# Deck Officers' Preferred Steering Modes and Future Perspectives on Ships' Navigational Aids

Sami Wahlroos

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Author: Sami Wahlroos
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Supervisor(s): Peter Björkroth & Katarina Sandström

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## Abstract

Autopilot systems and bridge navigational aids such as the Electronic Chart Display and Information System (ECDIS) and Automatic Radar Plotting Aids (ARPA) have revolutionized ships bridge operations. This thesis investigates how deck officers use autopilot steering modes—Track, Heading, and Course—and bridge navigational aids. Thesis also examines influences of company policies, captain's orders, and deck officer experience.

A mixed-methods approach, combining structured interviews with 11 deck officers, revealed key trends: Heading mode was dominant (78%), Track mode was selectively used (18%) in predictable conditions, and Course mode was rarely used (4%) due to limited practicality and rarity of its availability in the bridge systems. External factors, including company policies, shaped mode preferences, with less experienced officers relying more on automation and experienced officers favoring manual control for its adaptability to most situations.

Navigational aids like ECDIS and ARPA were essential for improving situational awareness and assisting in collision avoidance and challenging navigational situations. Features such as Estimated Time of Arrival (ETA) calculators and radar overlays were frequently used. Previous studies expressed concerns about over-reliance on automation and skill degradation, which highlighted challenges in balancing human oversight and automated technology.

The thesis also investigated outlooks on emerging technologies like artificial intelligence (AI) and Maritime Autonomous Surface Ships (MASS). Deck officers emphasized the need for human oversight to reduce risks, especially for passenger vessels. Recommendations include adding manual navigation training, especially for emergency situations and encouraging balanced policies in usage of automation to ensure manual navigational capabilities of deck officers and safety in future maritime operations.

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Language: English
Key Words: Autopilot Systems, Bridge Navigational Aids, Maritime Automation, Situational Awareness, Human-Technology Interaction.

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# 1 Introduction

The maritime industry remains a cornerstone of global trade, with over 80% of goods transported via sea routes annually (IMO, 2023). As this sector evolves, advanced navigational technologies such as autopilot systems, Electronic Chart Display and Information Systems (ECDIS), and Automatic Radar Plotting Aids (ARPA) have changed traditional navigation. These tools not only improved safety but also redefine the role of deck officers in bridge operations, emphasizing the interaction between automation and human expertise.

Autopilot systems, a key component of modern navigation, operate through three primary steering modes: *Heading, Course,* and *Track*. These modes reflect varying levels of automation, with Heading mode offering the highest level of manual control, Course mode compensating for environmental influences like wind and current, and Track mode representing high-level automation by enabling accurate following to pre-planned routes in ECDIS. While these systems optimize navigational accuracy, their effectiveness is influenced by external factors, such as company policies, captain's orders, and environmental conditions, as well as internal factors, including the experience and decision-making preferences of deck officers.

The integration of these systems into maritime industry has brought both benefits and challenges. Research highlights the efficiency gains from automation, such as reduced cognitive workload and enhanced situational awareness (Kaber, Endsley, 2004) However, it also raises concerns about automation complacency, skill degradation, and the reliability of automated systems under complex conditions (Parasuraman & Riley, 1997). These issues require a deeper understanding of how deck officers interact with automation to ensure a balanced approach to safety and operational efficiency.

Levels of Automation (LOA) theory provides a useful framework for analyzing the interactions between deck officers and automated systems in navigation. Autopilot modes align with this framework, offering insight into the decision-making processes and situational awareness of deck officers. For instance, heading mode represents low-level automation where manual control is predominant, while Track mode exemplifies high-level automation, reducing the need for operator intervention but potentially increasing the risk of complacency. (M.L. Cummings, 2004)

This thesis explores the use of autopilot steering modes and navigational aids, focusing on how deck officers adapt to different levels of automation. It examines the influence of organizational factors, like company policies, leadership directives such as captains' orders, and personal experiences and preferences on their choices. By integrating structured interviews with 11 deck officers from diverse backgrounds, the study provides qualitative and quantitative insights into the navigational operations of modern bridge systems.

## 1.1 Research Questions

- How do deck officers utilize the three primary autopilot steering modes (Track, Heading, and Course) and navigational aids such as ECDIS and ARPA?
- How do company policies, captain's orders, and individual background influence their choices?
- What are deck officers' perspectives on the future of navigation, including automation and autonomous ships?

The findings of this study contribute to maritime management by addressing important issues in interaction with modern and rapidly changing technology. As the industry transitions toward increased automation and technologies like Maritime Autonomous Surface Ships (MASS), this research emphasizes the importance of maintaining a balance between technological automation and human oversight. By identifying the challenges and opportunities presented by automation, the study offers useful recommendations for maritime training institutions, policy development, and automation system design.

The results aim to inform industry decision makers, including maritime policymakers, training institutions, and shipping companies, on how to address the challenges of automation while preserving the essential role of professional skills in guaranteeing safety and performance.

# 2 Purpose

The purpose of this thesis is to investigate how deck officers operate ships’ autopilot system steering modes (Track, Heading, and Course) and navigational aids such as the Electronic Chart Display and Information System (ECDIS) and Automatic Radar Plotting Aids (ARPA) in their regular navigational operations. It aims to understand the factors influencing these decisions, including company policies, captain’s orders, and individual backgrounds. Additionally, this research investigates deck officers' perspectives on the future of maritime navigation and the increasing role of automation and autonomous ships.

## 2.1 Objectives

### 2.1.1 Examine the Utilization of Autopilot Steering Modes:

This thesis investigates how frequently, and under what circumstances deck officers use each autopilot steering mode. Track mode, representing high levels of automation, is expected to be more common in more predictable, low-traffic conditions, whereas Heading mode, a lower level of automation, may be more common in dense traffic and less predictable situations. By mapping these preferences, this research seeks to provide understanding into the usage of ships’ bridge systems.

### 2.1.2 Analyze External and Individual Influences on Decision-Making:

Navigational decisions are shaped by a range of external and personal factors. For instance, company policies encouraging safety and optimization of routes, may prioritize Track mode, while captain’s orders may encourage more manual control of Heading mode. Individual factors, such as experience and familiarity with automated systems, also play a role. Research indicates that less experienced officers often rely more on automation to compensate for their developing skills, while experienced officers favor more manual control (IMO, 2023).

### 2.1.3 Explore Perspectives on Future Automation and Autonomous Ships:

The maritime industry is quickly developing toward higher levels of automation, including Maritime Autonomous Surface Ships (MASS) and AI-driven navigational systems. This study examines how deck officers perceive these advancements, including their potential benefits and challenges. It also evaluates concerns, such as automation complacency and skill degradation, which have been noted as key challenges in previous studies (Nof, 2023).

## 2.2 Significance

This thesis addresses the growing need for a balanced approach to automation in maritime navigation. While technologies like ECDIS and autopilot reduce cognitive workload in navigation, they also raise concerns about automation complacency and manual skill degradation (Chan, Norman, Pazouki Golightly, 2022). By analyzing real-world practices and perspectives, this research aims to connect the gap between technological advancements and human factors in modern navigation. This thesis offers practical recommendations for maritime training institutions, shipping companies, and policy makers.

## 2.3 Practical Implications

### 2.3.1 Training and Skill Retention:

The findings will advise maritime training institutions to emphasize both traditional manual navigation skills and technologically advanced navigational aids. Continuous professional development is important to reducing risks associated with skill degradation.

### 2.3.2 Policy Recommendations:

The study aims to provide evidence-based recommendations for shipping companies and Maritime policymakers like IMO. These policies should focus on flexibility, allowing deck officers to adapt automation levels to situational demands and personal preferences.

### 2.3.3 Safety and Operational Efficiency:

By identifying best practices in the use of autopilot modes and navigational aids, this research contributes to an increase in safety and operational navigational optimization.

The purpose of this thesis is to contribute to the ongoing dialogue about the integration of automation into maritime navigation, indicating that human skills remain essential for safe and optimal navigation.

# 3 Theoretical starting points

In the maritime industry, the integration of modern navigational technologies has significantly changed traditional practices, requiring a re-evaluation of navigators' roles and the interaction between manual control and automation. This section explores the foundational theories supporting this thesis, including the Technology Acceptance Model (TAM) and the Levels of Automation (LOA) framework. Additionally, it addresses key concepts such as automation complacency and skill degradation, which are important for understanding the relationship between navigator and rapidly advancing technology in navigation.

## 3.1 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by F. D. Davis (Davis, 1989), is a widely used framework for understanding how users come to accept and apply new technologies. TAM identifies two primary determinants of technology adoption:

Perceived Usefulness (PU): This refers to the degree to which a mariner believes that using specific technology will enhance their job performance. For example: A deck officer might prefer Track mode on autopilot during open-sea navigation because it reduces manua workload and maintains a pre-planned route accurately. Conversely, Heading mode might be favored in complex or high-traffic situations because it allows for more direct control, which the officer might perceive as more useful for maintaining safety.

Perceived Ease of Use (PEOU): This refers to how effortless a mariner perceives the technology to be. Technologies with intuitive interfaces, like ECDIS with visual overlays and alarms, are more likely to be adopted. For example: Officers who find ECDIS user-friendly may rely on its route planning and error alerts. Others might avoid certain features if they perceive the system as overly complex or if insufficient training has been provided.

In the context of maritime navigation, TAM has been applied to understand how mariners adopt and use advanced navigational technologies, such as Electronic Chart Display and Information Systems (ECDIS) and Automatic Radar Plotting Aids (ARPA). The adoption of autonomous maritime operations has also been analyzed using a modified TAM model, addressing various effects arising from the introduction of Maritime Autonomous Surface Ships (MASS). (SSRN, 2022)

The Technology Acceptance Model provides valuable insights into the factors influencing the adoption of navigational technologies in the maritime industry. Understanding these factors can aid in designing and implementing systems that align with mariners' needs and preferences, ultimately improving safety and efficiency in maritime operations. (Academia, 2018)

## 3.2 Levels of Automation (LOA)

The Levels of Automation (LOA) framework, articulated by Parasuraman, Sheridan, and Wickens (2000), categorizes automation into distinct levels ranging from fully manual control to full autonomy (Parasuraman et al., 2000) LOA helps analyzing how tasks are allocated between navigators and electronic navigational aids, making it relevant to autopilot steering modes:

Manual Control (Low Automation):
Represented here by Heading mode, where the officer maintains direct control, ensuring adaptability in changing environments.

Shared Automation (Medium Automation):
Represented by Course mode, which compensates for environmental factors like wind and current while requiring some operator input.

Full Automation (High Automation):
Represented by Track mode, where the autopilot follows a pre-made route without continuous manual oversight.

The LOA framework highlights that no single mode is universally ideal; the effectiveness of an automation level depends on the operating context. Flexibility in automation means that operators must have the ability and the training to transition between automation levels as situations demand. For instance, a ship navigating through open waters might rely on Track mode for efficiency but switch to Heading mode when entering a busy port, where precise, real-time control becomes essential (Parasuraman et al., 2000).

## 3.3 Automation Complacency

Automation complacency refers to the reduced awareness of operators who over-rely on automated systems. In maritime contexts, this complacency can result in delayed manual interventions to emergency situations, as deck officers may assume that systems such as autopilot or ECDIS will function flawlessly. Research shows that increased automation can unintentionally lower the situational awareness and manual skills of operators (Parasuraman & Riley, 1997).

This thesis utilizes automation complacency in analyzing why some officers, particularly those with extensive experience, prefer Heading mode, which demands active engagement, over more automated modes like Track mode.

## 3.4 Skill Degradation

Skill degradation refers to the decline in manual and cognitive skills due to prolonged reliance on automation. In maritime navigation, this issue is particularly important as advanced systems like ECDIS and autopilot have become standard. Studies highlight that skill degradation poses risks in emergency scenarios where manual intervention is required (Wrobel et al., 2022). To reduce this risk, maritime training increasingly emphasizes hybrid training models that balance technological knowledge with traditional navigation skills. This thesis investigates how officers view the balance between manual navigation and automation, with a focus on retaining important navigational skills.

## 3.5 Connection to Human Factors

Human factors, including situational awareness, decision-making, and teamwork, remain fundamental to maritime safety. Even with advanced automation, operators are responsible for interpreting data, managing navigational bridge systems, and making important decisions. Research suggests that best outcomes occur when technology supports, rather than replaces, human expertise (Endsley, 1995).

Situational Awareness (SA): M.R. Endsley defines SA as the perception, comprehension, and projection of environmental elements critical to decision-making. High-automation modes, such as Track mode, can reduce SA by disengaging navigators from active control, stressing the need for proactive monitoring (Endsley, 1995)

Decision-Making in Automation: Effective decision-making combines automation with human judgment, ensuring that operators remain engaged and capable of responding to unexpected challenges. This study investigates how decision-making varies across different steering modes.

The integration of human factors with automation is particularly relevant to this thesis, as it examines how deck officers navigate using multiple steering modes and navigational aids under different navigational environments.

## 3.6 Emerging Concepts in Maritime Navigation

The increasing adoption of Maritime Autonomous Surface Ships (MASS) introduces new challenges and opportunities for navigation.

Artificial Intelligence (AI): AI-driven navigational aids are changing route optimization and real-time analytics, etc., offering improved performance but raising concerns about ethical and operational consequences (Li, Yuen. (2024).

Autonomy in Shipping: The maritime industry predicts the adoption of MASS in cargo operations, particularly on short and repetitive routes, while passenger vessels continue to prioritize human supervision on board ships.

This thesis investigates how these advancements influence deck officers' views and their readiness to adapt to the developing navigational practices.

Conclusion

The theoretical starting points outlined here provide a foundation for understanding the relationship between deck officers’ decision-making and evolving automation in maritime navigation. By applying TAM and LOA, and addressing challenges such as automation complacency and skill degradation, this thesis aims to contribute to the development of balanced navigational practices that optimize both safety and performance.

# 4 Theoretical Background

The maritime sector has undergone significant advancements in technology over recent decades, reshaping modern navigation and emphasizing the need for an understanding of their functions, possibilities and consequences. This section explores the key components of modern navigation, including autopilot systems, Electronic Chart Display and Information System (ECDIS), and Automatic Radar Plotting Aids (ARPA) and their relationship with the Levels of Automation (LOA), while addressing the influence of human factors such as situational awareness and decision-making in maritime navigation.

## 4.1 Autopilot Systems and Steering Modes

Autopilot systems are essential to modern ship navigation, providing automated control over steering while reducing deck officer’s workload. Autopilot systems offer three primary steering modes, Track mode, Heading mode, and Course mode, each representing a different level of automation.

### 4.1.1 Track Mode:

This mode follows a route created on route planner on the Electronic Chart Display and Information System (ECDIS). It is automatically adjusting for cross-track deviations by utilizing GPS. It is particularly suited for open waters with little navigational challenges.

### 4.1.2 Heading Mode:

This mode maintains constant heading based on the gyro compass heading set by the officer on watch (OOW). It is easier to notice drift factors such as wind and current, allowing the possibility for real-time adjustments to counter these changes in environment condition. It offers operators greater control in high-traffic areas or more challenging conditions.

### 4.1.3 Course Mode:

This mode maintains a course over ground, compensating for drift factors such as wind and current. However, its slower response to stabilize course, and popularity of other modes limit its usage.

The division of these steering modes corresponds to varying levels of automation as outlined in the Levels of Automation (LOA) framework. Heading Mode represents low automation, requiring most human oversight. Track Mode, in contrast, reflects a higher level of automation, where the system autonomously follows a route with minimal intervention. Understanding these distinctions is essential to evaluating their usage in specific navigational situations. (Karim, 2020)

## 4.2 Electronic Chart Display and Information System (ECDIS)

ECDIS is a geographic information system used for nautical navigation that complies with International Maritime Organization (IMO) regulations as a method of electronic navigation. It replaces traditional paper charts, using Electronic Navigational Charts (ENC´s) and integrating data from GPS, radar, AIS, and other navigational sensors into one digital platform. It improves situational awareness and decision-making by offering features such as route planning, safety alarms, and cross-track error alerts. (Asyali, 2012)

- Operational Use: Functions like Estimated Time of Arrival (ETA) calculators, predictors and radar overlays are frequently used for monitoring and maneuvering.

- Integration with Autopilot: ECDIS interacts with autopilot systems in Track Mode, allowing vessels to automatically follow routes made in the route planner. However, the system's reliance on accurate input data Emphasizes the importance of cross-verification with radar and visual observations.

Despite its benefits, over-reliance on ECDIS may lead to automation complacency, as navigators risk becoming passive monitors rather than being active decision-makers. Studies emphasize the importance of training to reduce these risks (Wrobel et al., 2022).

## 4.3 Automatic Radar Plotting Aids (ARPA)

ARPA radar systems improve radar functionality by allowing automatic tracking of targets and calculating essential data such as speed, course, Closest Point of Approach (CPA) and Time to Closest Point of Approach (TCPA). (Yousefi. 2007)

- Collision Avoidance: ARPA is essential for collision avoidance, particularly in high-traffic areas or low-visibility conditions. Its ability to predict potential navigational hazards in real-time significantly improves safety in maritime navigation.

- Integration with ECDIS: Data from ARPA radar systems can be overlaid on ECDIS, enabling mariners to combine information from multiple ships' navigational aids and make better informed decisions.

- Human Oversight: Despite its benefits, ARPA requires skilled navigators to understand its outputs accurately and respond appropriately to system alerts. Errors in judgment or over-reliance on automated features can compromise safety.

## 4.4 Levels of Automation (LOA) and Navigational Practices

The LOA framework categorizes the allocation of tasks between human operators and automated systems (Parasuraman, Sheridan, Wickens. 2000). It provides a perspective for evaluating how different steering modes align with different levels of automation: (Jamieson, Skraaning. 2016)

- Low Automation: Heading Mode reflects near manual navigation with minimal automation, where navigators maintain direct control and respond to changes in environment. Changes in environment require constant navigators' input.

- Medium Automation: Course Mode introduces automated compensation for environmental factors like drift but involves significant navigators' involvement.

- High Automation: Track Mode represents near-full automation, by autonomously following pre-set routes made in ECDIS route planning. Requires minimal navigator input (In open seas and low traffic conditions) but constant monitoring of navigational situation.

Applying LOA to maritime navigation reveals how automation influences deck officers' roles, from decision-making to level of manual control. For instance, navigators using Track Mode must constantly monitor data reliability, while those navigating in Heading Mode remain actively engaged in navigation.

## 4.5 Human Factors: Situational Awareness and Skill Degradation

The successful integration of automation depends heavily on human factors, particularly situational awareness and skill degradation.

- Situational Awareness (SA): Is defined as understanding environment, its elements, and how it changes with respect to time and other factors. SA is essential for safe navigation (Endsley, 1995). High levels of automation, as seen in Track Mode, may reduce SA by reducing navigators' direct interaction with the Ships' navigational aids. (Endsley, 1995)
- Skill Degradation: Extended dependence on automation can weaken manual and cognitive skills, leaving operators unprepared for emergencies or system failures (Wrobel, 2022). Research Emphasizes the need for hybrid training programs that combine traditional manual navigation techniques with advanced automated technology.

## 4.6 Integration and Implications for Training

As technology advances, the interaction between human expertise and automation becomes increasingly complicated. Maritime training must adapt to ensure navigators remain proficient in manual skills while taking advantage of the benefits of automation. Emphasizing cross-verification techniques and critical thinking can help bridge the gap between human judgment and technological capabilities.

Conclusion

The theoretical background Focuses on the relationship between automation, human factors, and navigational systems in maritime operations. By examining autopilot systems, ECDIS, ARPA, and the LOA framework, this thesis highlights the importance of balanced integration of new technology into maritime navigation. As the maritime industry moves toward greater automation, understanding these changes will be essential for optimizing navigational safety and productivity.

# 5 Previous research/similar studies

This section reviews existing literature relevant to autopilot systems, navigational aids, and human-technology interaction in maritime navigation. The studies presented provide understanding into how advancements in technology and human decision-making shape modern navigation, presenting a basis for analyzing the findings of this thesis.

## 5.1 Use of Autopilot System and Steering Modes

Research on autopilot systems has focused on their ability to improve safe navigation and optimization. Kim, Schröder-Hinrichs, & Baldauf. (2020) analyzed preferences for different autopilot modes, observing that Heading mode is most commonly used due to its adaptability in different navigational conditions, while Track mode is suitable for predictable, low-traffic situations. Course mode, however, has minimal usage due to its slower response to stay in course.

Studies can also aid connecting different autopilot modes to Levels of Automation (LOA) theory. Sheridan and Verplank (1978) created LOA, which provides a framework to understand varying degrees of human-and machine interaction. For instance, Track mode aligns with higher levels of automation due to its dependence on pre-made routes done in ECDIS route planning mode, while Heading mode reflects lower automation levels requiring constant navigator input.

## 5.2 Navigational Aids: ECDIS and ARPA

ECDIS and ARPA play key roles in improving safety through integrating data from other navigational aids and collision avoidance capabilities. Van Westrenen and Praetorius (2014) evaluated ECDIS's capability in reducing workload, finding that its real-time alerts and cross-track error notifications allow navigators to maintain better situational awareness. However, they caution against over-reliance, as it can lead to automation complacency.

ARPA's role in collision avoidance has also been widely studied. Chauvin, Lardjane, Morel, Clostermann & Langard. (2013) observed that while ARPA significantly improves decision-making by automating radar tracking, its effectiveness depends on the operator’s ability to analyze its data correctly. These findings align with this thesis, where deck officers highlighted ETA calculators and predictors as fundamental tools but noted potential challenges with system reliability.

## 5.3 Human Factors in Maritime Navigation

Human factors are key components of safe navigation. Endsley (1995) introduced a situational awareness model comprising three stages: perception, comprehension, and projection. Research demonstrates that situational awareness is essential for managing complicated situations and integrating human judgment with automation.

The risks of automation complacency were documented by Parasuraman and Riley (1997), who found that operators often become over-reliant on automated systems, leading to delays in manual interventions. This concern is particularly relevant in environments with high levels of automation, such as ships' modern integrated bridge systems.

Recent studies by Chan, Norman, Pazouki & Golightly. (2022) expand on this, identifying skill degradation as a key concern due to long-term dependence on automation. The researchers argue that traditional seamanship skills must be maintained through continuous training to counteract this decline.

## 5.4 Perspectives on Automation and Autonomous Ships

Developments in Maritime Autonomous Surface Ships (MASS) have caused significant academic interest. Kitada, Lundh & MacKinnon. (2019) identified key challenges in integrating autonomy into maritime sector, focusing on the importance of regulatory policies and human oversight. Cargo vessels on short, repetitive routes were highlighted as ideal candidates for early adoption. Similarly, Komianos (2018) analyzed the role of technologies such as AI and real-time data analytics in enabling further autonomy. While these innovations promise higher productivity, the study stressed the importance of having human operators to oversee and intervene when necessary. Participants in this thesis repeated these findings, expressing optimism about MASS for cargo operations while expressing concerns about safety and system reliability for passenger ships.

## 5.5 Gaps in Existing Literature

While existing research provides important findings, notable gaps remain:

- Context-Specific Analysis: Many studies lack specificity, focusing on general trends rather than the operational differences among ship types and routes.
- Integration of LOA Theory: Studies did not directly connect steering modes with levels of automation.
- Longitudinal Studies: There is Limited research about emerging technologies of maritime navigation.

This thesis addresses these gaps by examining how deck officers use steering modes and navigational aids in different situations, integrating LOA theory to provide an analysis of human-automation interaction.

# 6 Methods and Procedures

This study applies a mixed-methods survey-based approach to explore deck officers' preferences for steering modes (Track, Heading, and Course modes), their use of ships' navigational aids (ECDIS, ARPA, and autopilot), and their perspectives on future automation and autonomous ships. The goal is to understand how these factors are influenced by company policies, captain's orders, and officers' backgrounds. The research also incorporates previous studies about how integration of automated systems affects manual navigation skills and situational awareness.

The research is divided into two phases: quantitative data collection and qualitative open-ended questions. This mixed-methods approach allows for comprehensive analysis, providing both statistical insights and in-depth understanding of deck officers' views on maritime navigation. (Creswell & Plano Clark, 2017).

## 6.1 Research Design

Quantitative Phase**:** The study begins with a survey designed to quantify the frequency of steering mode usage (Track, Heading, Course). Participants are asked to report how often they use each mode (measured on a scale of 0-100%) and to provide details on the context in which each mode is used (e.g., open sea, port approaches and high traffic areas). Deck officers background info and outlook on automation and the future of ship navigation is also conducted in quantitative manner.

Qualitative Phase**:** In-depth, open-ended questions are conducted with deck officers to explore the reasons behind their steering mode preferences and their use of Electronic Chart Display and Information System (ECDIS) functions. The survey also addresses how company policies or captain's orders influence decision-making. Other topics conducted in qualitative approach include; how bridge navigational tools have changed during deck officers' career, what will be next game changer in navigation and how navigation will change in the next 10 years. This qualitative data provides deeper understanding into officers' decision-making and outlook on future of maritime navigation.

## 6.2 Sample Selection

The study targets a diverse sample of licensed deck officers working across various ship types, including different types of cargo- and passenger vessels. Participants were found through my own contacts. The sample includes deck officers with a range of experience levels to capture a wide range of perspectives. 11 deck officers participated in the survey.

Participants were differentiated using the following criteria:

- Years of experience: Participants are divided into categories based on their experience level (less than 1 year, 1-3 years, 3-5 years, 5-10 years and over 10 years) to assess whether experience affects steering mode preferences, use of bridge navigational tools and attitudes toward automation.
- Ship types: Deck officers from different ship types (e.g., passenger- and cargo ships) are included to determine whether operational environments influence the choice of steering modes, use of navigational aids and outlook on future.
- Geographical routes: Participants are differentiated by their route length. This included short shipping routes (less than 2 days), medium shipping routes (3-4 days), and long shipping routes (more than 5 days), to assess how voyage length influences the use of technology and steering modes. Also deck officers sailing on standard and non-standard routes are differentiated.

## 6.3 Data Collection Tools

Survey Instrument**:** A structured survey is used to collect data. Quantitative approach is used on steering mode usage, outlook on future of autonomous vessels and background info of deck officers. Survey topics include:

- What percentage of time do you use *Track mode*, *Heading mode***,** and *Course mode* when navigating your ship?"
- In what types of situations do you prefer to use each mode?
- Deck officers background info.
- Outlook on automation and the future of ship navigation**.**

Open-ended questions are used on the qualitative aspects of the research. This encourages participants to share detailed experiences and insights. Survey topics include:

- Which **Electronic** Chart Display and Information System (ECDIS) functions are frequently used and in what situations?
- How the use of autopilot, ECDIS, and ARPA has changed over the participant's career.
- What will be next game changer in navigation technology?
- How navigation will change in next 10 years.

The survey also addresses how company policies or captain's orders influence decision-making in choosing steering mode.

## 6.4 Data Analysis

Quantitative Data Analysis: The survey data is analyzed using descriptive and inferential statistics. Frequency distributions are used to determine how often officers use different steering modes and navigational aids, while cross-tabulation is used to identify correlations between officer experience, ship type, route length and steering mode preferences. Statistical software such as Excel is used for this analysis.

Qualitative Data Analysis**:** The qualitative data is analyzed using thematic analysis. Method is described by (Braun & Clarke, 2006). Thematic analysis allows for the identification of common themes in following topics:

- In what situations different steering modes are used.
    - How company policies/captains' orders affect which steering mode is used.
- ECDIS functions frequently used.
- Change in usage of bridge navigational aids.
- Future of bridge navigational aids.
- Outlook towards future of automation.

## 6.5 Ethical Considerations

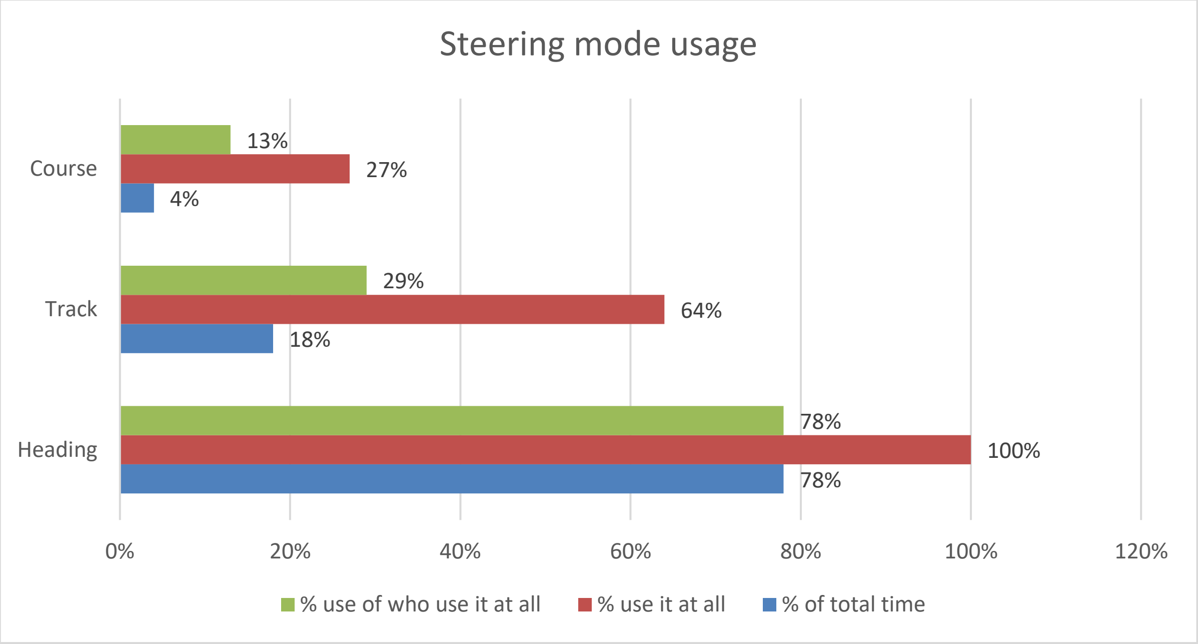
This study adheres to the ethical guidelines for research. All data collected is anonymized to protect the privacy of the participants.

## 6.6 Limitations

While the study aims to provide comprehensive understanding of the steering mode preferences and navigational practices of deck officers, certain limitations are to be acknowledged. First, the small sample size of 11 deck officers may limit the generalizability of the findings to the broader maritime industry. However, this may open an opportunity for further research in master's thesis. Second, the reliance on self-reported data could introduce bias, as participants may offer professionally desirable responses. Finally, the rapid pace of technological advancement in the maritime sector means that the study's findings may be time-sensitive, particularly as autonomous ship technology continues to develop.

# 7 Results and Interpretation of the Results

This section presents the findings from structured interviews with 11 deck officers, focusing on their usage of autopilot steering modes, ships' navigational aids, and the factors influencing their choices. Insights are drawn from both quantitative and qualitative responses to provide a comprehensive understanding of deck officers navigational preferences and perspectives on the future of maritime automation. Research questions can be found in Appendix A.



## 7.1 Track Mode

Track mode was used by 64% (A, B, C, E, G, H, K) of deck officers, averaging 18% of total navigation time of participants. Of those deck officers who used track mode, it was applied in 29% of their total steering time. Officers primarily used Track mode in open waters with minimal traffic, describing it as beneficial for steady routes during long passages and crossings (Respondents A, B, G, I, K). However, it was rarely used near land or in high-traffic areas due to its limited adaptability for other traffic, for example.

Track mode was most mentioned 5(A, B, G, I, K) times as being used in open waters and with little or no traffic.

Interpretation: The selective use of Track mode aligns with its high level of automation, where the system autonomously follows a pre-planned route without manual intervention. This reflects Level 3 Automation in navigation, where the navigation system handles operational control in specific scenarios, requiring human supervision for exceptions. (Parasuraman, Sheridan, Wickens. 2000)

## 7.2 Heading Mode

Heading mode was preferred in most situations and was most frequently used, averaging 78% of all navigation time, and was employed by all deck officers (100%). Its adaptability to most navigational situations made it the preferred mode in traffic-dense areas, during bad weather, or when high steering accuracy was required (Respondents G, H, I). This mode allows officers to maintain manual control while using automation for course stability.

Interpretation: Heading mode represents Low level of Automation, where the autopilot system provides support but requires continuous navigator input and decision-making. Its widespread use demonstrates its role in maintaining situational awareness and responsiveness in changing navigational environments.

## 7.3 Course Mode

Course mode was the least and rarely or never used, averaging only 4% of total navigation time. Only 27% (A, G, H) of deck officers reported using it at all. Of those who use course mode, use it 13% of total time steering. It was cited for its slow response to stabilize course and usage in similar situations with other modes (Respondents F, G). Its limited functionality made it less favorable in comparison to Track mode. Heading mode gives better understanding of drift factors such as wind and current.

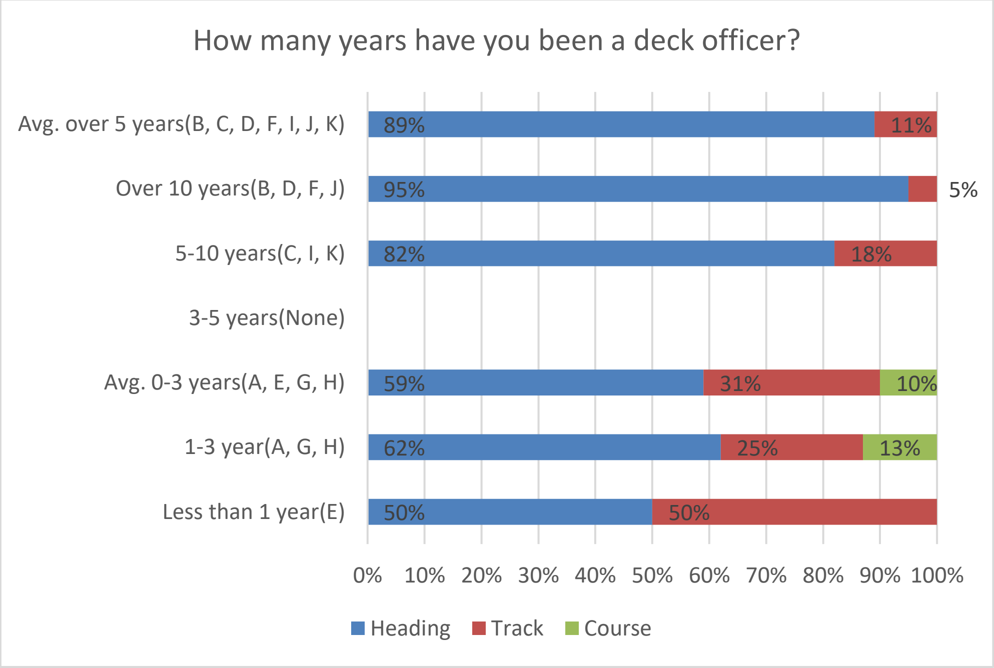
Interpretation: Course mode is considered a medium level of automation. It has limited adaptability and features compared to newer, integrated systems like Track mode. Its low usage is explained mostly that course mode is equipped in far less ships than heading and track modes are. But also transition toward more automated systems may leave it out of competition, since most deck officers are still using heading mode, even if course mode is available.

## 7.4 Autopilot Steering Mode Utilization

Background info of interviewed deck officers.

Question 9.1. How many years have you been a deck officer?

Averages:
Less than 1 year(E): Heading. 50%, Track. 50%, Course. 0%.
1-3 years (A, G, H): Heading. 62%, Track. 25%, Course. 13%.
Avg. 0-3 years (A, E, G, H): Heading. 59%, Track. 31%, Course. 10%
3-5 years (None):
5-10 years (C, I, K): Heading. 82%, Track. 18%, Course. 0%.
Over 10 years (B, D, F, J): Heading. 95%, Track. 5%, Course. 0 %.
Avg. over 5 years (B, C, D, F, I, J, K): Heading. 89%, Track. 11 %, Course. 0%.

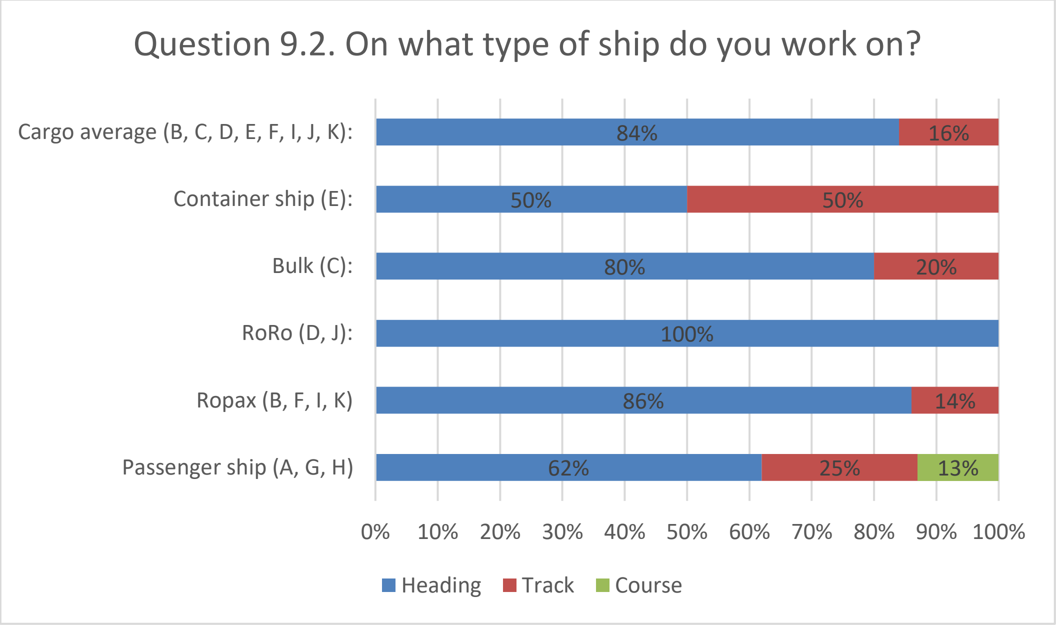


All deck officers who had less than 3 years of experience (A, E, H) had captains/company policies about steering mode usage (Average (A, E, H): Heading. 62%, Track. 33%, Course. 5%.). Deck officers with less experience were using less heading mode (59% vs. 89%) and more track mode (31% vs. 11%) on average. They were also the only ones who had captains/company orders in place (A, E; H).

Question 9.2. On what type of ship do you work on?

Averages:

| | | | |
|---|---|---|---|
| Passenger ship (A, G, H): | Heading 62%, | Track 25% | Course 13%. |
| Ropax (B, F, I, K): | Heading 86%, | Track 14% | Course 0% |
| RoRo (D, J): | Heading 100% | Track 0% | Course 0% |
| Bulk (C): | Heading 80% | Track 20% | Course 0% |
| Container ship (E): | Heading 50% | Track 50% | Course 0%. |
| Cargo average (B, C, D, E, F, I, J, K): | Heading 84%, | Track 16 %, | Course. 0%. |

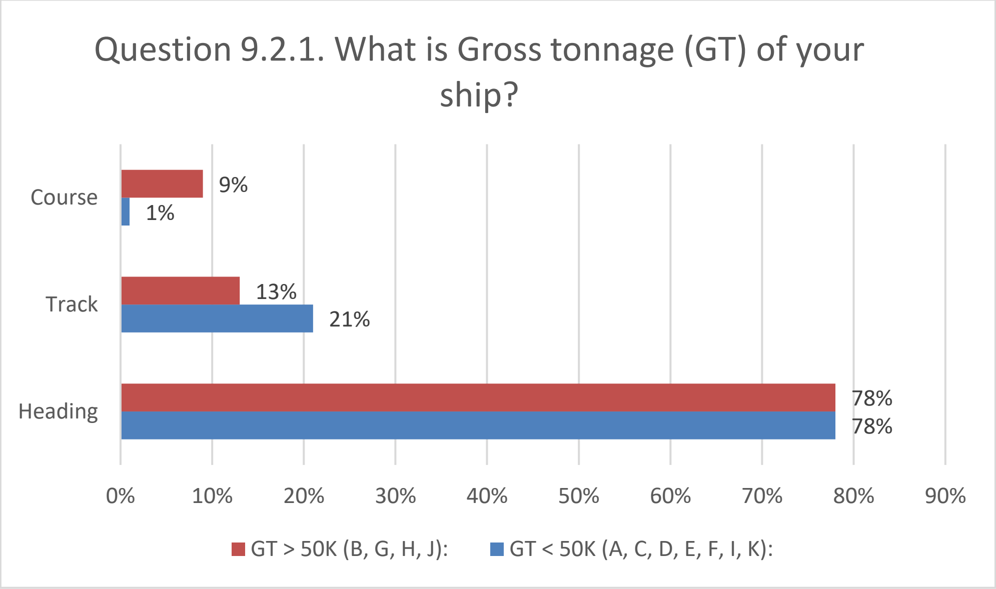

Question 9.2. On what type of ship do you work on?

Passenger ships (2/3) had captains/company orders (A, H) in place more often than on cargo ships((E)1/8).

Question 9.2.1. What is Gross tonnage (GT) of your ship?

Averages:

| | | | |
|---|---|---|---|
| GT < 50K (A, C, D, E, F, I, K): | Heading 78%, | Track 21%, | Course 1%. |
| GT > 50K (B, G, H, J): | Heading 78%, | Track 13%, | Course 9%. |



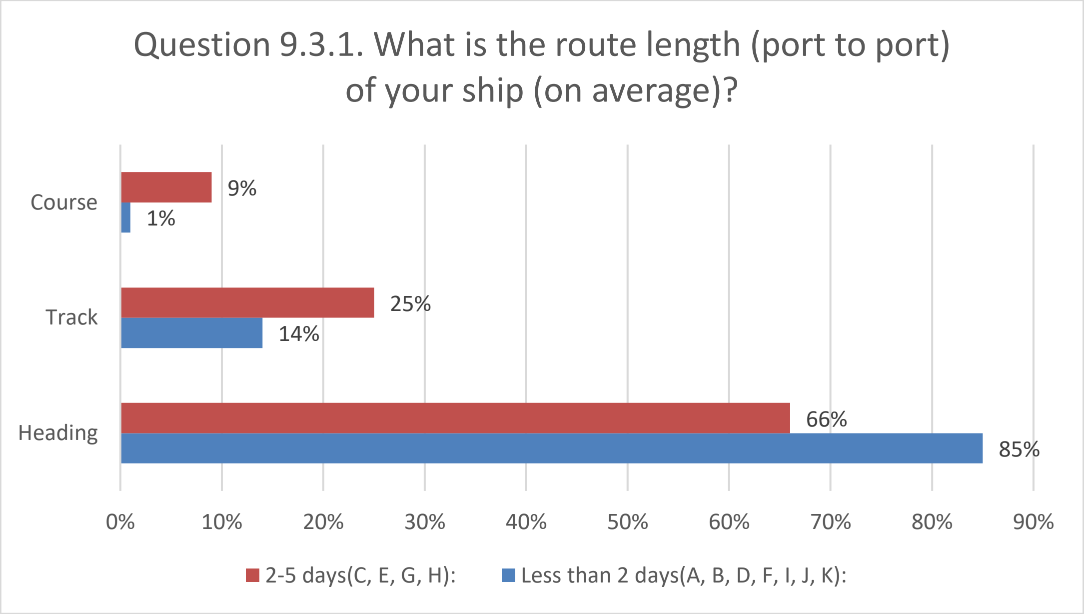
Deck officers on ships with gross tonnage less than 50 000 (A, C, D, E, F, I, K): used slightly more track mode and less course mode than deck officers on ships with gross tonnage over 50 000(B, G, H, J).

Question 9.3. On what shipping routes do you work on?

Question 9.3.1. What is the route length (port to port) of your ship (on average)?

Averages:

| | | | |
|---|---|---|---|
| Less than 2 days (A, B, D, F, I, J, K): | Heading. 85%, | Track. 14%, | Course. 1%. |
| 2-5 days (C, E, G, H): | Heading. 66%, | Track. 25%, | Course. 9%. |



Deck officers with routes less than 2 days (A, B, D, F, I, J, K), used heading mode (85% vs. 66%) more often than deck officers on routes between 2-5 days (C, E, G, H). Track mode (14% vs. 25%) and Course mode (1% vs. 9%) was used less with routes Less than 2 days (A, B, D, F, I, J, K), compared to routes between 2-5 days (C, E, G, H).

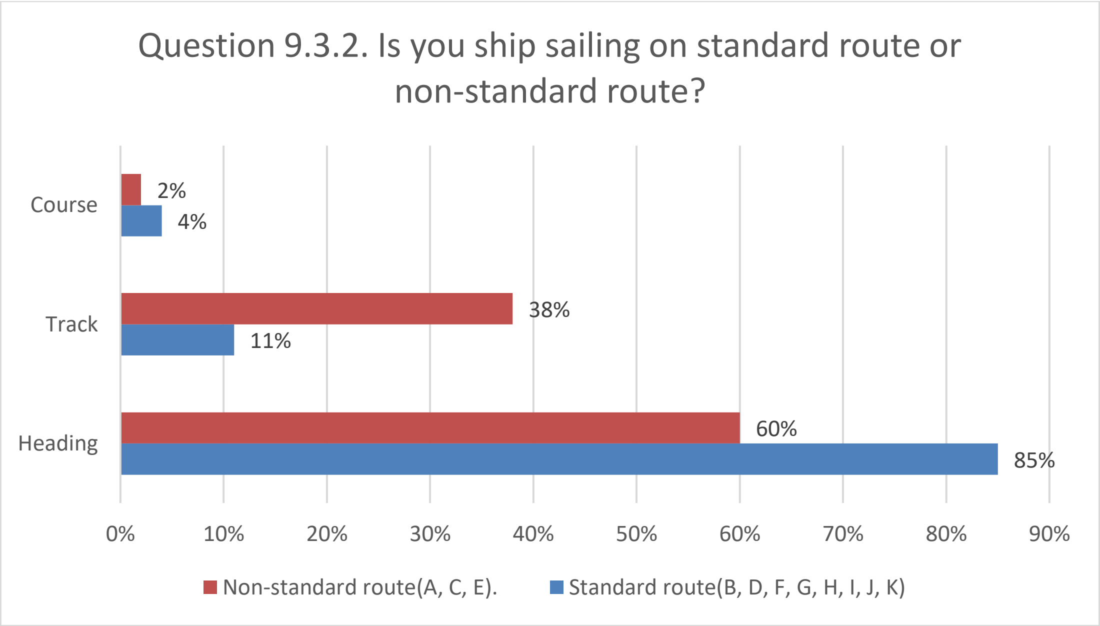
Captains/company orders were in place on 2(E, H) out of 4 ships on routes between 2-5 days (C, E, G, H), compared to only 1(A)out of 7 in routes Less than 2 days (A, B, D, F, I, J, K):

Question 9.3.2. Is you ship sailing on standard route or on non-standard route?

Averages:

Standard route (B, D, F, G, H, I, J, K): Heading. 85%, Track. 11%, Course. 4%.

Non-standard route (A, C, E) Heading. 60%, Track. 38%, Course. 2%.



Captains/company orders were in place on 2(A, E) out of 3(A, C, E) ships on Non-standard routes, compared to only 1(H)out of 7(B, D, F, G, I, J, K). in Standard routes.

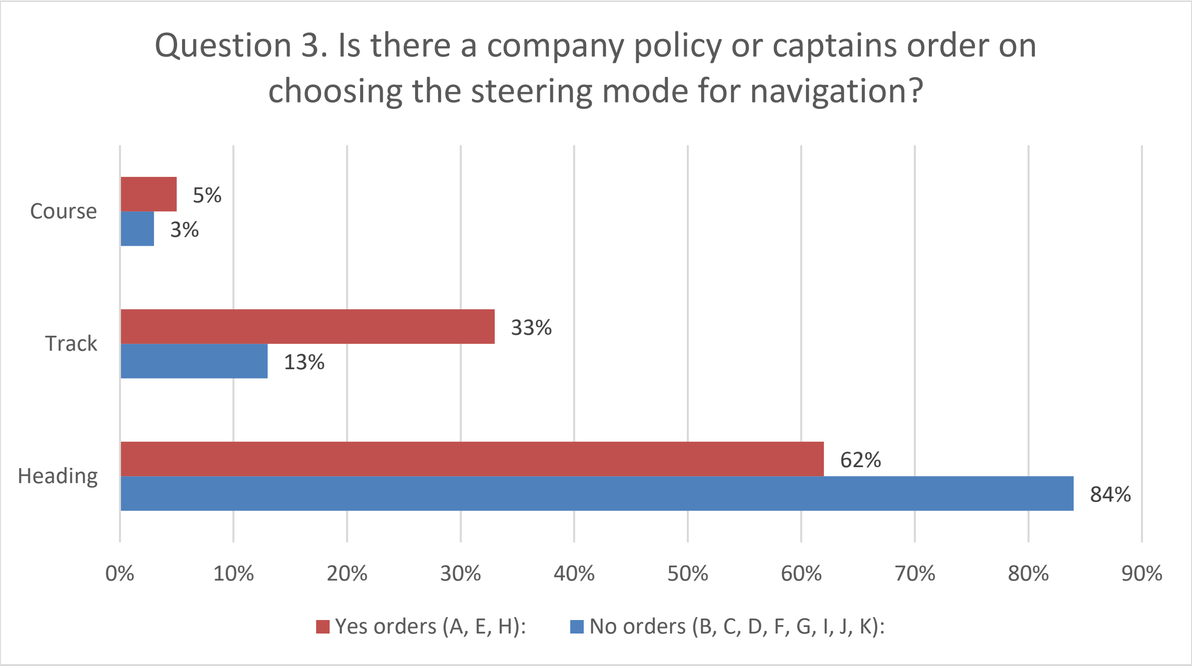
## 7.5 Influence of External Factors

Captain's Orders: The captain, or master, holds absolute authority on a ship. He or she is responsible for its safe and efficient operation, including navigation. The captain’s orders are specific directives issued to the crew, detailing procedures for various situations to maintain safety and operational standards. These orders are typically documented in standing orders and supplemented by night orders, which outline expectations during the captain's absence, such as protocols for watchkeeping, navigation and emergency responses. (Knowledgeofsea. 2020).

Company Policies: Shipping companies establish comprehensive policies to ensure that their vessels operate in line with legal requirements and industry standards. These policies include safety protocols, environmental protection measures, and operational procedures. For example: (Marfletmarine. 2022).

Question 3. Is there a company policy or captains order on choosing the steering mode for navigation? If so, please explain? Is it situation related or constant?

Averages:
No orders (B, C, D, F, G, I, J, K): Heading 84%, Track 13%, Course 3%.
Yes orders (A, E, H): Heading 62%, Track 33%, Course 5%.



- Deck officers with captain/company orders used less heading mode (62% vs. 84%) and more Track mode (33% vs. 13%) than deck officers without orders.
- (27%) of Deck officers were subject to company policies or captain’s orders. They used Heading mode less frequently (62%) and Track mode more frequently (33%) compared to deck officers without policies (Heading 84%, Track 13%).
- All deck officers who had less than 3 years of experience (A, E, H) had captains/company policies about steering mode usage in place.

- Captain’s/company orders were in place on 2(E, H) out of 4(C, E, G, H) ships on routes between 2-5 days, compared to only 1(A)out of 7(A, B, D, F, I, J, K) in routes Less than 2 days.
- Captain’s/company orders were in place on 2(A, E) out of 3(A, C, E) ships on Non-standard routes, compared to only 1(H)out of 7(B, D, F, G I, J, K). in Standard routes.
- Passenger ships (2/3) had captains/company orders (A, H) in place more often than on cargo ships((E)1/8).

Interpretation: External policies influence automation in navigation usage. It is mainly practiced on deck officers with less experience and so it can be considered a safety precaution in this research. However, these policies may also limit opportunities for manual navigation practice, raising concerns about skill degradation (Wrobel, Montewka, & Kujala, 2022).

Individual Experience: Less experienced officers (less than three years) used Heading mode less frequently (59%) and Track mode more often (31%) compared to those with over 10 years of experience, who relied heavily on Heading mode (89%).

Interpretation: Experience shapes navigation preferences, with experienced officers favoring manual control for its adaptability for most situations. This aligns with research emphasizing the role of experience in building confidence and independent decision-making in more challenging navigational scenarios.

## 7.6 Use of Navigational Aids

Frequently used ECDIS functions included:

- ETA Calculators (Respondents A, B, F, I).
- Predictors for Maneuvering (Respondents F, I).
- Line of Position Plotting for accuracy verification (Respondents A, J).

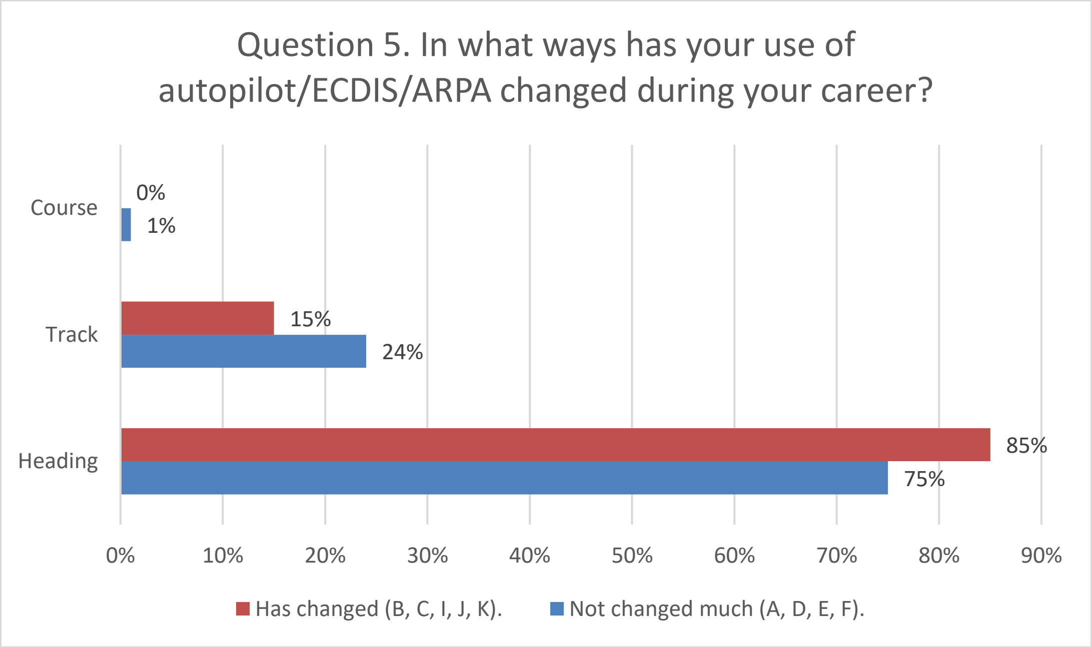
Officers cited ECDIS as indispensable during harbor maneuvers and high-traffic situations, where real-time data integration increased situational awareness.

Question 5. In what ways has your use of autopilot/ECDIS/ARPA changed during your career?

Averages (5. A-K):

Not changed much (A, D, E, F): Heading 75%, Track 24%, Course 1%.

Has changed (B, C, I, J, K): Heading 85%, Track 15%, Course 0%.



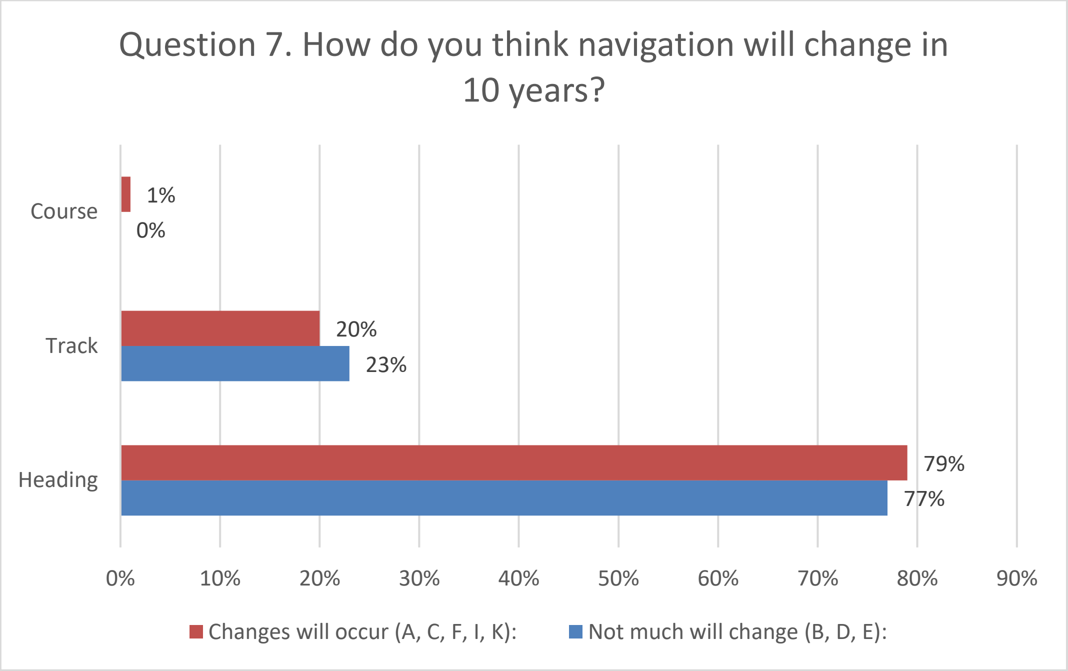
Deck officers who think their use of autopilot/ECDIS/ARPA has changed (B, C, I, J, K) during their career use more heading mode (85% vs. 75%) and less track mode (15% vs. 24%) than deck officers who think not much has changed (A, D, E, F) in their usage of autopilot/ECDIS/ARPA in their career.

Interpretation: ECDIS supports Level 2 Automation by aiding decision-making while maintaining human oversight (Parasuraman, Sheridan, Wickens. 2000). However, over-reliance on its automated features risks automation complacency, a challenge noted in broader research on automation.

Question 7. How do you think navigation will change in 10 years?

Averages:

| | | | |
|---|---|---|---|
| Not much will change (B, D, E): | Heading. 77%, | Track. 23%, | Course. 0%. |
| Changes will occur (A, C, F, I, K): | Heading. 79%, | Track. 20%, | Course. 1%. |

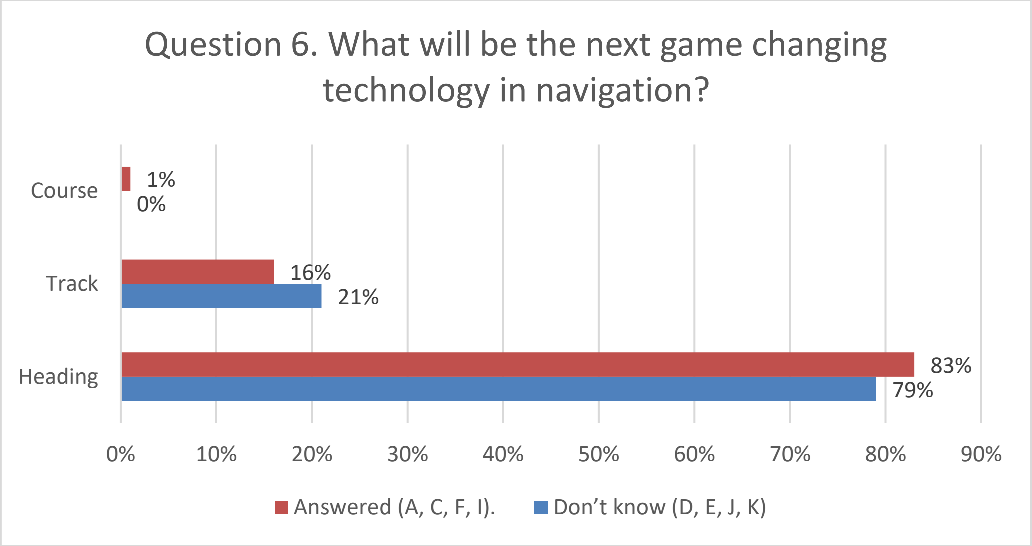


Not much difference was found in steering mode usage between deck officers who think navigation will change in 10 years (A, C, F, I, K) and deck officers who think not much will change (B, D, E). Heading mode (79% vs. 77%), Track mode (20% vs. 23%) and Course mode (1% vs. 0%)

Question 6. What will be the next game changing technology in navigation?

Averages:

| | | | |
|---|---|---|---|
| Don’t know (D, E, J, K). | Heading. 79%, | Track. 21%, | Course. 0%. |
| Answered (A, C, F, I). | Heading. 83%, | Track. 16%, | Course. 1%. |



Deck officers who answered something (A, C, F, I) about the next game changer in navigation used slightly more heading mode (83% VS. 79%) and slightly less track mode (16% VS. 21%) than deck officers who did not have an idea (D, E, J, K) about the next game changer in navigation.

Findings: Respondents identified artificial intelligence (AI) for route optimization, real-time data analytics, and integrated bridge systems as transformative innovations. Autonomous ships were also highlighted, particularly for cargo operations (Respondents A, C, F, I).

Interpretation: These perspectives reflect industry trends toward Level 4 Automation, where systems manage most functions with limited human input (Parasuraman, Sheridan, Wickens. 2000). However, concerns about safety and regulatory preparedness persist, particularly for passenger ships.

## 7.7 Adoption of Autonomous Systems

Question 8.1. In your view, will fully autonomous/remote controlled ships be more common in future on Passenger ships or Cargo ships?

Only one (J) deck officer thought fully autonomous/remote controlled ships would be more common in Cargo ships than passenger ships. All others (A, B, C, D, E, F, I, K) who have answered the question think fully autonomous/remote controlled ships will be more common on cargo ships. Most respondents believed autonomous ships would first gain popularity in cargo operations, short routes, and small ships.

Question 8.2. In your view, will fully autonomous/remote controlled ships be more common in future on small ship (Deadweight (DW) less than 10,000 tonnages) or large ships (Deadweight (DW) more than 10,000 tonnages)?

Out of 8 deck officers who answered this question, 6(A, B, C, E, I, K) think that fully autonomous/remote controlled ships will be more common in future on small ships (Deadweight (DW) less than 10,000 tonnages). This is 75% of total.

2(D, J) out of 8 deck officers think fully autonomous/remote controlled ships be more common in future on large ships (Deadweight (DW) more than 10,000 tonnages). This is 25% of total.

Question 8.3. In your view, will fully autonomous/remote controlled ships be more common in future on short shipping routes (less than 3 days) or long shipping routes (More than 3 days)?

Majority of Deck officers (6 out of 8) think fully autonomous/remote controlled ships will be more common in future on short shipping routes (A, B C, E, J, K) than long shipping routes (D, I).

Question 8.4. In your view, will fully autonomous/remote controlled ships be more common in future on Standard route or Non-standard route?

Only one deck officer(D) thinks fully autonomous/remote controlled ships be more common in future on Non-standard route than on Standard route. 7 deck officers (A, B, C, E, I, J, K) think fully autonomous/remote controlled ships be more common in future on Standard route. Total of 8 deck officers (A, B, C, D, E, I, J, K) answered this question.

Interpretation: These views align with the maritime industry's cautious approach to autonomous technology, emphasizing slow adoption in less complex and lower-risk routes.

Challenges identified by participants: GPS interference was cited as significant risk in system reliability. (Respondent K).

Interpretation: These challenges highlight the importance of ongoing training and the integration of backup systems to guarantee safety. (Wrobel, Montewka, & Kujala, 2022).

## Conclusion

The results reveal detailed interaction between navigators and automation in maritime navigation. While Heading mode remains the most common steering preference for its flexibility, Track mode is selectively used in predictable scenarios. External influences, such as company policies, and individual experience significantly shape automation usage. Additionally, the reliance on ECDIS and the cautious optimism toward future technologies point out the industry's transitional phase toward higher levels of automation.

By addressing challenges such as skill degradation and system reliability, this study contributes to the wider discussion on navigating the balance between human expertise and technological advancement in maritime navigation.

# 8 Critical Examination and Discussion

This section evaluates the findings of this study within the wider context of maritime navigation and automation. It highlights the strengths and limitations of current practices, explores theoretical consequences, and offers practical recommendations. Key themes include steering mode usage, the influence of external factors, the use of bridge navigational aids, and perspectives on future trends in maritime automation.

## 8.1 Steering Mode Utilization

The results reveal significant preferences among the three steering modes: Heading, Track, and Course. Heading mode, with an average usage of 78%, dominates due to its adaptability in different navigational situations and real-time control, especially in high-traffic areas or challenging weather conditions. Conversely, Track mode (18% usage) is preferred for open waters and standard routes, where its ability to follow pre-planned routes improves route optimization, which saves time and fuel consumption. Course mode (4% usage) is the least utilized, reflecting its overlapping functions in other steering modes. Course mode is also equipped in far less ships that heading and track modes are.

Strengths of Heading Mode: Heading mode's adaptability aligns with findings in automation literature emphasizing operator involvement during more challenging navigational environments (Endsley, 1995).
By offering real-time control, it supports situational awareness and reduces over-reliance on automation.

Track Mode for Less complicated navigational Environments: The selective use of Track mode illustrates its capability in more predictable navigational environments. However, its limitations in more challenging navigational environments demonstrate a need for improved training to guarantee effective use without over-reliance (Wrobel, Montewka, & Kujala, 2022).

Limited use of Course Mode: Course mode's limited functionality and slower responsiveness, compared to Heading and Track modes, make it less relevant in modern autopilot systems. Its low usage is explained mostly that course mode is equipped in far less ships than Heading and Track modes are. But also transition toward more automated systems may leave it out of competition, since most deck officers are still using heading mode, even if course mode is available.

## 8.2 Influence of External Factors

The analysis of external factors like company policies and captain's orders reveals distinct patterns in steering mode usage:

- With Policies: Officers reported 62% usage of Heading mode and 33% usage of Track mode.
- Without Policies: Heading mode usage rose to 84%, with Track mode falling to 13%.

Impact of Policies on Automation: Policies about Track mode usage reflect a push toward more standardized practices in navigation and reduced manual intervention. While this supports consistency, it can lead to skill degradation if officers rely excessively on automation (Parasuraman & Riley, 1997). Policies must balance automation benefits with opportunities for manual control.

Variability in Practices: The increased reliance on Heading mode without policies points out the value of individual judgment and manual skill. This finding aligns with studies supporting independent decision-making by deck officers to improve adaptability in different navigational situations.

Experience as a reducing Factor: Experienced deck officers showed higher reliance on Heading mode (89%) than less experienced counterparts (59%). This suggests that experienced navigators are more confident in manual navigation, showing the importance of training and experience in maintaining navigational skills. It should also be taken into account that younger officers may be more in touch in using electronic aids compared to more experienced deck officers who have used older methods for long time.

## 8.3 Use of Navigational Aids

ECDIS and ARPA systems were identified as essential instruments in this research for improving navigational safety and capabilities. Frequently used ECDIS features included Estimated Time of Arrival (ETA) calculators, predictors for maneuvering, and line-of-position plotting.

ECDIS as a Decision-Making Tool: The integration of real-time data with user-friendly interface allows ECDIS to reduce cognitive workload in navigation and improve decision-making. However, over-reliance on ECDIS can lead to automation complacency, particularly in situations requiring manual navigation expertise (Wrobel, Montewka, & Kujala, 2022).

ARPA's Role in Collision Avoidance: ARPA's ability to calculate collision risks complements ECDIS's functionalities, particularly in high traffic areas. Despite these advantages, operators must validate ARPA outputs to guarantee accuracy, supporting the need for extensive training.

## 8.4 Views on Automation and the Future of Navigation

Some participants expressed cautious optimism about Maritime Autonomous Surface Ships (MASS), identifying short routes, smaller vessels, and cargo operations as the most likely candidates for early adoption. However, concerns about safety, reliability, and human oversight remain.

Future AI-Driven improvements: Participants highlighted AI-driven route optimization and real-time data analytics as innovative technologies. These tools match the larger industry focus on time optimization and saving resources while being eco-friendly. However, the ethical and practical effects of these systems need more research before widespread usage.

Challenges of Autonomy in Passenger Ships: The importance of passenger safety make full autonomy less practical for passenger ships, Emphasizing the need for human supervision on board. This perspective aligns with IMO's regulatory focus on human factors in development of Maritime Autonomous Surface Ships (MASS). (IMO, 2023).

## 8.5 Challenges and Limitations

The study identifies the following key challenges in the current navigational environment:

Skill Degradation: Extended reliance on automation weakens manual navigation skills, a concern repeated in previous studies (Wrobel, Montewka, & Kujala, 2022).

System Vulnerabilities: GPS interference and other technical issues point out the need for backup systems and cross-verification with radar and visual navigation.

Addressing these challenges requires a multi-dimensional approach, including:

- Improved training programs focusing on manual navigation skills and monitoring.
- Company policies supporting balanced automation and manual usage in navigation.
- Investment in adaptable navigation technologies.

## 8.6 Strengths and Limitations of the Study

### 8.6.1 Strengths:

- The mixed-methods approach provides a comprehensive understanding of navigational practices applied by deck officers.
- Participant diversity (experience levels, ship types, and route types) strengthens the study’s relevance.
- Experienced participants: 7 deck officers with over 5 years of experience.

### 8.6.2 Limitations:

- The small sample size (11 participants) limits generalizability.
- Rapid technological advancements may present time-sensitive findings.

## 8.7 Implications and Recommendations

- Training and Development: Maritime training institutes should offer combined models, with advanced automation skills and traditional manual skills, especially for emergency situations in navigational training.

- Company/Captains Policy Adjustments: Policies should encourage rational use of automation (track mode) while Encouraging preservation of manual navigational skills.

- Future Research: Extended and longitudinal research with larger sample size to track the developing impact of automation on navigation.

Conclusion

This section highlights the challenges of balancing automation and human elements in maritime navigation. Heading and Track modes dominate due to their individual strengths. The minimal use of course mode reflects its weaknesses, like problems in course stabilization in navigational use. Course mode is also equipped in far less ships than heading and track modes.

External factors like company policies and experience levels significantly influence navigational practices, highlighting the need for adaptive strategies. As the maritime industry moves toward greater automation, tackling challenges such as skill degradation and system reliability will be important to preserving safe navigational practices for future.

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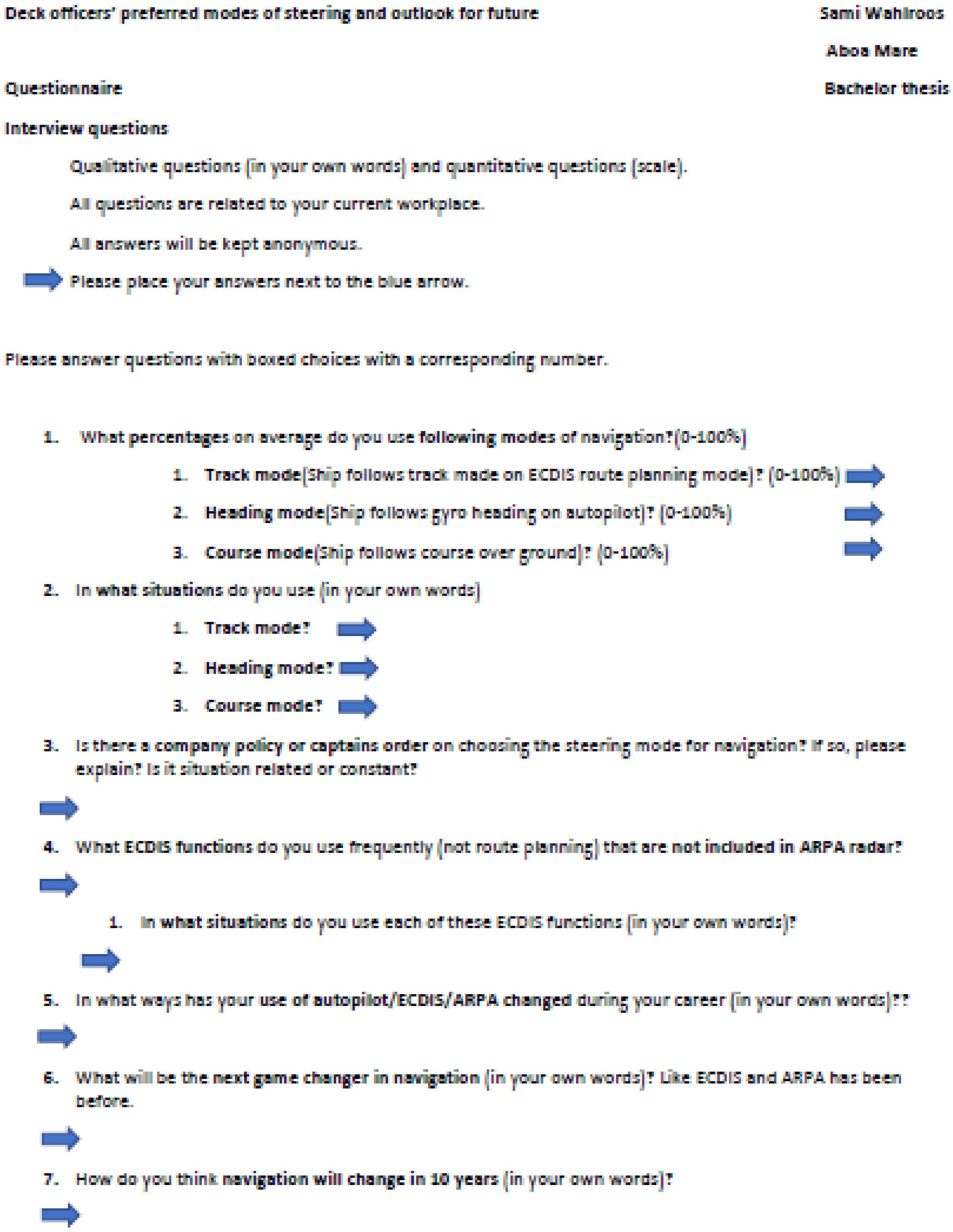
# 10 Appendices

Appendix A: Research Questionnaire



**Deck officers' preferred modes of steering and outlook for future** **Sami Wahlroos**

**Aboa Mare**

**Questionnaire** **Bachelor thesis**

**Interview questions**

Qualitative questions (in your own words) and quantitative questions (scale).

All questions are related to your current workplace.

All answers will be kept anonymous.

➡ Please place your answers next to the blue arrow.

Please answer questions with boxed choices with a corresponding number.

1. What percentages on average do you use **following modes of navigation?**(0-100%)
    1. **Track mode**(Ship follows track made on ECDIS route planning mode)? (0-100%) ➡
    2. **Heading mode**(Ship follows gyro heading on autopilot)? (0-100%) ➡
    3. **Course mode**(Ship follows course over ground)? (0-100%) ➡
2. In what situations do you use (in your own words)
    1. **Track mode?** ➡
    2. **Heading mode?** ➡
    3. **Course mode?** ➡
3. Is there a **company policy or captains order** on choosing the steering mode for navigation? If so, please explain? Is it situation related or constant?

➡

4. What **ECDIS functions** do you use frequently (not route planning) that are **not included in ARPA radar?**

➡

    1. In what situations do you use each of these ECDIS functions (in your own words)?

    ➡

5. In what ways has your use of **autopilot/ECDIS/ARPA changed** during your career (in your own words)??

➡

6. What will be the **next game changer in navigation** (in your own words)? Like ECDIS and ARPA has been before.

➡

7. How do you think **navigation will change in 10 years** (in your own words)?

➡

8. In your view, will fully autonomous/remote controlled ships be more common in future on following ships or routes? (Scale 1-5):

    1. Passenger ships (scale 1-5) Cargo ships

| | | | | |
|---|---|---|---|---|
| 1. Mostly Passenger ships | 2. Majority passenger ships | 3. Evenly common | 4. Majority cargo ships | 5. Mostly Cargo ships |

    2. Small ships (DW less than 10,000 tonnages) (scale 1-5) Large ships (DW more than 10,000 tonnages)?

| | | | | |
|---|---|---|---|---|
| 1. Mostly small ships | 2. Majority small ships | 3. Evenly common | 4. Majority large ships | 5. Mostly large ships |

    3. Short shipping routes (less than 3 days) (scale 1-5) Long shipping routes (More than 3 days)?

| | | | | |
|---|---|---|---|---|
| 1. Mostly short routes | 2. Majority short routes | 3. Evenly common | 4. Majority long routes | 5. Mostly long routes |

    4. Standard route (scale 1-5) Non standard route "Wild line"

| | | | | |
|---|---|---|---|---|
| 1. Mostly standard route | 2. Majority standard route | 3. Evenly common | 4. Majority "wild line" | 5. Mostly "wild line" |

9. **Background info of interviewed deck officers**

    1. How many years have you been a deck officer?

| | | | | |
|---|---|---|---|---|
| 1. Less than 1 year | 2. 1-3 years | 3. 3-5 years | 4. 5-10 years | 5. Over 10 years |

    2. What type of ship do you work on?(Passenger/cruise, ro-pax, container, bulk carrier, oil tanker, ro-ro, LNG)

        1. What is Gross tonnage of your ship?

| | | | |
|---|---|---|---|
| 1. GT Less than 10.000 | 2. GT between 10.000 - 50,000 | 3. GT between 50,000 - 100,000 | 4. GT over 100.000 |

    3. On what shipping routes do you work on?

        1. What is the route length(port to port) of your ship (on average)?

| | | |
|---|---|---|
| 1. Less than 2 days | 2. 2-5 days | 3. More than 5 days |

        2. Is your ship sailing on standard route or non standard route"wild line"?

| | |
|---|---|
| 1.Standard route | 2. "Wild line" |

10. Is there any additional comments you would like to make regarding this topic?