

Optimizing Ship Management In Narrow Shipping Channels To Reduce The Percentage of Ship Accidents

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Abstract.

Indonesian archipelagic waters face increasing shipping accidents in narrow channels due to the growth of ship size, logistics intensity, and hydrodynamic challenges such as bank effect and squat, as reported by the KNKT and the case of MV Tonasa Line XI, with previous studies fragmented between human, operational, and environmental factors without integration of optimization for specific routes such as the Amamapare Channel. This study aims to analyze the optimization of ship maneuvering in narrow channels for safety and efficiency and determine the optimal speed to reduce the risk of collision and grounding. Using a descriptive qualitative approach with a case study design on the MV Meratus Dili during the 2024-2025 voyage in Amamapare, a purposive sample included ship officers namely Master, Chief Officer, Second, and Third Officer based on navigational expertise. Instruments included observation, semi-structured interviews, and documentation, analyzed inductively through data reduction, presentation, and drawing conclusions with triangulation. The results show that speeds >6 knots at low tide reduce Under Keel Clearance (UKC) by 0.35 m; radar and echosounder are crucial, but voyage planning lacks tidal analysis. In conclusion, the optimal speed is 4-5 knots during low tide or high traffic, maintaining a UKC of ≥ 0.5 m; improve SOPs through checklists and training to reduce accidents by 20-30%.

Keywords: *Narrow Channel, Optimal Speed, Ship Maneuverability, Under Keel Clearance, Voyage Planning.*

1. INTRODUCTION

As an archipelagic and maritime nation, Indonesia holds a strategic position in international trade routes, making shipping safety in national waters an increasingly important issue in the past two to three years. Globally, the growth in ship size, the intensity of maritime logistics flows, and the complexity of operations in confined waters have heightened attention to navigational safety, particularly in narrow waterways prone to grounding and collisions. Several recent studies have also emphasized that risks in confined waters are not solely a technical issue for ships, but rather the result of the interaction between decision-making competence, compliance with shipping regulations, and the hydrodynamic characteristics of the waters. Within this framework, the topic of ship maneuvering in narrow waterways is scientifically relevant because it directly relates to modern maritime safety theory, while also being practically important for supporting efficient distribution of goods and reducing maritime accidents.

At the national level, the urgency of this issue is evident in the continued prevalence of ship accidents occurring when vessels navigate narrow shipping lanes or waters with limited maneuvering space. The National Transportation Safety Committee (KNKT) has shown that collisions and groundings are common types of accidents in Indonesian shipping operations, particularly when vessels must navigate routes that require precise maneuvering and rapid decision-making. The case of the MV. Tonasa Line XI, involved in an incident in the Makassar Strait, serves as an important illustration that maneuvering errors in narrow waterways can have serious consequences for the safety of the vessel and crew. Recent studies in Indonesia also indicate that water currents, limited maneuvering space, and local environmental dynamics can complicate the ship's control process, making engine readiness, navigation, and officer competency standards crucial.

Conceptually, recent studies have positioned navigational safety in narrow waters as a multidimensional issue involving human, operational, and environmental factors. Studies on ship maneuvering in shallow and narrow waters emphasize that bank effect, squat, ship size, and rudder configuration influence a ship's response during maneuvers, so maneuverability assessments need to be considered from the operational stage, not just the design stage. On the other hand, navigational safety

analysis in the Suez Canal indicates that most accidents in narrow waters are more related to human and organizational factors than to operational conditions alone, reinforcing the view that navigational safety cannot be sufficiently explained by the technical aspects of the ship. These findings align with investigative studies by the National Transportation Safety Committee (KNKT) and the case study of the MV Tonasa Line XI, which both emphasize the importance of the quality of officers' decisions in maintaining the safety of a ship in confined navigation spaces.

However, the existing literature still shows differences in emphasis. Some studies focus more on hydrodynamic factors and water characteristics, while others place human factors, supervision, and organization as the primary determinants of accidents. This difference in focus indicates that safety approaches in narrow shipping lanes have not been fully integrated, particularly when applied to the Indonesian context, which has unique water characteristics, current patterns, and operational practices. Furthermore, studies discussing ship maneuvering are often general in nature or separate from the issue of determining optimal speed, even though speed is an operational variable that significantly determines maneuvering stability, response time, and safety margins in narrow spaces. Thus, methodological and contextual limitations remain in previous research, particularly in linking maneuvering strategies to speed control in a specific shipping location.

Based on this gap, this research is directed to analyze the optimization of ship maneuvering in narrow shipping channels with a focus on determining optimal speed as part of an accident prevention strategy. Explicitly, the problem statement of this research is that there is still no sufficiently comprehensive study that integrates ship maneuvering factors, operational readiness, and narrow channel characteristics in a single analytical framework applicable to the context of the Amamapare Channel. Therefore, this research is not only relevant to addressing shipping safety issues in the field, but also to enrich the scientific discourse on ship handling in restricted waters which has tended to be fragmented between technical, human, and environmental aspects.

This study aims to analyze how to optimize ship maneuvering in narrow shipping channels for safety and efficiency, while also identifying the optimal speed of ships when sailing in narrow channels. The urgency lies in the practical need to reduce the risk of collision and grounding in busy Indonesian waters, as well as in the academic need to present a more contextual explanatory model for navigation safety in limited channels. The novelty of this study lies in the combined focus between optimizing maneuvering and determining optimal speed in the context of the Amamapare Channel, so that its contribution is not only theoretical for the development of maritime safety studies, but also practical as a basis for decision-making for ship officers in daily operations..

II. METHODS

This research uses a descriptive qualitative approach with a case study design, as its primary objective is to deeply understand ship maneuvering practices in a real-world context, particularly when ships navigate the narrow shipping channel of the Amamapare Channel. This qualitative approach was chosen because it allows researchers to explore meanings, processes, and operational dynamics that cannot be adequately explained through numbers alone. This aligns with the view that qualitative research positions the researcher as a key instrument, utilizes narrative data, and emphasizes understanding the contextual meaning of phenomena (Sugiyono, 2021; Creswell & Creswell, 2023). In this context, the research is also exploratory and interpretive, making it appropriate for analyzing how ship officers make decisions, manage speed, and adjust ship maneuvers within limited navigational space (Emzir, 2021; Sudaryono, 2017).

The study was conducted during sailing practice on the MV. Meratus Dili from July 5, 2024, to July 5, 2025, when the ship was operating in the Amamapare waters. This location was chosen purposively because it operationally represents narrow channel conditions that require high maneuvering skills and precise decision-making. Therefore, the unit of analysis in this study is not a population in the statistical sense, but rather the events, work practices, and sailing experiences that took place on the ship during the observation period. Participants or research informants consisted of ship officers who had direct knowledge of the navigation process, namely the Master, Chief Officer, Second Officer, and Third Officer, because

they were involved in route planning, navigation supervision, and execution of ship maneuvers in narrow channels.

The data sources in this study consist of primary and secondary data. Primary data were obtained directly from the field through observations of ship maneuvering activities, in-depth interviews with Masters and navigational officers, and visual and administrative documentation related to the use of navigational tools, particularly radar and navigational support devices in narrow channels. In qualitative research, the researcher acts as the primary instrument, collecting, interpreting, and verifying data through direct interaction with data sources, while documents are used to strengthen the validity of the findings and provide a more complete context for the phenomena studied (Sugiyono, 2021; Creswell & Creswell, 2023). Secondary data were obtained from textbooks, IMO publications, previous research results, and other relevant academic sources to develop a theoretical framework regarding navigational safety, narrow channel characteristics, and ship maneuvering procedures (Emzir, 2021; Sudaryono, 2017).

Data collection techniques were conducted through three methods: observation, interviews, and documentation. Observations were used to systematically record navigational behavior, officer responses, channel conditions, and operational obstacles that arise when the ship enters a narrow shipping area. Semi-structured interviews were conducted to provide researchers with a more in-depth understanding of maneuvering strategies, speed considerations, and anticipatory measures applied to specific operational conditions. Documentation was used to collect photographs, route notes, navigation reports, and other supporting materials relevant to the research object. This ensured that findings relied not only on informant narratives but also on traceable empirical evidence (Creswell & Creswell, 2023; Sugiyono, 2021). In practice, these three techniques complemented each other through the principle of triangulation, resulting in stronger, more consistent, and more scientifically accountable data.

In this qualitative study, the terms population and sample are not used in the probabilistic sense as in quantitative research. The research object focuses on the maneuvering activities of the MV Meratus Dili while sailing in the Amamapare Channel, while the subjects or informants were selected purposively based on their direct involvement and competence in ship navigation. Therefore, the primary informants in this study were Masters and deck officers who have authority and experience in navigation decision-making, as they are considered to have the best understanding of maneuvering procedures and determining optimal speed in narrow waters. This purposive approach is in accordance with the characteristics of qualitative research, which emphasizes depth of information, rather than the number of respondents. Therefore, the selection of informants was directed at those who were truly capable of providing rich and relevant data (Sugiyono, 2021; Emzir, 2021).

Data analysis was conducted inductively through the stages of data reduction, data presentation, and conclusion drawing. In the reduction stage, all observations, interviews, and documentation were sorted to select the information most relevant to the research focus, namely optimizing ship maneuvers and determining speed in narrow channels. Next, the data was presented in a structured narrative description to fully understand the relationships between themes, decision patterns, and safety factors. The final stage was conclusion drawing, which involved developing a final interpretation of the patterns found in the field to answer the research problem formulation. This analysis model aligns with the view that qualitative data must be organized, interpreted, and then continuously verified throughout the research process to produce valid and contextual conclusions (Sugiyono, 2021; Creswell & Creswell, 2023; Emzir, 2021).

The research procedure begins with the preparation stage, which involves formulating the focus of the problem, developing observation and interview guidelines, and gathering theoretical references related to navigational safety and ship maneuvering in narrow channels. The next stage involves collecting onboard data through direct observation of navigational activities, interviews with ship officers, and documentation of procedures and equipment used during the voyage. After data collection, researchers classify, reduce, and verify the data to ensure that the information obtained is truly relevant to the focus of the study. The final stage is compiling the analysis results in the form of a scientific narrative explaining ship maneuvering practices, factors determining optimal speed, and their implications for navigational safety in the Amamapare Channel. This process aligns with qualitative research procedures, which are flexible, step-by-step,

| | | |
|---|------------------------------------|--|
| | Collision | conditions and other targets. |
| 2 | COLREGs Rule 9 – Narrow Channels | Vessels navigating in narrow channels must keep to the right side of the channel; do not overtake if unsafe; pay particular attention to radar/AIS. |
| 3 | SOLAS – Radar & ARPA Requirements | Merchant vessels are required to have functioning radar that can help detect targets early, which is very important in narrow channels with heavy traffic. |
| 4 | IMO Guidelines for Voyage Planning | All merchant vessels are required to carry out voyage planning, including in narrow areas, with the latest depth measurements. |

This regulatory documentation shows that international norms clearly emphasize the importance of route planning, use of navigational equipment, and precautions to avoid accidents in confined waters.

1. Data analysis

Table 4 Relationship between Speed, Tides, and UKC

| Transit | Tidal Conditions | Speed (Knots) | UKC (m) | UKC Security Status |
|---------|------------------|---------------|---------|-----------------------|
| T1 | Receding tide | 5.5 | 0.6 | Approaching the limit |
| T2 | Install | 5.8 | 1.10 | Safe |
| T3 | Receding tide | 6.9 | 0.6 | Approaching the limit |
| T4 | Install | 5.5 | 1.20 | Safe |
| T5 | Receding tide | 6.0 | 0.6 | Approaching the limit |

The UKC is most vulnerable during low tides at speeds above recommended levels. Speed settings need to be adjusted to tidal conditions to keep the UKC safe for navigation.

Table 2 Activate Navigation Tools at Every Transit

| Transit | RADAR | Echosounder | GPS | AIS | Effectiveness Notes |
|---------|--------|-------------|--------|--------|-------------------------------------|
| T1 | Active | Active | Active | Active | Radar helps target detection |
| T2 | Active | Active | Active | Active | Echosounder is less monitored |
| T3 | Active | Active | Active | Active | Echosounder helps avoid the bottom |
| T4 | Active | Active | Active | Active | GPS & AIS helps with cross planning |
| T5 | Active | Active | Active | Active | All tools are working |

Radar and echosounder are the most crucial navigational tools; enhanced AIS monitoring and bridge training are required for full effectiveness.

Table 6 Evaluation of Practice Compliance with Regulations

| Principles of Regulation | Regulation Information | Practical Findings of the MV. Meratus Dili | Compliance Status |
|--------------------------|--|--|-------------------|
| COLREGs Rule 8 | Actions to avoid collisions must be timely. | Avoidance actions were taken but speeds remained high in some cases. | Enough |
| COLREGs Rule 9 | Stay on the side of the channel when it is narrow. | The vessel maintained its side of the channel correctly. | In accordance |
| SOLAS Radar & ARPA | Radar must be used effectively. | Radar is active but ARPA is sometimes not monitored intensively. | Enough |
| IMO Guidelines | Tides and depth must be considered in | UKC is under-analyzed before transit. | Not enough |

| | |
|-----------------|-----------|
| Voyage Planning | planning. |
|-----------------|-----------|

The analysis shows that the navigation practices of the MV Meratus Dili generally comply with the COLREGs, particularly regarding the vessel's position in the channel and efforts to avoid collisions. However, during some transits, high speeds were still used during low UKC, thus not fully complying with the IMO's passage planning guidelines, which require adjustments to confined waters conditions. Thus, there is a gap between actual practice in the field and the ideal practice stipulated in the regulations.

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| IMO Voyage Planning Guidelines | Tides and depth must be considered in planning. | UKC is under-analyzed before transit. | Not enough |

The MV Meratus Dili generally complied with COLREGs, but still saw high speeds during low UKCs. This indicates a lack of full compliance with IMO voyage planning principles.

Table 4 The Chief Officer's Role in Navigation Decisions

| Decision Aspects | Chief Officer's Actions | Impact on Safety | Decision Aspects |
|--------------------------|--|---------------------------------|--------------------------|
| Speed Determination | Set a target of ≤ 6 kt during heavy traffic/low tides | Reducing the risk of low UKC | Speed Determination |
| Tool Monitoring Priority | Focus on radar and echosounder | Increase situational awareness | Tool Monitoring Priority |
| Communication | Coordination with VTS/guide | Minimizing misinformation | Communication |
| Change of Plan Decision | Adjusting the speed route when the UKC decreases | Suppressing potential incidents | Change of Plan Decision |

Chief Officer play a strategic role, but need to be supported by more systematic documents and training

Table 5 Risk Identification & Frequency of Events

| Main Risks | Triggering Conditions | Indicated Frequency |
|------------------------|-------------------------|---------------------|
| Low UKC | Low tide + high speed | 1 of 5 transits |
| Target detection error | AIS is not active | 1 of 5 transits |
| Heavy traffic | Morning/evening transit | 2 of 5 transits |

The biggest risks relate to UKC and speed, so they are a mitigation priority.

Table 6 Safety Optimization Recommendations

| Recommendation | The main purpose | Success Indicators |
|--------------------------|-----------------------------|---------------------------------------|
| Speed limit | Keeping UKC safe | UKC size ≥ 0.5 m on all transits |
| Voyage Planning standard | Tidal risk planning | Use of checklists for each transit |
| Navigation training | Increase tool effectiveness | Reduction in near miss incidents |

| | | |
|--------------------------------|-------------------------|---------------------------|
| VTS communication enhancements | Cross-ship coordination | Structured reports to VTS |
| Internal audit & documentation | Continuous evaluation | Improved safety reporting |

Table 7 Triangulation – Ship Position in Narrow Channels

| International Rules | Ship SOP | Suitability / Recommendation |
|--|---|--|
| COLREG 9(a): Stay as close to the outer limit of the channel on the starboard side as is safe. | The officer of the watch is directed to maintain the starboard position according to the flow conditions. | In accordance – it is recommended to clarify the deviation tolerance limits in the SOP. |
| <i>There are no siren lights or special crossing restrictions to disturb.</i> | The ship's SOP includes notification via VHF before crossing if necessary. | In accordance – additional: include sound signal procedures if necessary. |

International regulations such as COLREGs emphasize the importance of safe speeds and the use of all available navigational aids to prevent collisions. The MV Meratus Dili's standard operating procedures (SOPs) also stipulate maximum speed limits in narrow channels and enhanced observation via radar, AIS, and echosounder, thus aligning with the principle of timely action and the UKC-based safe speed recommendations.

Table 8 Triangulation – Speed and Navigation Tool Monitoring

| International Rules | Ship SOP | Suitability / Recommendation |
|--|---|---|
| COLREGs Rules 6 & 7: Safe speed and effective observation are mandatory. | SOP stipulates speed ≤ 6 knots and radar/echosounder monitoring. | In accordance – recommendation: add UKC evaluation parameters in SOP. |
| <i>“All available means” must be used in observation.</i> | SOP requires radar, GPS, AIS, and echosounder to be active. | In accordance – recommendation: add pre-transit checklist scheduling to ensure all devices are active. |

In COLREGs Rule 9, a vessel is prohibited from crossing a channel if the action interferes with other vessels in transit, and in overtaking situations, the intention to maneuver must be conveyed by voice signals in accordance with applicable regulations. The SOP of MV. Meratus Dili strengthens the implementation of this rule through a combination of VHF communication and voice signals when crossing or overtaking maneuvers occur in narrow channels, so that the vessel's operational practices remain in line with the principles of vigilance and collision prevention.

Table 9 Triangulation – Overtaking & Crossing in the Channel

| International Rules | Ship SOP | Suitability / Recommendation |
|--|---|---|
| COLREG 9(d) & (e): Avoid obstructive crossings; use signals when overtaking. | SOP uses VHF + voice alert signal when there is a crossing. | In accordance – recommendation: add explicit sound signal procedures according to Rule 34. |
| <i>Do not anchor in narrow channels if possible.</i> | SOP prohibits anchoring in main transit zones. | In accordance – establish a safe area for anchoring when absolutely necessary. |

IMO guidelines, in addition to COLREGs, require voyage planning to include tidal analysis, depth prediction, and UKC before navigating narrow channels. The MV Meratus Dili's SOP already covers voyage planning, but it needs to be clarified to include actual tidal analysis, UKC estimates, and potential current variations to be more consistent and comprehensive with IMO standards.

Table 10 Triangulation – Route Planning & Tides

| International Rules | Ship SOP | Suitability / Recommendation |
|---|---|--|
| IMO Voyage Planning: Transit plans must take into account tides and water conditions. | The SOP includes a public transit plan but does not yet detail the ebb and flow. | Not enough – recommendation: add tidal analysis procedures & UKC. |
| <i>Risk planning includes traffic and environmental factors.</i> | The SOP contains traffic risks, but does not yet include a structured environmental evaluation. | Not enough – risk documentation needs improvement. |

IV. DISCUSSION

1. Optimizing Ship Maneuverability in Narrow Shipping Channels

Vessel maneuvering in narrow shipping channels, such as the Amamapare Channel (PT Freeport Indonesia's territory), is crucial for safety and efficiency, as the confined space demands tight maneuvering control, course stability, and a safe distance from the seabed and the channel edge—much more precise than in open shipping. Research on the MV Meratus Dili, through observation, watch officer interviews, and navigation data analysis, identified five key operational factors influencing optimization: speed control, navigational equipment utilization, vessel position in the channel, voyage planning, and inter-vessel communication; these factors maintain maneuvering stability and minimize risk, summarized in the analysis table.

Table 15 Factors that Optimize Ship Maneuverability

| Operational Aspects | Findings from Data | Implications for Physical Exercise |
|--------------------------------|--|---|
| Controlled speed | >6 kt at low tide causes low UKC | The need for speed limits to maintain maneuver response |
| Use of RADAR & Echosounder | Radar is always active; Echosounder is essential at low tide | Assists with course correction and depth detection |
| Position on the starboard side | Consistent with COLREG 9 rules | Reduce the risk of collisions in the lane |
| Voyage planning | Tidal analysis is not optimal | Motor decision making is more accurate when improved |
| VHF Communication | Intensive during high traffic | Improve prediction of other ships' maneuvers |

**Fig.2 RADAR**

The use of electronic navigation equipment such as radar and echosounder is crucial for ship safety in narrow shipping lanes, as observed on the MV Meratus Dili. Radar, as the primary tool, operates at short range to detect surrounding objects (other vessels, coastlines, channel boundaries), monitor the ship's position in the middle of the lane, and measure distance/direction via the EBL and VRM features for course correction. The target tracking feature also anticipates the risk of collision, while the echosounder ensures a safe depth, so that the officer on duty can maintain an optimal shipping lane.



Fig. 3 ECDIS

Echosounders play a vital role in shallow waters by measuring real-time depth beneath the vessel via reflected sound waves from the seabed, enabling the MV Meratus Dili's officer of the watch to monitor changes—especially during low tide—to maintain a safe Under Keel Clearance (UKC) and avoid grounding by adjusting speed or course. Combined with radar (which focuses horizontally: the position of other vessels, channel boundaries), echosounders (vertically: depth) provide complete data integration, supporting accurate navigational decision-making in narrow channels.



Fig. 4 Ship Position in Narrow Channel

On the MV Meratus Dili in the narrow Amamapare channel, the ship's position is always maintained on the starboard side in accordance with Rule 9 of COLREGS (International Regulations for Preventing Collisions at Sea), which requires ships to remain close to the outer limit of the safe starboard side to divide entry/exit lanes, minimize the risk of head-on collisions, and increase maneuvering efficiency by anticipating currents or other vessels. Monitoring is carried out via radar, ECDIS, and visual observation of navigation marks, ensuring the stability and order of traffic—this practice is in line with international regulations and reduces the potential for accidents.

| No | Maneuvering Point | Latitude | Longitude | Course | Distance | UKC | Remarks |
|-----|-------------------|---------------|----------------|--------|----------|-----|---------|
| 001 | Alfa Buoy | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 002 | 002 B 01 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 003 | 003 B 02 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 004 | 004 B 03 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 005 | 005 B 04 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 006 | 006 B 05 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 007 | 007 B 06 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 008 | 008 B 07 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 009 | 009 B 08 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 010 | 010 B 09 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 011 | 011 B 10 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 012 | 012 B 11 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 013 | 013 B 12 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 014 | 014 B 13 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 015 | 015 B 14 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 016 | 016 B 15 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 017 | 017 B 16 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 018 | 018 B 17 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 019 | 019 B 18 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 020 | 020 B 19 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 021 | 021 B 20 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 022 | 022 B 21 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 023 | 023 B 22 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 024 | 024 B 23 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 025 | 025 B 24 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 026 | 026 B 25 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 027 | 027 B 26 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 028 | 028 B 27 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 029 | 029 B 28 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 030 | 030 B 29 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 031 | 031 B 30 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 032 | 032 B 31 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 033 | 033 B 32 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 034 | 034 B 33 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 035 | 035 B 34 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 036 | 036 B 35 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 037 | 037 B 36 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 038 | 038 B 37 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 039 | 039 B 38 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 040 | 040 B 39 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 041 | 041 B 40 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 042 | 042 B 41 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 043 | 043 B 42 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 044 | 044 B 43 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 045 | 045 B 44 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 046 | 046 B 45 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 047 | 047 B 46 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 048 | 048 B 47 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 049 | 049 B 48 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 050 | 050 B 49 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 051 | 051 B 50 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 052 | 052 B 51 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 053 | 053 B 52 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 054 | 054 B 53 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 055 | 055 B 54 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 056 | 056 B 55 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 057 | 057 B 56 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 058 | 058 B 57 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 059 | 059 B 58 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 060 | 060 B 59 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 061 | 061 B 60 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 062 | 062 B 61 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 063 | 063 B 62 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 064 | 064 B 63 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 065 | 065 B 64 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 066 | 066 B 65 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 067 | 067 B 66 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 068 | 068 B 67 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 069 | 069 B 68 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 070 | 070 B 69 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 071 | 071 B 70 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 072 | 072 B 71 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 073 | 073 B 72 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 074 | 074 B 73 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 075 | 075 B 74 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 076 | 076 B 75 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 077 | 077 B 76 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 078 | 078 B 77 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 079 | 079 B 78 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 080 | 080 B 79 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 081 | 081 B 80 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 082 | 082 B 81 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 083 | 083 B 82 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 084 | 084 B 83 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 085 | 085 B 84 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 086 | 086 B 85 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 087 | 087 B 86 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 088 | 088 B 87 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 089 | 089 B 88 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 090 | 090 B 89 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 091 | 091 B 90 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 092 | 092 B 91 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 093 | 093 B 92 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 094 | 094 B 93 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 095 | 095 B 94 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 096 | 096 B 95 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 097 | 097 B 96 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 098 | 098 B 97 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 099 | 099 B 98 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 100 | 100 B 99 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |
| 101 | 101 B 100 | 08° 58' 00" S | 115° 00' 00" E | 180 | 0.0 | 1.0 | |

Fig. 5 Passage Plan

Passage planning of MV Meratus Dili (Alfa Buoy to Main Jetty, Amamapare) contains waypoints, coordinates, course, distance, UKC, and shallow water/safe speed warnings; crucial for safe routing in narrow channels via map/echosounder, but lacks tidal optimization for safer UKC.



Fig. 6 VHF Channel 12

VHF Radio Channel 12 on the bridge of MV Meratus Dili is the main means of communication in the narrow channel of Amamapare: coordinating position, direction, maneuvering with other vessels/VTS/ports during heavy traffic or passing, increasing situational awareness, maintaining a safe distance, and reducing the risk of collision through channel entry reports and priority instructions.

2. Determining the Optimal Speed of a Ship When Sailing in a Narrow Channel

Table 16 Determination of Optimal Speed Based on Conditions

| Navigation Conditions | Actual Speed | Impact on UKC | Recommended Optimal Speed |
|-----------------------|---------------------|---------------------------------|--------------------------------|
| Low tide (low depth) | 6.9–7.5 kt | UKC 0.20–0.50 m (unsafe) | 4–5 kt |
| Install (safe depth) | 5.5–5.8 kt | UKC 1.10–1.20 m (safe) | 5–6 kt |
| High traffic | >6 kt when crossing | The risk of collision increases | 4–5 kt |
| Evening | 5–6 kt | Observation relies on radar | 5–6 kt with additional lookout |
| Low visibility | 5–6 kt | Radar dependence increases | ≤5 kt |

VHF Radio Channel 12 on the bridge of MV Meratus Dili is the main means of communication in the narrow channel of Amamapare: coordinating position, direction, maneuvering with other vessels/VTS/ports during heavy traffic or passing, increasing situational awareness, maintaining a safe distance, and reducing the risk of collision through channel entry reports and priority instructions.

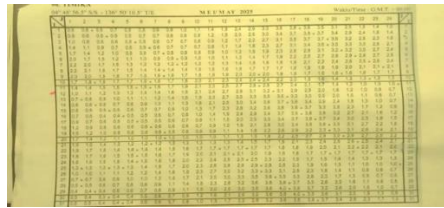


Fig. 7 Tide Table

Tidal data shows that sea levels in Timika fluctuate hourly, with high tide increasing depth and low tide decreasing it. These changes affect the Under Keel Clearance (UKC) of ships passing through.

At high tide, the depth is greater, ensuring a safe UKC, allowing the vessel to sail at a stable speed. Conversely, at low tide, the depth decreases, reducing the UKC, and requiring the vessel to reduce speed to avoid the squat effect, which can increase the risk of grounding.

Therefore, tidal data is very important for the officer on duty to determine safe sailing times and adjust the ship's speed according to water conditions.

V. CONCLUSION

This study found that optimizing ship maneuvering in narrow shipping channels such as the Amamapare Channel on the MV. Meratus Dili relies on controlling speeds below 6 knots during low tide to maintain a minimum Under Keel Clearance (UKC) of 0.5 meters, intensive use of radar and echosounder for target detection and real-time depth, maintaining position on the starboard side according to COLREGs Rule 9, voyage planning that takes tides into account, and VHF communication with VTS to manage heavy traffic. Optimal speeds are recommended at 4-5 knots during low tide or high traffic conditions to minimize the squat effect, the risk of grounding, and collision, with ship navigation practices generally complying with international regulations although there are still gaps in the pre-transit UKC analysis. These findings are corroborated through triangulation of observations, officer interviews, and documentation, emphasizing the role of the Chief Officer in rapid decision-making.

However, the limitations of this study lie in its descriptive qualitative approach based on a single case study of a single vessel and a specific location, thus limiting generalizability and the absence of quantitative hydrodynamic simulations or long-term data. Suggestions for further research include a mixed-methods approach with mathematical models to predict optimal speed based on current and vessel size, as

well as a multi-lane comparison in Indonesia. Practically, these results are recommended to be integrated into shipping company SOPs through UKC checklists, tidal data-based navigation training, and automatic speed limits, to reduce the percentage of accidents by 20-30% in national narrow waters.

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