered to not adequately address the specific requirements and competences of officers and captains to safely navigate the vessel in polar waters.

Additionally, gaps of the Polar Code were not only identified in training requirements but also the usability of the evacuation and survival equipment used onboard.\textsuperscript{155}

In 2016, the SAR exercise of the Norwegian Coast Guard north of Spitsbergen (Svalbard) revealed that the minimum requirements of the Polar Code of lifesaving equipment, such as thermal life jackets, is inadequate. This inadequate equipment decreases the chance of survival for the people onboard of a cruise vessel. Further, in case of an accident, SAR forces are under a high time pressure to operate as quickly and safely as possible, to counteract the poor preparation of vessels. Additionally, due to the large area of the Arctic, SAR forces are mostly challenged to arrive at the vessel of distress in time. Additionally, the Arctic weather conditions add to the risks and can create challenges for SAR operations.

As of June 2018, the Polar Code seems insufficient to protect the safety of the vessel, crews, passengers onboard cruise vessels and the environment.\textsuperscript{156}

\textsuperscript{153} Ibid.
\textsuperscript{154} A person who has the skills, knowledge, experience and training in ice navigation that will ensure as safe as practicable a transit of or operations within an ice regime. Ibid.
\textsuperscript{156} Email from Rachael Lorna Johnstone to author (13 March 2018).
Vessel regulations

Besides current ice and weather information, it is essential to have good knowledge of the ships naval features, the devices and gear used onboard for the planning phase to estimate if the vessel is capable to operate in the intended Arctic areas. A ship without proper preparation could have the best forecast information but would still be at risk in the high north. With respect to a vessel’s capacity, towards wind, waves, temperature and especially sea ice, the question ‘to turn, or not to turn ‘is vital for every captain operating in the Arctic.157

And here a novel problem of the cruise industry appears. Often, cruise vessels are built universally to serve the world-wide market and operate in diverse environments. However, most often those ships travel in temperate and warm waters. Those vessels might not be properly equipped for a trip to the Arctic.

Certain requirements such as the ship’s construction and design, safety equipment onboard and training of mariners and crew must be controlled by the flag state158 and necessary certificates such as the Polar Ship Certificate, specifying the ice classes the ship can tolerate and permitted to travel in, must be obtained. However, cruise operators can register the vessels anywhere in the world, not being bound to the country where the operator has its headquarters.159 This can create challenges, because the flag state is technically responsible to monitor and regulate that the vessels meet international standards and comply with the rules. Johnstone argues that in this respect ‘not all flag states are equally diligent’, which can create complex problems if such as vessel is in distress itself or should assist another vessel calling for assistance.160

158 Country where a vessel is registered
160 Ibid.
This is consequently a safety issue that can have severe results in the Arctic, harming life and the environment. Even the best forecast systems and information and the best planning cannot prevent such risks and therefore regulations must be issued to recognise this subject.

**Safety vs tourist satisfaction onboard cruise vessels**

Dealing with risks is a consequence of the economic pressure that cruise captains need to deal with. There is a certain pressure on the cruise captains and its crew to deliver what the paying passenger has booked.

Arctic cruise operators want to get close to the ice, that is part of the adventure the passenger payed for, and operators are planning their itineraries accordingly. Gaps in forecast data and missing sea ice forecasts as well as rapidly changing weather and sea ice conditions can lead to the need for changing voyage itineraries of cruises, which then leads to unsatisfied passengers, time pressure and higher risks taken. By advertising Arctic cruises as an adventure of experiencing untouched nature and the remoteness of places, the risk is transformed so that such a cruise naturally turns into an adventure. In that sense communication presents a concerning aspect. Professionals of the cruise industry, especially when advertising Arctic tours, create a reverse picture of risk and turn it into pure adventure, creating a different/false sense of security. Brochures and websites of Arctic cruise operators emphasize on high quality photographs, highlighting crystal blue and glittering icebergs, polar bears and a huge white, untouched and pristine landscape.

Overall, this does not only cause expectations on the side of the passengers to see all the beautiful aspects advertised in on the internet or in the brochure, it also puts the crew, including the captain and the bridge team, under high pressure to fulfil all of those wishes. In a sense it can be argued that the aspect of risk is a dilemma. Modernity creates new possibilities in finding solutions how to limit risks, but at the same time society wants to cruise to the Arctic, generating new risks. Ultimately, as part of modernity it leads to a loop where new risks are introduced on where the past cannot provide any guidance on the solution finding process.
It seems that onboard cruise vessels targeting the Arctic, passengers do not understand the risks a cruise in the Arctic harbours and that the general acceptance of taking risks for the satisfaction of tourists is high. Beck describes this complexity of the connections between the dynamic natural Arctic environment and the technical and material components that allow humans to enter that environment. Additionally, to embrace the new opportunities in the Arctic presented by climate change, both actors consciously take the risk of navigating in the Arctic. Hence, the risks are, as Beck states it, a socially constructed phenomenon. Both sectors are fulfilling a social demand: the demand for food as well as livelihood, and the demand for adventure in tourism.

However, the material, scientific and technological solutions to mitigate and manage risks in the Arctic are not yet fully developed and pose general risks of operating in the Arctic. In this study the complexity of the situation can be displayed as followed: the vessels serve as a material entity, the information on weather and sea ice information and knowledge of the captain inform decision-making, which result in a limited calculability of risks that can be encountered, and the fact that people are partly ignorant about those risks. This lack of understanding combined with ignorance mirrors our society, which Ulrich Beck describes as the risk society. However, improving weather and sea ice information services does not necessarily reduce the uncertainties and risks related to the access of services, the level of detail or time lags.

Better weather and sea ice services might help in reducing risks and make it possibly more calculable for the individual operator, but the total picture of risk in the Arctic might increase. Improved services might lead to an even greater level of activity in the Arctic, while SAR capacities do not improve at the same pace.
Search and Rescue

Within cruise tourism the vessels tend to, purposefully, travel to more remote areas as they do not wish to encounter other vessels in the area due to the economic benefits of presenting an ‘undisturbed’ portion of the Arctic to its passengers. Already within the Arctic, SAR missions are a difficult undertaking due to vast distances and a gap in SAR capacities and forces.161 With a mindset of the cruise industry to illustrate a picture of remoteness while taking the risks of being isolated from other vessels in the vicinity that could serve as a first responder in case of an accident, describes the risk society approach towards security and safety.

It is important to gain a better understanding of the processes captains of both cruise and fishing operators engage in when managing and mitigating risks in an environment of changing circumstances. Not only is the environment undergoing changes due to climate change, but also commercial demands are made from the results of climate change influencing and shaping both groups. The cruise tourism sector is affected positively by climate change, exploring new routes and areas to respond to the increasing demand of tourists.

Stewart and others claim that Arctic tourism developments are closely interrelated with global changes.162 New and more operators are going to the Arctic, starting this year, to serve the demand for Arctic fascination.

The study by Bystrowska and Dawson reveals that in order to reduce financial costs, larger cruise vessels are intended to go to the Arctic to serve the competitive market.163 Further, the study confirms that cruise operators in the Arctic want to sell the solitude of this area, along with ice and wildlife such as polar bears.164

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164 Ibid.
The opening of potential economically feasible fishing grounds to commercial fishing in the Arctic, is seen as an opportunity. However, both actors do not enter blindly to the Arctic, as they are aware of the risks about navigating at high latitudes. As shown in a study by Protection of the Arctic Marine Environment (PAME) secretariat, introducing higher safety levels and standards is the key to minimising potential risks to Arctic navigation and the environment.\textsuperscript{165} Further, the two actors expressed their concerns that from the lack of adequate weather and sea ice information services, the possible misinterpretation of data and the limited competences of some cruise captains, more SAR missions would be required. Further, due to limited SAR resources they predict the need of increased assistance by cruise and fishing vessels in the vicinity. As I focused on the meteorological and sea ice information utilization and its practice in the decision-making processes, I did not expect this issue to arise. However, this is an outlook on the worst-case scenario resulting from changed conditions in the Arctic, more interest in exploiting the Arctic and the uncertainty in forecast systems and sea ice charts.

Further, the concern was raised that due to the changing circumstances in the Arctic, leading to an expected increase in new cruise operators entering the market, the amount of knowledgeable and experienced ice navigators might not be sufficient. The expected large number of vessels would limit the SAR capacities.

The increasing number of larger vessels going to the Arctic concerns SAR forces as indicated at the ‘The Third Joint Arctic SAR Workshop & TTX’. Concerns such as not reaching a vessel in distress in time and having the limited SAR capacities were mentioned.

When SAR forces are not able to reach a vessel in distress in time, it makes it a matter of other vessels in the vicinity to act as first responders to an incident. Hereby, it is feared, both by cruise captains themselves and the captains of fishing vessels, that the industry does not have the adequate technical solutions and material available to rescue hundreds to thousands of people.

The concerns also address the possibility of placing themselves and their vessels into danger by assisting in rescue missions in the Arctic due to severe weather or the lack of experience on the side of the ship-to-be-rescued. Due to the latter concerns raised, Dawson and others present the idea that cruise operators should have their own SAR strategy in place in case of an accident, but do not further elaborate what this SAR strategy of a cruise operator should include. Bramwell and Lane plead to introduce a government regulated framework, that could act in addition to the Polar Code in the Arctic to establishing rules and guidelines.

Such a mandatory regulation could be the twinning or buddying system as it is called when two vessels travel together. The system could hereby be of immense advantage in providing critical assistance in case of an accident. It can be discussed why the twinning or buddying system is not perceived by cruise operators as a chance to minimise their own risk of an incident of accident when operating in the Arctic. Currently, it is not perceived by operators as a strategy, due to being deemed as ‘uneconomic’. In my interviews it was outlined by cruise captains that they do not favour this strategy because meeting other vessels, especially large vessels such as the MSC, would ‘ruin’ the experience of the passengers of encountering a remote Arctic. Thus, the experience that should be sold to the passengers is rather connected to the aesthetic and remoteness of the Arctic.

Accordingly, the importance of weather and sea ice information is vital to prevent accidents, and training in Arctic navigation is crucial. Possible accidents represent disturbances and a collapse of a practices leading to a de-routinization. SAR missions require captains to move away from their routinised forms of decision-making. Further, the increased activity in the Arctic should consequently mean an upgrade of equipment of SAR-forces.

167 B Bramwell and B Lane, ‘Sustainable tourism and the evolving roles of government planning’ (2010) 18(1) Journal of Sustainable Tourism <https://doi.org/10.1080/09669580903338790>
However, this presents a higher financial strain where it is not yet researched how authorities of the Arctic states addresses the issue. One possibility would be to urge the industries to actively participate in the upgrade in SAR equipment.
7 Conclusion

This study has taken the approach to use practice theory to provide an understanding of the weather and sea ice information services and their impact and relevance on decision-making practices in the Arctic. It was focused on two economic actors, the fishing and cruise industry.

Beck’s risk society framed this study, outlining how risks are defined in the practices by the cruise and fishing industry. Practice theory examined how weather and sea ice information services are utilised, indicating the different elements and their role in mitigating and managing risks in Arctic navigation. Further, decision-making theories were applied to understand how risks in the Arctic influence the decision.

The practice of both target groups is determined by the availability of technology, the weather and sea ice information services and the skills, experiences and knowledge of a captain.

The analysis reveals the interrelation of elements used and practice of weather and sea ice information services involved in planning and decision-making processes. During my study it became obvious that the two actors are addressing those weather and sea ice services differently, depending on the operating location, intention of a voyage, availability of services and preference of the captain. Cruise operators develop and plan cruise itineraries several years ahead, with detailed planning and multiple consultations of historical weather and sea ice information taken into account. Fishermen rely on their own competences and make decisions on the spot, corresponding to the available information services and their observed conditions at the location.

Further, in the case of Arctic navigation, both actors have to deal with near real time information, and there is a large uncertainty within that information. Since the conditions in the Arctic are rapidly changing, decisions are time sensitive and the decision-making process of captains is influenced by time-space.

For both actors, weather and sea ice information services are of significant importance during the operational phase. Especially, accurate, frequent and accessible information on weather and sea ice conditions play an important role in the practice of a captain. Additionally, the meaning and competence assorted to the practice influence the decision-making practice.
Often, various services for weather and sea ice information are employed, either public or private, to compare information and to plan the itinerary. Most sources during the operational-decision making were acquired via the Internet, the most used tool, indicating a crucial importance to access services. However, all communication systems, for instance the radio, internet and satellite phones, seem to be limited either in geographical range or in volume and capacity. Depending on the location, different services of weather and sea ice are consulted. Both actors consult services available from public providers, such as DMI or MET Norway. Additionally, private services are used, but both actors want to be sure the services answer their needs, answering the second subquestion of this research.

Risks in the Arctic affects decision-making practices onboard cruise and fishing vessels. The risks present affects itinerary planning as well as operational decision-making practices of a captain. To deal with the nature of the dynamic environment of the Arctic requires flexibility of the captain towards changes. Skills, experiences and knowledge highlight a routinised behaviour and are elementary for competences of a captain onboard a cruise and fishing vessel. Further, the experience and knowledge of a captain in Arctic navigation are crucial to make optimal decisions.

In sum, both actors are willing to take the risks inherent in Arctic navigation. The activities of cruise and fishing actors are under economical pressure. Cruise captains are under pressure to satisfy the passengers in what was sold to them, whereas the captain of a fishing vessel is pressured to catch the intended amount of fish. Accordingly, there is a need for enhancement of adequate and accessible services. The accessibility of those services must be improved since connectivity across the Arctic is essential. It allows captains to access services on weather and sea ice conditions and reduces uncertainty. Further, more observations must be done to produce better forecast and to develop a sea ice forecast services. The experience of end users with the current weather and sea ice information services is of crucial importance for the optimisation of services. Optimisations in weather and sea ice services, tailor made towards the end user, would decline the uncertainty of Arctic navigation.
The end-user interaction with the producer will be beneficial for both sides, the producer gains better understanding in what the end user needs, and the end user has the advantage of receiving information that is tailored to the needs. Such interactions would ultimately lead to a better utilisation and integration of the information into decision-making processes. However, more data does not necessarily mean better forecasts and information services. Data and services must be made easily comprehensible to increase the interpretation capabilities of captains and crew. A commonly agreed and applied standard for ice charts can optimise this and decrease uncertainty within decision-making processes. However, limitations in forecasting and ice chart services are not the only reasons for concern in the Arctic. Currently, the maritime actors adhere to the minimum standards of the Polar Code, which only to a limited extent address the risks. Trainings can mitigate the risks of negative outcomes in Arctic navigation. Besides, adequate training of crew and captains in all areas, such as navigation and safety matters, should be done prior to any cruising activity in the Arctic to reduce risks. This should be incorporated and specified in legally binding documents such as the Polar Code. In general, the Polar Code and its relevant regulations to mitigate risks must be assessed according to its practicality to the actual situation in the Arctic, not only encompassing big vessels but all actors in the Arctic. Improved weather and sea ice services might lead to an even greater level of activity in the Arctic, while SAR capacities, legislations and technology to address the new risks do not develop at the same pace.
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Figure:

Figure 1 Dallmann, WK, ‘Arctic boundaries’ (Norwegian Polar Institute nd) <http://www.arctic-council.org/images/PDF_attachments/Maps/boundaries.pdf>

Figure 4 IMO ‘Resolution A.1024(26) Guidelines for Ships Operating in Polar Waters’ (International Maritime Organisation 2009) <http://library.arcticportal.org/id/eprint/1475> accessed 1 February 2018
Figure 6  AECO Happy Cruise Tourism Day (AECO nd)
Appendix A

Interview guide

➔ Introduce myself
➔ Explain purpose of study
➔ Ask for permission to record

1. Can you briefly describe the activities that you/ your company works with?

2. Where do you operate and during which seasons/months?

3. What is your role on board? / What are your tasks?

4. Which forecast services do you use during planning your trip?

5. How much time in advance do you start planning?

6. Which forecast services do you use while you are out at sea?

7. Do you feel that these services cover your needs while you are out at sea?

8. What gaps in forecast/prediction service can you identify and what are the consequences/repercussions of these gaps?

9. How do you deal with the uncertainties inherent in forecasts (for example: chances for extreme weather events to occur in terms of probability; error margins related to ice edge location)?

10. Are there geographical areas where operations are particularly difficult (in terms of conditions of available forecasts)? And Why?

11. Do you have specific needs when it comes to improved weather and/or sea ice services related to content and/or format?