Dinamika Bahari
Journal of Maritime Dynamic
October 2023

DOI: https://doi.org/10.46484/db.v4i2.402

Volume : 4
No : 2
Pages : 49 - 61
ISSN : 2087-3050
e-ISSN : 2722-0621

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The Effect of Ship Maneuvering and Weather on Ship Berthing Position with Icy Water

Abstract: Ship maneuvering implements sailor skills in maneuvering ships from a departure place to a destination safely, effectively, and efficiently. Ship maneuvers are carried out in waters, but ship maneuvers in icy waters have serious challenges and must be executed carefully. The ice-bound maneuvering procedure must consider the technique used. Besides that, the weather factor can cause obstacles in the movement. Thus, skill in ship maneuvers and accurate analysis are needed to reach a berth position in icy waters. This research aims to analyze whether there is a significant influence between ship maneuvering techniques and weather simultaneously on the ship's berthing position in ice waters. This study uses a quantitative descriptive method. The data sources were obtained through observation, the ship's bell book, and documentation, which were then processed into numbers describing the research variables. These numerical data are used in research to test hypotheses regarding the partial and simultaneous influence of ship maneuvering techniques and weather on ship berthing positions with conditions of icy waters. The study results indicate that the ship's maneuvering techniques and the weather have a significant effect partially or simultaneously on the position of the ship's berth in icy waters.

Keywords: ship maneuvering, weather, ship berthing position, icy waters

INTRODUCTION

Ships are operated under various loading conditions with changes in the draft or trim. Therefore, it is necessary to understand how changes in the loading conditions affect ship maneuvering from the viewpoint of navigation safety (Yasukawa et al., 2023). However, managing ship maneuvering time is a complex task (Yalcin et al., 2022).To achieve smooth ship maneuvers when docking, undocking, anchoring, sailing in narrow shipping lanes, or passing traffic separation charts, the master and officer must pay attention to factors that can influence the ship maneuvering process, such as current weather conditions, as well as the latest states regarding the readiness of the pier, the berthing position that the ship will occupy for carrying out the loading and unloading process. Natural factors such as weather make analysis important for captains in developing ship maneuvering strategies.

In Figure 1 below, the average winter temperature recorded from 2019 to 2021 reached -13° Celsius to -15° Celsius in January. On December 21, 2020, in the northern hemisphere, winter began with natural symptoms in the form of decreasing air humidity and the chance of rain, an increasing chance of snow, and thin to thick layers of ice starting to form on the surface of the water in several areas. The process of thickening the ice layer and decreasing sea water temperature occurred until it reached its lowest point in January. According to Figure 1, the temperature drop in January 2021 reached the lowest point from -13° Celsius to -15° Celsius. Therefore, as the density of seawater decreases due to cold

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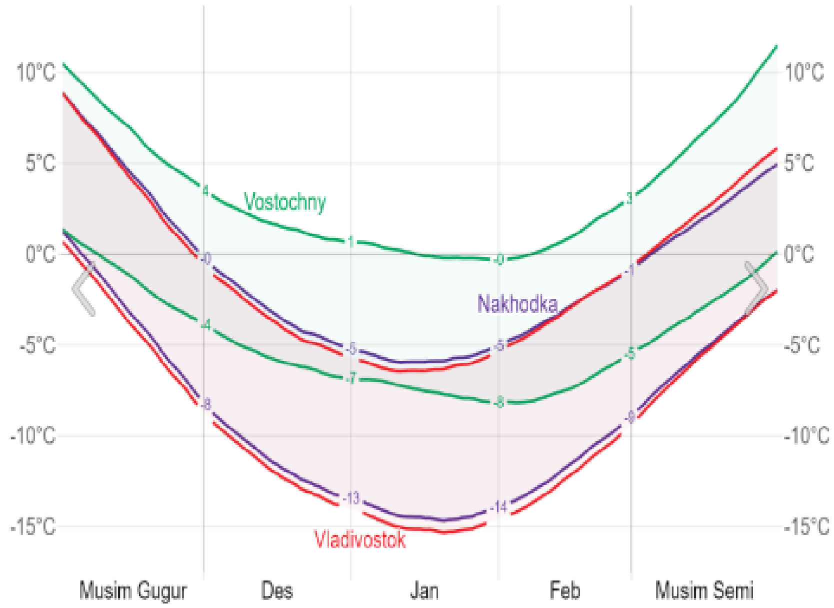
temperatures, the formation of the ice layer will become thicker from 20 cm to 80 cm (data processed by researchers through direct observation and observation, 2021).



Note:
Vostochny
Nahhodka
Vladivostok

Figure 1. Average High and Low Temperatures in Vostochny, Nakhodka, and Vladivostok in 2019-2021
Sources : (https://id.weatherspark.com/compare/s/3/143188~103556~143113/Perbandingan-Cuaca-rata-rata-pada-Musim-dingin-di-Nakhodka-Vostochny-dan-Vladivostok)

In January 2021, MV. Geopark Venus sailed from the port of Nakatsu, Japan, to the port of Nakhodka, Russia, which is geographically located at latitude 42° North and experienced winter with an average temperature of -20° Celsius to -29° Celsius. This must be the primary concern and focus for visitors. The master and officer tried to minimize the risks that might occur, such as damage to several parts of the ship due to having to force the ice layer to break up due to the impact of freezing sea water in Nakhodka port with ice thickness from 20 cm to 80 cm or the freezing of ballast water due to delays. The ship's crew poured Anti Frozen Liquid into the ballast tanks through sounding pipes at certain times and in specific doses. These chunks of ice are the primary concern in the ship's berthing maneuvers at the Nakhodka port (Lipski, 2020). Weather analysis, which is wind conditions, environmental temperature, and ice thickness that occur at Nakhodka port, must be carried out earlier to minimize the possibility that could occur during the ship's maneuvering process.

Thus, the guidelines for ship maneuvers in breaking ice waters issued by the company, updated information regarding port conditions, and ice breaker vessel communication must be the primary guidance for the master and officer to avoid navigational dangers and damage to the ship's hull, especially on bull bows and ship propellers. In this situation, analysis of the ship's berthing position and port weather forecasts with various information and direct observations become the main focus in choosing a ship maneuvering strategy. Ship maneuvering techniques were the main focus for the Captain, Officer, and the entire MV. Geopark Venus crews carry out ship maneuvers during the berthing process safely, effectively, and efficiently. Apart from ship maneuvering strategies and techniques, various weather conditions that significantly influence the ship's berthing position, such as strong winds, freezing temperatures, and icy waters, are the main factors that make good ship maneuvering strategies. Port weather conditions with strong winds and cold temperatures also support the formation of layers of ice that can quickly reach an average ice thickness of 20cm to 80cm. Besides that, the occurrence of snow storms also causes the maneuvering process to be disrupted, and the ship's berthing position is difficult to determine.

Ship maneuvering is a technique or method of bringing a ship from one place to another that is known to be effective, efficient, and safe to carry out an activity by utilizing the internal and external conditions of the ship so ship maneuvers do not require a long time, the use of materials fuel is economical, and ships can be protected from the dangers it causes (Purwantomo, 2019). When maneuvering a ship, every master and officer must pay attention to and be critical of the ship's maneuvering skill. It is ideal if the well-qualified theoretical knowledge is combined with sufficient experience in ship operations. Several internal factors influence the ship's movement, such as the ship's shape, the type and strength of the ship's propulsion force, the draft of the ship, and the condition of the trim and list or tilt of the ship. Meanwhile, the external factors that influence the ship's maneuvering are wind and wave conditions, current conditions, and the depth and width of the channel or sailing area.

According to Kartasapoetra (2004), *Weather* is a natural phenomenon caused by a combination of natural elements: solar radiation, temperature, humidity, cloud thickness, rain, evaporation, air pressure, and wind. Weather control is a factor that influences the weather elements, which results in differences in weather from one place to another. The sun is a significant weather controller and is the primary energy source for life on Earth, which can cause air movements and ocean currents. The ship's berthing position is a location point on the port pier as the port authority determines the vessel's berthing location for the loading and unloading activity to take place. A dock is a place where ships dock or dock to carry out the process of loading and unloading goods, both for import and export purposes. It was explained by Triatmodjo: 157-159 in HSB 2009 that the selection of the pier type is adjusted to the factors that influence the type of pier structure, such as the topography of the coastal area, the type of ship served, and the carrying capacity of the land.

Ice water is seawater that freezes and floats on the sea's surface, forming a sharp angle at the end and having mass or weight. The first indication that seawater will turn into ice is ice with a diameter of 2 cm to 5 cm and shaped like ice flowers or thin ice slabs several millimeters in size floating on the surface of seawater. This shapeless ice flower will experience repeated and continuous cooling until it forms a dense and increasingly thick ice layer. This research aims to discover how ship maneuvers and weather have a significant partial or simultaneous influence on the position of the ship's dock in icy waters.

METHOD

The research methods used in this research are quantitative methods using data analysis assistance from IBM SPSS Statistics 25 Software. The population of this research is 28 data populations consisting of movement data and secondary data regarding the weather. The samples were data from the MV. Geopark Venus ship's maneuvering techniques and weather data collected through graphic analysis of weather observation. The research instruments in this research are field notes, data qualifications, and data collection instruments. Researchers used the Excell software, which is raw data and must be processed further. Then, the stages of data processing using the IBM SPSS Statistics 25 software are data coding, data editing, data structure and data files, data entry, and data cleaning (Breuninger, 2023).

In this research, researchers used descriptive statistical techniques. The data that has been collected will be subjected to univariate and statistical analysis. Analysis of this

research data uses IBM SPSS Statistics 25 software. Researchers will use the 2x2 table chi-square test to test the relationship between independent and dependent variables. In making decisions about test results, researchers use a degree of significance of 0.05 with the provision that it is meaningful if the p-value < 0.05 and not significant if the p-value is > 0.05 in continuity correction if the value of each cell is not less than 5. If the results of the chi-square analysis of the 2x2 table contain cells with an E value of less than 5, then the p-value used is the value from Fisher's bivariate exact test p-value (Abdullah, 2015).
The hypothesis of this research is:
H_0: There is no significant influence between ship maneuvering techniques and weather simultaneously on the ship's berthing position and conditions of icy waters.
H_1: There is a significant influence between ship maneuvering techniques and weather simultaneously on the ship's berthing position and the conditions of icy waters.

RESULTS AND DISCUSSION

The research results are explained as follows.

Table 1. Frequency of data indicating changes in ship speed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Stop Machine	7	25.0	25.0	25.0
	Moving Machine	21	75.0	75.0	100.0
	Total	28	100.0	100.0	

It is recorded in the bell book or ship movement book during the berthing process on January 14, 2021, that in the ship movement process according to Table 1. The ship experienced the engine stopping seven times, with a percentage of 25%, and experienced the engine moving (the engine only moved forward, without a machine moving backward) 21 times, with a ratio of 75%.

Table 2. Frequency of data on the duration of changes in ship speed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 minute - 2 minute	13	46.4	46.4	46.4
	More than 3 minute	15	53.6	53.6	100.0
	Total	28	100.0	100.0	
	0 minute - 2 minute	13	46.4	46.4	46.4
	Total	24	100.0	100.0	

Based on Table 2, the implementation of the berthing process with icy water conditions has a duration of changing the ship's speed 13 times in 0 minutes to 2 minutes with a percentage of 46.4%, and the duration of changing the ship's speed is 15 times for more than 3 minutes the change in speed ships with a percentage of 53.6%. In Table 3, the ship speed determined by the Ice Bound Maneuvering Procedure is a safe speed that cannot exceed 4kts in Table 3. The implementation of the ship berthing process is carried out by setting a ship speed of 0kts to 2.0kts with a frequency of 13 times the ship's speed setting and producing a percentage of 46.4%, as well as setting a ship speed of more than 2.1kts 15 times and having a percentage of 53.6% in carrying out the berthing process in icy water conditions.

Table 3. Speed of the ship

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0kts - 2,0kts	13	46.4	46.4	46.4
	More than 2,1kts	15	53.6	53.6	100.0
	Total	28	100.0	100.0	

Table 4. Data frequency indicating changes in UKC (Under Keel Clearance)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Changes	16	57.1	57.1	57.1
	No Changes	12	42.9	42.9	100.0
	Total	28	100.0	100.0	

In Table 4, it is indicated that 16 ship UKC changes occurred with a percentage of 57.1%, and ships did not experience UKC changes 12 times with a percentage of 42.9%. UKC (Under Keel Clearance) has an influence on the estimated occurrence of ship strandings due to the Squat Effect that occurs on ships with seabed calculated from the sea depth at the ship's maneuvering point, namely 11.5 m to 9 m with the ship's deepest draft of 5.84 m, based on from the results of the Squat Effect calculation, the ship experienced the highest value of Squat Effect of 0.232 m and the lowest value of 0.003 m.

Table 5. Frequency of temperature change indication data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Changes	8	28.6	28.6	28.6
	No Changes	20	71.4	71.4	100.0
	Total	28	100.0	100.0	

Based on Table 5, the cold temperature during the reclining process changes eight times with a percentage of 28.6% and does not change 20 times with a percentage of 71.4%. This indicates that the cold temperatures during the ship's berthing process did not change much, according to weather reports from https://id.weatherspark.com/countries/RU.

Table 6. Data frequency indicating changes in wind speed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Changes	9	32.1	32.1	32.1
	No Changes	19	67.9	67.9	100.0
	Total	28	100.0	100.0	

According to Table 6, it is indicated that there were changes in wind speed during the ship's maneuvering period, the berthing process took place nine times with a percentage of 32.1%, and there was no indication that there was a change in wind speed 19 times with a percentage of 67.9%. The weather report from the website https://id.weatherspark.com/countries/RU shows that the wind speed was 3.6 kts to 7.2 kts during ship movements. According to Table 7, it is indicated that there was a change in wind direction nine times with a percentage of 32.1%, and there was no change in wind direction 19 times with a percentage of 67.9%. Changes in wind direction during the berthing process are also the focus in choosing ship maneuvering techniques and executing them carefully. Changes in wind direction can be an obstacle in reaching the predetermined berthing position and can cause the possibility of a collision.

Table 7. Frequency of wind direction change data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Changes	9	32.1	32.1	32.1
	No Changes	19	67.9	67.9	100.0
	Total	28	100.0	100.0	

The data indicating ice thickness has the results shown in Table 8 that ice thickening occurred during the berthing process 14 times with a percentage of 50%, and no thickening of the ice layer occurred—14 times with a percentage of 50%. The thickening of the ice layer started from the ship's anchor position. It thickened significantly to a maximum thickness of 80 cm, which formed around the ship's anchor position and caused large deviations because the ship could not anchor in the wharf position perfectly.

Table 8. Frequency of data indicating the thickening of the ice layer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Changes	14	50.0	50.0	50.0
	No Changes	14	50.0	50.0	100.0
	Total	28	100.0	100.0	

Table 9. Descriptive data on ship maneuvering variables

	N	Minimum	Maximum	Mean	Std. Deviation
Indication of Ship Speed Changes	28	1	2	1.75	.441
Duration of Change in Ship Speed	28	1	2	1.54	.508
Ship Speed	28	1	2	1.54	.508
UKS Changes	28	1	2	1.43	.504
Valid N (listwise)	28				

Table 10. Descriptive Data for Weather Variables

	N	Minimum	Maximum	Mean	Std. Deviation
Changes in Temperature	28	1	2	1.71	.460
Changes in Wind Speed	28	1	2	1.68	.476
Change in Wind Direction	28	1	2	1.68	.476
Thickening of the Ice Sheet	28	1	2	1.50	.509
Valid N (listwise)	28				

The independent variable data in Table 9 and Table 10 were then processed using bivariate analysis and multivariate analysis using ship berth position data as a fixed variable obtained from documentation and observation.

Table 11. Data on ship berth position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Changes	13	46.4	46.4	46.4
	Changes	15	53.6	53.6	100.0
	Total	28	100.0	100.0	

Table 11 describes descriptive data from observation and video recordings of ship movements for the berthing process with the conditions of icy waters.

Table 12. Results of the One-Sample Kolmogorov-Smirnov Normality test

	Unstandardized Residual
N	

		28
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	.38008069
Most Extreme Differences	Absolute	.172
	Positive	.166
	Negative	-.172
Test Statistic		.172
Asymp. Sig. (2-tailed)		.033[c]
Exact Sig. (2. tailed)		.340
Point probability		.000

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

The normality test results are shown in Table 12. The test criteria for rejecting H0 if sig. < 0.05 with a significance level of 5%. The H0 value explains that the data is normally distributed, while the H1 value explains that the data is not normally distributed. The conclusion is that it can be accepted if the value of the H0 analysis shows sig. > 0.05. Based on the test data above, the Exact sig value is obtained. (2-tailed) of 0.340 (sig. 0.340 > 0.05). So, the decision taken is that H0 is accepted. The conclusion drawn is that the samples studied were normally distributed.

Table 13. Frequency Distribution of Data on Vessel Movement Variables

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Influential	16	57.1	57.1	57.1
	Non Influential	12	42.9	42.9	100.0
	Total	28	100.0	100.0	

Based on the research results in Table 13, the total number of research data is 28. Based on the available study data about ship maneuvering variables, it has been observed that these variables exert a significant influence of 57.1% on the berthing position. In contrast, 42.9% of the variables do not exhibit any discernible impact on the berthing position.

Table 14. Frequency distribution of weather variable data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Influential	15	53.6	53.6	53.6
	Non Influential	13	46.4	46.4	100.0
	Total	28	100.0	100.0	

Based on the research results in Table 14, the total number of research data is 28. In the weather variable research data, the variable will influence changes in the ship's berth position by 53.6% and will not affect the ship's berth position by 46.4%.

Table 15. Frequency distribution of ship berthing position variable data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Changes	13	46.4	46.4	46.4
	Changes	15	53.6	53.6	100.0
	Total	28	100.0	100.0	

Based on the research results in Table 15. shows that from the influence of existing variables, the ship's berthing position can change by 53.6%, and no change is possible with a value of 46.4%.

Table 16. Cross Tabulation 2x2 Chi-Square Test Relationship Between Ship Movement Variables and Ship Berthing Position

CHI-SQUARE TESTS					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	12.253[a]	1	.000		
Continuity Correction	9.719	1	.002		
Likelihood Ratio	13.794	1	.000		
Fisher's Exact Test				.001	.001
Linear-by-Linear Association	11.815	1	.001		
N of Valid Cases	28				
a. 0 cells (0%) have an expected count of less than 5. The minimum expected count is 5,57.					
b. Computed only for a 2x2 table					

Based on the results of the analysis in Table 16. above, it is known that the ship maneuvering factor with its influence on the ship's berthing position shows the analysis results using the chi-square test with a p-value of 0.002 where the result is smaller than 0.05 (5 %). So, researchers can conclude that there is a significant relationship between ship maneuvering variables and the possibility of changes in the ship's berthing position in the icy waters. Based on the analysis results in Table 17 above, the weather variable analyzed using the chi-square test has a p-value of 0.007, where this result is smaller than 0.05 (5%). So, there is a relationship between weather variables and the possibility of changes in the ship's berthing position in the icy waters.

Table 17. Cross Tabulation 2x2 Chi-Square Test Weather Variables on Ship Berthing Position

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	9.403[a]	1	.002		
Continuity Correction	7.217	1	.007		
Likelihood Ratio	10.113	1	.001		
Fisher's Exact Test				.003	.003
N of Valid Cases	28				
a. 0 cells (0%) have expected count of less than 5. The minimum expected count is 6,04.					
b. Computed only for a 2x2 table					

Table 18. Effect of Ship Movement and Weather on Ship Berthing Position

		df	Sig.	Exp (B)	95% C.I for EXP (B)	
					Lower	Upper
Step 1[a]	Ship maneuvering	1	.011	40.502	2.376	690.281
	Weather	1	.025	18.987	1.445	249.538
	Constant	1	.005	.000		
a. Variable(s) entered on step 1: Olah_Gerak_Kapal, Cuaca.						

Based on the results of the multivariate analysis test in Table 18, it is known that the ship maneuvering variable has a calculated value from the multivariate p-value of 0.11 with an influence value on the ship's berthing position of 40.5%. In comparison, the weather variable has a calculated p-value of 0.25 with an influence value on the ship's berthing position of 18.9%. In the results of this multivariate test, ship maneuvering and weather variables jointly or simultaneously influence the ship's berthing position with the icy water conditions by 59.4%. The results of this analysis indicate that 40.6% of the causes of changes in leaning position were caused by other variables not discussed in this study.

Based on the chi-square test results, the final results show that the research data to determine the effect of ship maneuvering techniques on the ship's berthing position uses the chi-square test with a p-value of 0.002, where the result is smaller than 0.05 (5 %). It can be concluded that there is a relationship between the ship's maneuvering variables and its berthing position. The results of this research are very consistent with the implementation of ship maneuvering techniques to achieve the ship's berthing position with the icy water conditions. The ship maneuvering techniques implemented during the berthing process greatly influence the ship's berthing position. The change in ship speed is an effort to maintain the ship's speed by the procedures for maneuvering ships sailing in icy waters or by the Ice Bound Maneuvering Procedure issued by the Russian port authority. This movement of the engine backward aims to prevent the ship's propeller from being damaged due to the absorption process of the ship's propeller rotation of the fragments and chunks of ice floating around the ship so that changes in the ship's speed only focus on stopping the engine or in the future.

Apart from that, the master and officer must maintain the ship's speed in a safe condition or by the ice-bound maneuvering procedure (Rajagopal and Zhang, 2021); a maximum of 4 kts and the maximum speed when approaching the dock for the berthing process is 2 kts. This procedure follows the safe speed the captain and officer apply during the berthing process in the icy waters.

Setting the ship's trim is necessary before the ship docks to obtain the appropriate speed during ship maneuvers. Ice Bound Maneuvering Procedure: A ship that will sail or maneuver in icy waters must adjust the ship's trim until the ship looks up (trim by a stern). A ship's propeller, which is a tool used for ship maneuvering, is very easily damaged if a block of ice or damage hits it due to water suction or the rotation of the ship's propeller during the ship's maneuvering against chunks of broken ice around the ship's stern.

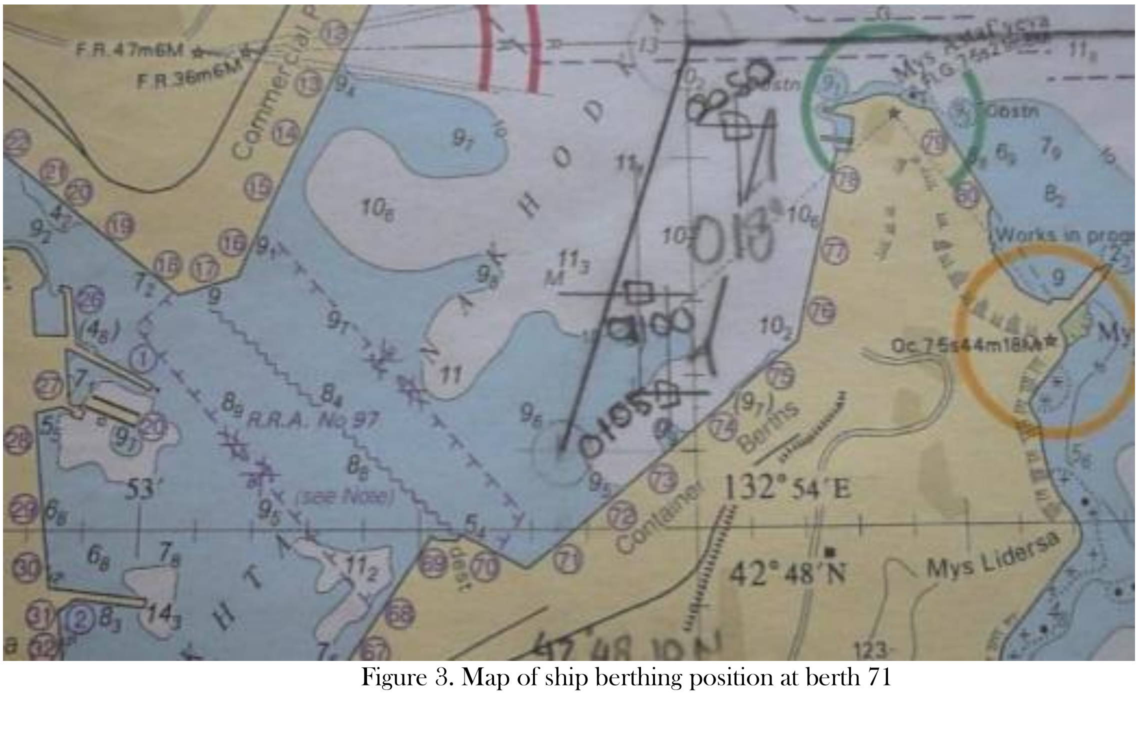


Figure 3. Map of ship berthing position at berth 71

Based on Figure 3. the ship berths at berth 71, one of the ship's berth positions with icy water conditions. If the safe speed of the ship is not regulated in such a way, then the ship can experience deviation or change in the position of the ship's berth. Conditions at berth 72, occupied by other boats, can cause a critical area, so the captain must be more careful in maneuvering the ship. The results of the cross-tabulation analysis using the chi-square test obtained a p-value of 0.002, where this result was smaller than the significance value of 0.05 (5%). To sum up, ship maneuvering techniques significantly affect the berthing position of the ship and the conditions of icy waters. Selection of ship maneuvering techniques that will be used in the berthing process for the use of engine forward or engine stop movements by paying attention to the condition of ice thickness, duration of ship engine movement to maintain safe ship speed following the Ice Bound Maneuvering Procedure to minimize damage to the hull ship due to chunks of ice, maintaining a safe speed when moving the ship, the berthing process with icy water conditions also helps reduce the impact of the ship's Squat Effect on the bottom of the waters (seabed).

Based on the chi-square test results, the final results show that the research data to determine the effect of weather on the ship's berthing position uses the chi-square test with a p-value of 0.007, where the result is less than 0.05 (5%). It can be concluded that there is a relationship between weather variables and the ship's berthing position. The extreme cold weather factor, which causes the waters in the port area to freeze, makes it difficult for the ship and causes difficulty in maneuvering the ship to reach the desired berthing position. The cold temperature, which occurs with temperature changes, becomes colder, 18° C to -22° C, causing seawater to freeze and form ice chunks more quickly. Cleaning ice chunks in the dock area is necessary to smooth the berthing process and minimize the occurrence of deviations or changes in the ship's berthing position due to the accumulation of ice chunks at the ship's berthing position.

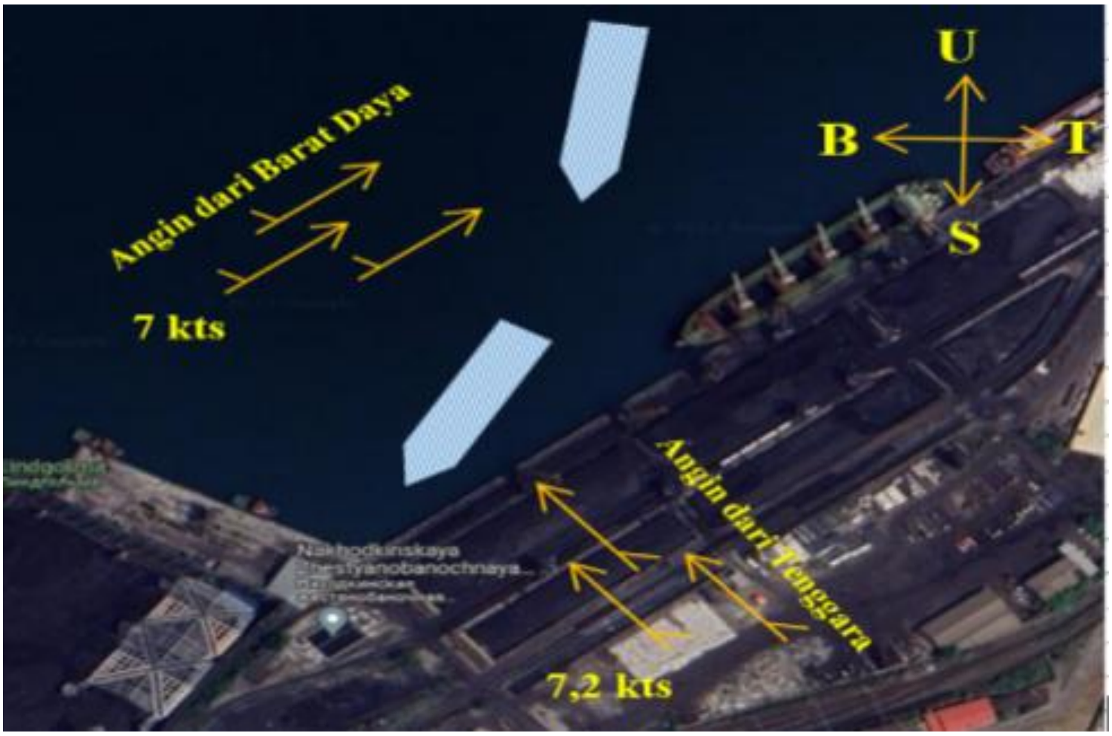


Figure 4. Effect of changes in wind direction and wind speed
Sources: Citra©2023Airbus, CNES/Airbus, Data peta ©2023Google

The wind also influences the ship's berthing process (Xiao et al., 2021). The fluctuations in wind direction and wind speed during the berthing process necessitate heightened caution and advanced analysis by the captain, officer, and on-duty pilot. This is necessary before executing the ship's maneuvers and entering the dock area. Based on Figure 4, winds that significantly change direction affect the ship's movement during the berthing process and can cause deviation and even changes in the ship's berthing position due to strong winds. The master, officer, and pilot on duty must carry out an analysis early to reduce the risk of damage to the ship due to errors in estimating the ship's movement or collisions with other ships at anchor due to errors in estimating critical areas or dangerous areas with other ships from the ship's berthing position set. Apart from changes in wind speed and direction that occur during the ship's berthing process, the condition of the ice layer formed with different ice thicknesses causes a significant influence on the ship's berthing motion and allows deviations in the ship's berthing position (Prasaja et al., 2023).

Based on Figure 5, the formation of layers of ice with different thicknesses can have an impact on the berthing process, with chunks of ice forming and eventually appearing around the ship's berthing position, making it difficult for the ship to maneuver to reach the specified berthing position until it is in position and docked flawlessly. The following is documentation from researchers with different movement times for ice conditions at the ship's berth position.

Figure 5. Ice thickness conditions during ship maneuvers

Based on the results of the multivariate analysis test from Table 18, it is known that the ship maneuvering variable has a calculated value from a multivariate p-value of 0.11 with an influence value on the ship's berthing position of 40.5%. In comparison, the weather variable has a calculated p-value of 0.25 with an influence value on the ship's berthing position of 18.9%. In the results of this multivariate test, ship maneuvering variables and weather variables jointly or simultaneously influence the ship's berthing position with the surrounding ice water conditions by 59.4%. This aligns with the researchers' experience carrying out onboard training. The choice of ship maneuvering techniques must be made very precisely and wisely. It starts with analyzing the weather occurring when the ship's berthing process is carried out by utilizing weather information from the port authority and weather news distributed via navigation tools, namely NAVTEX (Navigation Telex) (British Admiralty, 1976). The information collected is then processed and analyzed wisely to plan the ship maneuvering techniques that will be implemented. Apart from that, the ship maneuvering procedures that the company has circulated must be used as a reference in carrying out ship maneuvers, such as using safe ship speeds when maneuvering the ship. , proper use of ballast water, adequate selection of ship trim, and adjustment of the ship's draft to avoid damage to the ship's propeller due to ice floes.

Statistically, ship maneuvering variables and weather variables influence the ship's berthing position together, with an influence value of 40.5%, and weather variables with an influence value of 18.9%. The influence of ship maneuvering techniques affects more than weather variables (Wang et al., 2022). The results of this research align with the researchers' experience when carrying out sea practices on ships. Stable ship movements by estimating ship speed and significant changes in ship speed make ship movements more efficient even when the ship's movement breaks up the ice. In this research, the weather has a minor influence than the ship's movement on the ship's berthing position because weather factors take a relatively long time to form and cause changes in the ship's berth position (Wang et al., 2021). The formation of ice layers causes ice patches around the pier. From port waters, it clumps together and finally sticks to the pier's edge. The process of forming this layer of ice occurs repeatedly over a relatively long period.

The influence of the ship's berthing position caused by the ship's movement and weather indicators that have been mentioned has an impact on the deviation of the ship's berth position from the conditions of the surrounding icy waters, chunks of ice that gather, thicken and cover the dock area causing the ship to be unable to sail berthed and docked perfectly, so the gangway had to be stretched until it reached the dock, the wind blowing and changing direction caused the ship to be pushed outward. It was challenging to reach the ship's berth position (Bakar et al., 2022). The ship maneuvering techniques carried out by the captain and officer and the guide in executing ship movements are meticulous because the position of the ship is at the end of the pier with other ships that have docked at berth 72, causing many critical areas that must be executed carefully, the condition of the waters ice with different thicknesses, as well as narrow shipping lanes because the tugboat breaking through the ice waters is not as wide as the ship, causing the ship's hull to be slightly scratched and held back when the ship moves to reach the ship's berthing position (Song et al., 2022). The skills of the master and officer, as well as the guide in bringing the ship along, as well as the cooperation of the entire ship's crew, the ice breaker vessel crew, and guidance from the port authority are very much needed in achieving the ship's berthing position in the conditions of the surrounding ice waters.

CONCLUSION

There is a significant influence between ship maneuvering techniques and partial weather on the ship's berthing position and the conditions of the icy waters. Furthermore, there is a substantial influence between ship maneuvering techniques and partial weather on the ship's berthing position and the conditions of the icy waters. From the hypothesis test, it was found that there was a significant influence between ship maneuvering techniques and weather simultaneously on the berthing position of the ship and the conditions of the icy waters. This hypothesis can be proven through the results of multivariate analysis between the independent variable and the dependent variable. It is known that the ship maneuvering variable has a calculated value from a multivariate p-value of 0.11 with an influence value on the ship's berthing position of 40.5%.

In comparison, the weather variable has a calculated p-value of 0.25 with an influence value on the ship's berthing position of 18.9%. In this multivariate analysis, ship maneuvering and weather variables jointly or simultaneously influence the ship's berthing position with the surrounding ice water conditions by 59.4%. So, the researcher can decide that the results of hypothesis H_1 are accepted and H_0 is rejected.

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