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ASSESSMENT OF PASSENGER COMFORT ON THE FAST FERRY OPERATING IN THE STRAIT OF MALACCA

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The ship operator needs passenger feedback on the comfort of inter-island speed ferries as information on improving passenger comfort services. This paper analyzes the comfort of passengers on fast passenger ferries operating in the Malacca Straits directly. The survey focuses on directly assessing the level of passenger comfort and evaluating the leading causes of passenger discontentment. The strategy adopted is the dissemination of a questionnaire to onboard passengers, with a response rate of around 30 out of a minimum of 24 referring to the SLOVIN formula. The comfort score in the questionnaire is divided into five points, namely: uncomfortable or queasy, dizzy and slightly queasy, dizzy, slightly dizzy, and comfortable. The measured data were validated using Analysis of Variance (ANOVA) and the Dunnett Simultaneous Tests for Differences in Means, which gave a P-value of 0.000 and a degree of confidence of 98.97%. The findings of the study indicated that respondents, on average, rated this ship as slightly uncomfortable to comfortable, giving it a comfort rating of 4.10 out of a possible 5. Moreover, three aspects, namely the ship's motion, the accommodation facilities, and the ship's vibration, significantly contribute to discomfort, as indicated by ratings of 3.8, 4.2, and 4.2, respectively, out of 5 (comfortable), indicating the severity of the effect. Furthermore, by knowing that the main source of passenger discomfort is ship motion, it can be input for ship operators in managing the comfort of ship passengers.

Keywords: ANOVA, dunnett simultaneous test, fast ferry, passenger comfort, questionnaire

1 INTRODUCTION

In many parts of Indonesia, inter-island passenger transportation is used, therefore ensuring the safety and comfort of the ship takes greater care. The Malacca Strait is a waterway that is passed by many passenger ships [1], for example, fast passenger ships operating from Bengkalis to Batam port, Indonesia. The data also shows that there are frequent accidents on the track in this area [2]. Thus, an investigation and analysis are needed so that the ship owner can find out the cause of the discomfort and safety of the ship's passengers. Up until now, the standard used to determine ship comfort has been seakeeping criteria at the time of shipbuilding design. However, this is not sufficient as a design criterion alone [1], and measurement of navigational quality under service conditions [3] must be carried out because comfort is a key parameter in the design and operation of passenger ships.

The main factors affecting comfort are the motion and acceleration experienced by ships while sailing rough waves, which are known to have an impact on passenger comfort and hamper navigational tasks for the crew [4]. In addition, previous research has demonstrated that human error is a major cause of ship accidents [1]. Where human factors account for up to 60% of high-speed ship accidents [1]. This human error is brought on by human fatigue or motion sickness [1]. According to Indonesian passenger ship accident data from 2015 to 2019, the National Transportation Safety Committee of Indonesia reveals that 58% of accidents occurred on fast boats, 31% on ro-ro ships, and 11% on cruise ships. The types of mishaps include capsizing, grounding, catching fire, colliding, and hilling. These accidents can be categorized as the consequence of human error, equipment failure, or a natural disaster. Human error accounted for 43% of the accident's occurrence, according to the data [2]. Indeed, weariness and seasickness among crew members are typically cited as the primary causes of shipwrecks in investigative reports [2].

In ship design, weariness and motion sickness are additional phenomena that must be considered, with the vessel's motion being one of their causes [5]. Where motion sickness is a complex autonomic phenomenon caused by intersensory conflicts across balance systems, resulting in a signal mismatch between susceptible individuals' static physical condition and their dynamic surroundings [6]. The operator of a ship should assess the vessel's motion in relation to the comfort of passengers. Theoretically, the vessel's motion causes balance issues in the ears and eyes, which can result in seasickness. However, defining the ship's motion performance evaluation is difficult, which could hinder the performance of the ship's crew. The requirements for how a ship should move are still too flexible, so crew comfort is not a top priority [7]. Thus, in the future, the level of passenger comfort can be used as a new seakeeping criterion that serves as a guide for passenger and crew convenience. Seakeeping prediction can be utilized to optimize hull geometry during the design phase [8]. However, for ships operating in sea lanes, several methods have been used to evaluate the level of passenger comfort, including direct onboard measurements using instrumentation tools [9] and onboard survey questionnaire approaches [7]. These questionnaires are not used to assess passenger comfort but only for the crew. In addition, Jamal et al. [6] have measured ship motion related to passenger comfort based on a review of ship motion.

This research is used to refine these findings to see how much the level of passenger comfort is based on human perception or the perception of the passengers themselves by asking ship passengers to fill out a questionnaire. the questionnaire is made different from the crew questionnaire because the standard of comfort is different. The crew is more trained while the passengers have different endurance.

This paper also describes a quantitative survey that is done as part of an ongoing effort to directly measure how comfortable passengers are on board. Earlier papers [5, 7] mostly looked at how comfortable the crew is. This study utilized a questionnaire to inquire about the passengers' level of comfort on the Malacca Strait-bound Passenger ship. In addition, the survey identifies the primary sources of uncomfort, providing ship operators and ship designers with actionable information. For the purpose of analyzing passenger comfort, the survey and analytic approach follow [1] with simplification, categorizing it into 5 scores: (score 1) extremely uncomfortable, (score 2) uncomfortable, (score 3) pretty uncomfortable, (score 4) a bit uncomfortable, and (score 5) comfortable.

2 LITERATURE REVIEW

The literature review in this study is used to ensure that the methods used in this study are relevant. There were two exposure discussions: one about the SLOVINS formula and one about the ANOVA method. The SLOVINS equation has been widely used to measure sample populations in research [10]. The formulation used is very easy, has a good level of accuracy and confidence, reaching 95% [10]. However, the level of accuracy can decrease if the number of samples used is smaller [11]. The SLOVIN formula refers to Eq. (1)

$$n = \frac{\mathrm{N}}{1+\mathrm{N}\,(\mathrm{e})^2} \tag{1}$$

Where n is the number of samples per total population (people), N is the number of population (people), and e is the percentage of the research budget that allows for sampling error while remaining tolerable, e equals 0,1 (10%) for a large population, and e equals 0,2 (20%) for a small population.

The ANOVA (analysis of variance) method is a statistical technique that is often used. One-way analysis of variance, or F-test, is the most common type of ANOVA in research. The validity of the F-test against non-normality has been studied from the 1930s to the present. According to the findings of these various studies, there are several studies with opposing views; there is evidence that supports and some that oppose its validity [11]. However, Blanca [11] has proven that this method can be used, with the result that 100% of the cases studied are valid regardless of the conditions being manipulated [11].

3 METHODOLOGY

3.1 Samples number and route in data retrieval

The comfort level of passengers traveling from Bengkalis to Batam across the Malacca Strait on the Passenger ship fast ferry is being evaluated. The passenger ship has the following principal dimensions: an overall length of 38.30 meters, a width of 7.40 meters, a depth of 2.70 meters, a draft of 1.30 meters, and a service speed of 32 knots. It can accommodate 379 passengers and 11 crew members. Fig. 1 depicts the overall configuration of the ship.

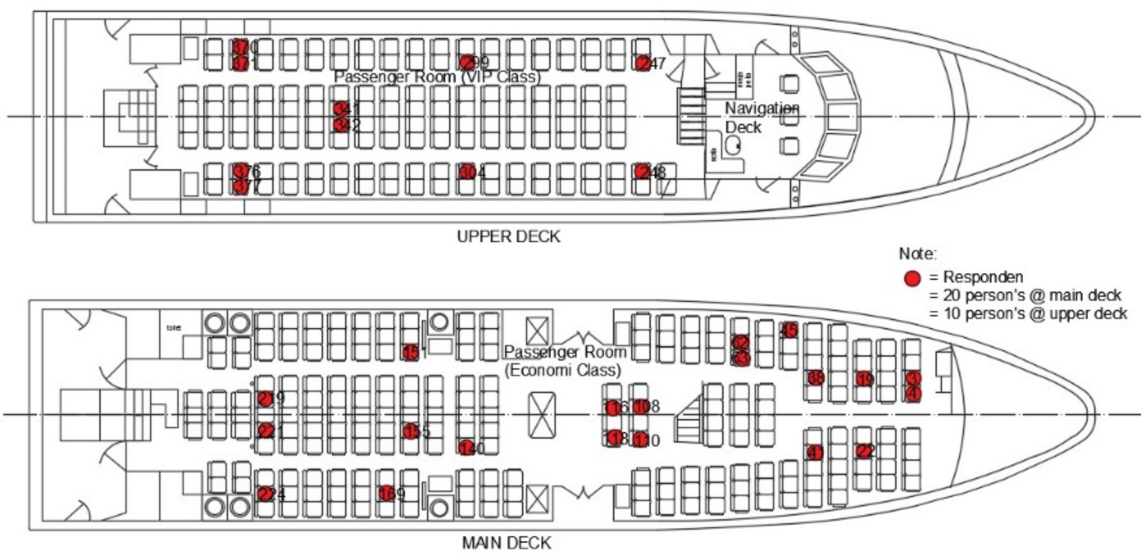

Fig. 1. Arrangement of respondents on ships

This study uses the SLOVIN algorithm to calculate the sample size of respondents [12]. According to the SLOVIN formula in Eq. (1), the number of respondents determined using the error coefficient of sampling error (e) is equal to 0.2, or 20% of the overall population in minuscule numbers. The estimated results indicate that a minimum sample size of 24 responders is required, but in this investigation, 30 passengers are utilized. The distribution of questioners is determined at random, with the mapping described in Fig. 1. Consequently, there are 20 responders in the economy room on the main deck and 10 responders in the very important person (VIP) room on the upper deck. Respondents are categorized based on the position of the passenger seat, gender, and age, with the aim of making it easier to analyze the factors that affect passenger uncomfort due to the motion of the ship in these three categories. In this case, the respondent's seat is separated into three same parts along a ship's length which include the bow, middle, and stern of the ship. Meanwhile, the gender and age of the respondents were classified into four categories: (i) males aged 16–30 years; (ii) males aged 31–45 years; (iii) females aged 16–30 years; and (iv) women aged 31–45 years.

The ship collected sampling data as it sailed from Bengkalis to Batam, stopping at three transit ports to load and unload passengers within 5–10 minutes before reaching its final destination in Batam. This expedition traversed three bodies of water, including the Malacca Strait, and covered a total distance of approximately 152.45 nautical miles. The shipping route consists of four distinct stages, including: (i) On the First Route, the cruise departs from the port of Bandar Sri Laksmana in Bengkalis (the first port) and arrives at the port of Tanjung Harapan (the second port) after 2 hours and 15 minutes and a distance of 93 kilobars. The ship traversed three bodies of water, namely Bengkalis Strait, Malacca Strait, and Panjang Strait, recording wave heights between 0.1 and 0.2 meters and wind speeds of up to 12 knots. (ii) Second Route: The second route departs from the port of Tanjung Harapan and travels to the port of Tanjung Samak (the third port) in 1 hour and 10 minutes, across a distance of 29.15 miles. This vessel traversed the waters of Panjang Strait, which reported wave heights of 0.1 meters and wind speeds between 6 and 11 knots. (iii) The Third Route, the voyage from Tanjung Samak Port to Tanjung Balai Port (4th port), takes 1 hour and 10 minutes and covers a distance of 28.88 miles. The ship traversed the Malacca Strait with wave heights of 0.4 meters and wind speeds between 9 and 18 knots. (iv) Fourth Route: The fourth route departs from Tanjung Balai Port and travels 35.49 miles to Batam Port (5th Port) in 1 hour and 25 minutes. This expedition through the Malacca Strait had wave heights of 0.3 meters and wind speeds ranging from 9 to 19 knots.

As seen in Fig. 2, questionnaire respondents were selected travellers going from Route 1 to Route 4. Passengers were handed questionnaires after boarding the ship for 30 minutes on the initial route, and the questionnaires were collected at Stage 4, 15 minutes before passenger disembarkation. The total time required to retrieve the survey data is 6 hours and 15 minutes.

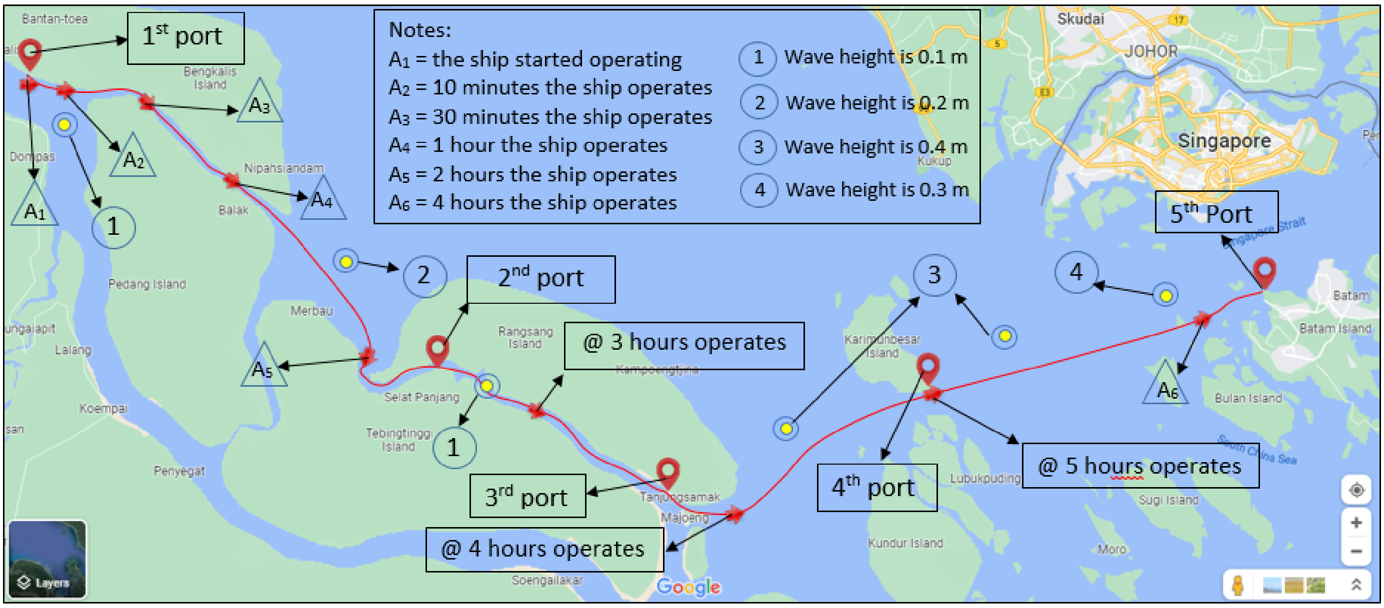

Fig. 2. Shipping route

Fig. 2 shows shipping routes based on a map of the Malacca Strait taken from Google Maps [13]. The red line shows the ship's route, which is based on data from the Geotracker app that was taken on board the ship. The coordinates for sampling are also recorded from the Geotracker and redrawn according to the coordinates on Google Maps.

3.2 Questionnaire design

The questions in the questionnaire are aimed at analyzing four aspects experienced or perceived by passengers, including: sickness, causes of sickness and uncomfort, types of uncomfort, and uncomfort related to the facilities on board [1, 7]. In each of these aspects, numerous questions have been given with answer choices that make it easy for correspondents to provide answers [14]. The total number of questions is 34, consisting of 6, 7, 5, and 16 questions, respectively, for aspects 1, 2, 3, and 4. Table 1 explains the four aspects of interest in this study, and Table 2 details the questions related to each aspect.

Table 1. Four aspects in questionnaire design

Aspects	Measured variables	Num. of questions
A	Direct evaluation of the seasickness status of the traveller	6 items
B	An analyse of the principal causes of seasickness and passenger uncomfortable	7 items
C	Evaluation of the respondent's habits when boarding the ship	5 items
D	Evaluation of the overall convenience of the ship's amenities	16 items

Table 2. List of questions and scoring on the questionnaire

A	Do you experience seasickness while sailing?	Queasy	Dizzy and a little queasy	Dizzy	a little dizzy	Comfort
	Scoring point	1	2	3	4	5
A.1	When you enter the passenger room before the ship operates, do you feel comfortable?	☐	☐	☐	☐	☐
A.2	After the ship sailed for 10 minutes	☐	☐	☐	☐	☐
A.3	After the ship sailed for 30 minutes	☐	☐	☐	☐	☐
A.4	After the ship sailed for 1 hour	☐	☐	☐	☐	☐
A.5	After the ship sailed for 2 hours	☐	☐	☐	☐	☐
A.6	After the ship sailed for 6 hours	☐	☐	☐	☐	☐
B	How would you rate the characteristics of the vessel?	Extremely uncomfor-table	Very uncomfor-table	Fairly uncomfor-table	a little uncomfor-table	Comfor-table
	Scoring point	1	2	3	4	5
B.1	Vessel's motion	☐	☐	☐	☐	☐
B.2	Vessel's vibration	☐	☐	☐	☐	☐
B.3	Sound, noise, acoustic	☐	☐	☐	☐	☐
B.4	Accommodation facilities	☐	☐	☐	☐	☐
B.5	Passenger room design	☐	☐	☐	☐	☐
B.6	Passenger seat	☐	☐	☐	☐	☐
B.7	Passenger room arrangement	☐	☐	☐	☐	☐
C	How do often you feel these experiences on the vessel's voyage (beside this vessel)?	Always	Usually	Sometimes	Seldom	Never
	Scoring point	1	2	3	4	5
C.1	Get seasickness	☐	☐	☐	☐	☐
C.2	Fatigue, tired	☐	☐	☐	☐	☐
C.3	Stumble, or hit an object by accident	☐	☐	☐	☐	☐
C.4	Slip, motion induce interrupted or loss of balance, fall	☐	☐	☐	☐	☐
C.5	Sleep disturbance or sleep interrupted	☐	☐	☐	☐	☐

D	Please mantion, if you agree with these statements!	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
	Scoring point	1	2	3	4	5
D.1	The vessel is comfortable	☐	☐	☐	☐	☐
D.2	The vessel is quite stable	☐	☐	☐	☐	☐
D.3	The vessel has a good layout	☐	☐	☐	☐	☐
D.4	The vessel quiet	☐	☐	☐	☐	☐
D.5	You find it difficult to move in or out when loading and unloading passengers	☐	☐	☐	☐	☐
D.6	We need a faster ship	☐	☐	☐	☐	☐
D.7	I like to use this vessel	☐	☐	☐	☐	☐
D.8	Sometime i am disturbed by the vessel's slamming	☐	☐	☐	☐	☐
D.9	I don't like the layout of the vessel	☐	☐	☐	☐	☐
D.10	Sometimes I feel that passengers are not being cared for in terms of comfort	☐	☐	☐	☐	☐
D.11	The vessel is noisy	☐	☐	☐	☐	☐
D.12	The passenger room is quite hot	☐	☐	☐	☐	☐
D.13	Sometimes the alarm system is confusing	☐	☐	☐	☐	☐
D.14	Some doors are difficult to open	☐	☐	☐	☐	☐

D	Please mantion, if you agree with these statements!	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Scoring point		1	2	3	4	5
D.15	Some areas of the vessel are very noisy	☐	☐	☐	☐	☐
D.16	Some ladders or stairs are too steep	☐	☐	☐	☐	☐

The questionnaires for elements A through D are each planned to have a maximum of five level rating points. For example, the answer options for aspect A questions include queasy, dizzy and a little queasy, dizzy, little dizzy, and comfort, with scores 1, 2, 3, 4, and 5 in sequential order. In reality, there are only two categories for the five assessment levels: scores 1 to 4 fall into the "uncomfortable" category, with the amount of discomfort corresponding to the score, and only a score of 5 is classified as "comfortable." The questions on Aspect B offer an appraisal of the source of the inconveniences reported by travellers. When the respondent is nearing the end of their journey or after passing the fourth travel route, they complete Aspect B of the questionnaire. The questions on Aspect C are designed to assess the amount of the respondent's body's resistance to events encountered throughout the journey, based on their experience aboard the prior ship. The questions on Aspect D are intended to elucidate respondents' perspectives on a variety of comfort-related shipboard amenities.

3.3 Data processing

Statistical methods are used to process the data from the responses in a way that helps researchers look into all important parts of this study.that the questionnaire data is accurate and usable, it is important to do an analysis of variance using the ANOVA method and validate the questionnaire data using the Dunnett simultaneous method. ANOVA figures out if a questionnaire's standard is good or bad by looking at the P-value, which is calculated by Eq. (2), and the F-value, which is calculated by Eq. (3) [12]. The P-value is a value that determines the level of confidence that variable A differs from variable B or that describes the level of influence of variables on measurement findings, with the effect being regarded as significant if the value is less than 5% [12]. The F-value is used to test each variable's influence on the test results; if the F-Value is greater than one, the variable has a larger effect; if it is equal to one, the variable has no effect.

$$P - Value = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{(n-1)S_x\, S_y} \tag{2}$$

Where $\bar{x}$ is the sample mean for the first variable, S_y is the standard deviation for the second variable, S_x is the standard deviation for the first variable, n is the column length, and $\bar{y}$ is the sample mean for the second variable. The F-value test statistic can be used if the mean square treatment and mean square error are known. F is calculated with two degrees of freedom, namely (r-1) and (n-r), and Fα is a previous value.

$$F - Value = \frac{MSTR}{MSE} \tag{3}$$

If the estimated F-value is greater than the critical region ($F_\alpha < F_0$), H_0 is rejected. That is, not all population averages are created equal. If the value of F_0 is in the critical zone ($F_\alpha \geq F_0$), however, H_0 is not rejected. This signifies that the average of all populations tested is the same. H_0 is rejected if F_α (df_1, df_2) ≤ F-Value, H_0 is rejected if F_α (df_1, df_2) > F-Value. Then, examine the mean square treatment (MSTR) and mean square error (MSE) or adjusted MS. MSTR and MSE values can be determined using Eqs. (4) and (5), respectively.

$$MSTR = \frac{\sum_{i=1}^{r} n_i(\bar{x}_i - \bar{\bar{x}})^2}{(r-1)} \tag{4}$$

$$MSE = \frac{\sum_{i=1}^{r}\sum_{j=1}^{n_j}(x_{ij} - \bar{x}_i)^2}{(n-r)} \tag{5}$$

Where r is the number of sample groups, n is the total number of data points, $\bar{\bar{x}}_i$ is the average value for each population$\bar{\bar{x}}$ is the grand mean calculated using Eq. (6), x_{ij} is the data point for each population, and $\bar{x}_i$ is the data point for each population. A one-way analysis of variance evaluates the difference in the mean that only included one variable that had an influence on the sample. The hypothesis test method is used to determine the null hypothesis and alternative hypotheses. The grand mean, denoted by the symbol $\bar{\bar{x}}$, use the Eq. (6). Eqs. (7) to (8) can be used to calculate population variance.

$$\bar{\bar{x}} = \frac{\sum_{i=1}^{r}\sum_{j=1}^{n_i} x_{ij}}{n} = \frac{\sum_{i=1}^{r} n_i\, \bar{x}_i}{n} \tag{6}$$

$$\sigma^2 = \frac{\sum_{i=1}^{n}(X_i - \mu)^2}{N} \tag{7}$$

$$S^2 = \frac{\sum_{i=1}^{n}(X_i - \mu)^2}{N} \tag{8}$$

Where σ^2 is the population variance, μ is the mean, S^2 is the sample variance, N is the number of data, and xi is the value of observation data.

4 RESULTS AND DISCUSSION

4.1 Passenger comfort findings

The data of respondents measuring the comfort of the Passenger ship were taken from 30 respondents with random data location. The largest distribution began with female responders aged between 16th-30th years as many as 42%, followed by male responders aged 16th-30th years as many as 31%, male responders aged 31st-45th years as many as 17%, and finally female responders aged 31st-45th years as many as 10%, according to Fig. 3. To ensure a comprehensive evaluation, the comfort of passengers on the Passenger ship is measured from four perspectives. The subsequent sections will discuss the evaluation outcomes one by one.

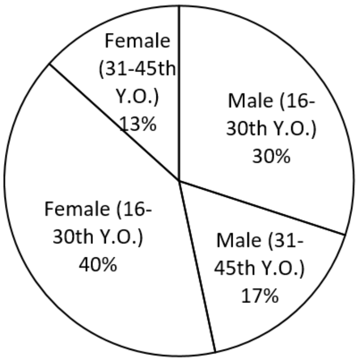

Fig. 3. Respondent distribution by age and gender

In this study, respondent data were collected randomly based on age and gender. This information, however, is based on how the seats were originally designed for the passengers (see Fig. 1). Respondents were also validated in saying that when they wanted to sit, they were healthy and comfortable before boarding the ship. The results of the distribution of respondent data based on age and gender are recorded according to Fig. 3.

4.1.1 Direct assessment of the seasickness status of the traveler

Direct assessment of seasickness on the passenger ship by categorizing passengers into two categories: comfortable and uncomfortable. The comfort category is obtained if the measurement results are in the scoring point of 5 (Sc.5 is comfort), whereas the uncomfortable category is in the scoring point of 1–4, which includes queasy (Sc.1), dizzy and a little queasy (Sc.2), dizzy (Sc.3), and a little dizzy (Sc.4). Men are much more trustworthy than women, while women between the ages of 31 and 45 are marginally more trustworthy than those between the ages of 16 and 30. This is evidenced by the results of analyzing the questionnaire data, as depicted in Fig. 4. The condition of the male gender after a 30-minute journey revealed that they were all in a state of "comfort," whereas the female gender had begun to experience "a little dizziness" by 17%, with an average level of 4.44 out of 5 points, and the difference in average comfort between men and women is 0.56 points, or 11.2%, see Fig. 5. In addition, the influence of a woman's age after traveling for more than six hours is minimal, with an average difference of 0.17 out of 5 points, or 3.4%. This direct assessment of the condition of passengers indicates that gender and age have an effect on seasickness in passengers. These findings are consistent with simulation-based research that shows gender has a strong influence on measuring respondent comfort and that age influences level of resistance to seasickness [15], which is influenced by hormonal changes caused by certain conditions [15].

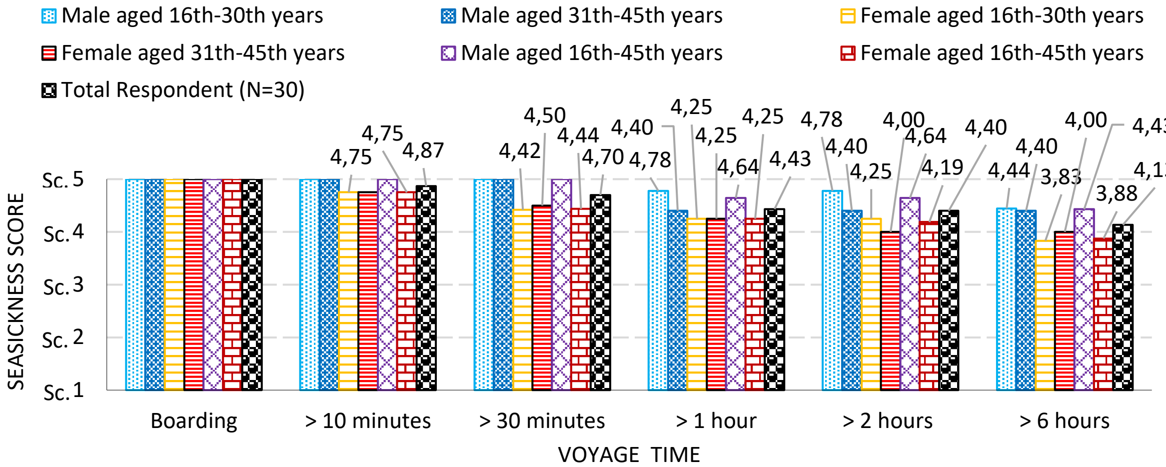

Fig. 4. Seasickness scoring is based on the respondent's age and gender

Male and female passengers are both comfortable at the time of boarding and before departure, as depicted in Fig. 4. The assessment results indicate that after 10 minutes of travel, on average, women begin to feel uncomfortable, with a comfortable score of 4.75 out of 5, with circumstances beginning to feel a little dizzy; this condition lasts for up to 30 minutes. The increase in boat travel time results in a reduced degree of passenger comfort, with the lowest level of comfort being experienced by women, who scored an average of 3.88 out of a possible 5 points or were already experiencing dizziness. The findings of the overall assessment showed that 70% of the passengers felt comfortable and 30% were uncomfortable, according to Fig. 5. The discomfort mentioned is that those who became dizzy felt queasy. Those who suffer from nausea and vomiting endure the most distress (Sc. 1). This syndrome occurs after a trip lasting more than 2 hours to more than 6 hours, with 3% to 17% of passengers reporting queasy, with a total of 13%, the most uncomfortable situations in scoring point 2, or being dizzy and a little queasy, are most frequently encountered when traveling over 1 hour; this percentage can vary depending on the conditions of the long trip. Figs. 6(a)-6(b) depict the distribution of respondents by age and gender who experienced queasy for 17% and discomfort for 30% of passengers, respectively, after a 6-hour journey.

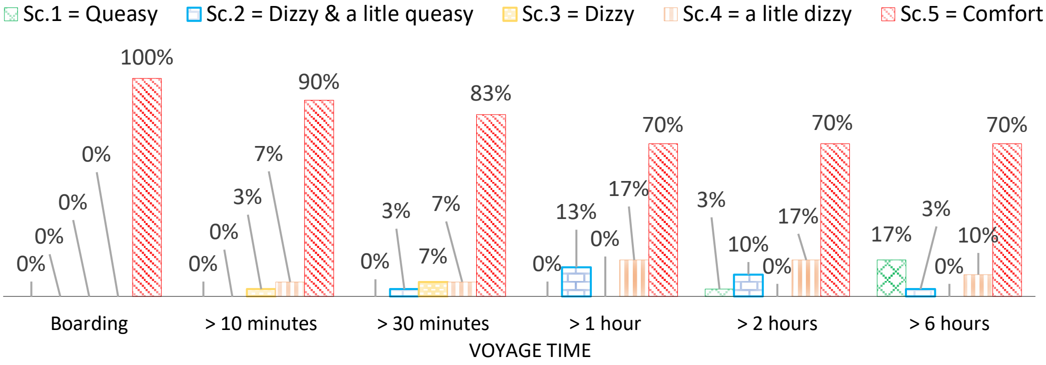

Fig. 5. The distribution of respondents related to the level of seasickness

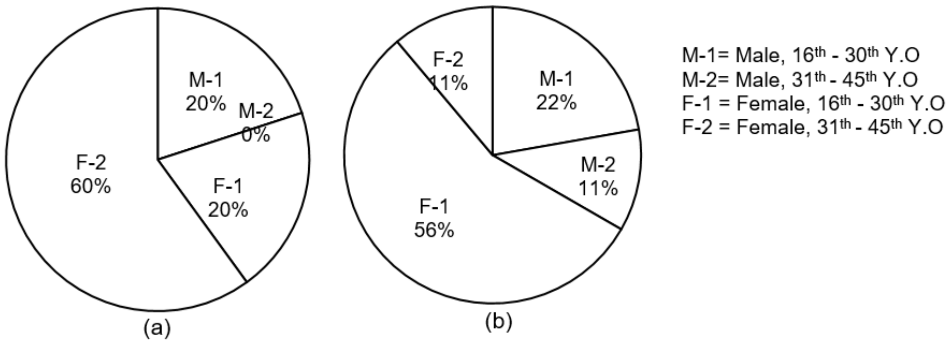

Fig. 6 Distribution of respondents based on age and gender after traveling for 6 hours;

(a) Queasy respondent data, (b) Uncomfortable respondent data

4.1.2 Assessment of the primary causes of passenger uncomfortable

The seven-question Part B questionnaire in Subchapter 2.2 is used to find out the main causes of seasickness or passenger discomfort. The questionnaire's scoring point responses are based on five level options: highly uncomfortable (Score 1), very uncomfortable (Score 2), fairly uncomfortable (Score 3), slightly uncomfortable (Score 4), and comfortable (Score 5).

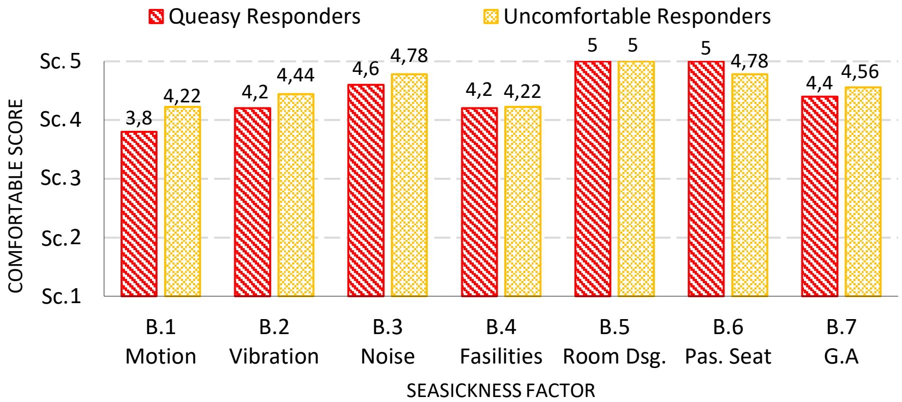

Fig. 7. Comfortable score for the causes of queasy and discomfort in passengers

Data processing is done to find out the main reasons why up to 30% of respondents felt uncomfortable on the ship and up to 17% of the total number of passengers felt queasy. The results of the study of what was making the biggest ship uncomfortable were given in order, starting with the ship's motion (B.1), then the ship's accommodations (B.4), and then the ship's vibrations (B.2). This is shown in Fig. 7. Respondents who said they were sick or felt pretty bad (with an average score of 3.8) gave the lowest comfort value. The differences between the results of the three causes are small, but the evaluation results for respondents who felt queasy and uncomfortable are similar. Additionally, the passenger room design is deemed comfortable by all respondents, including those who felt uncomfortable and sick, as shown in Fig. 7. The passenger seats (B.6) and noise, sound, and acoustics (B.3) aboard this ship are nearly comfortable, scoring between 4.6 and 5 on a scale of 1 to 5.

Consistent with the findings of other studies, this evaluation of passenger ships reveals that ship motion and noise are the primary causes of discomfort and sleep disturbances [16]. Additionally, it is demonstrated by ship motion, which includes heave, roll, and pitch motions, which are the primary factors of passenger ship comfort [5].

4.1.3 Assessment of the respondent's habits when boarding the ship

The purpose of this questionnaire's study of the respondent's boarding habits is to find out if the respondent's behavior has been linked to discomfort on ships in other places.Score 1 (Sc.1) is frequently experienced, score 2 (Sc.2) is rather frequently experienced, score 3 (Sc.3) is occasionally, score 4 (Sc.4) is ever, and score 5 (Sc.5) is never.

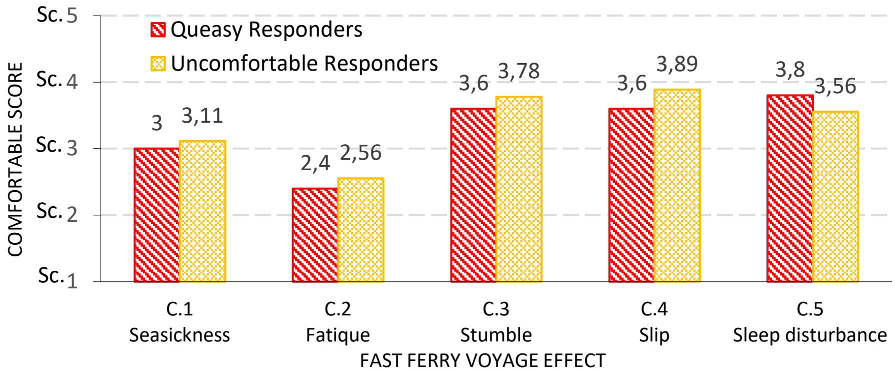

Fig. 8. Comfortable score for the habits of the queasy and uncomfortable passengers

The evaluation results depicted in Fig. 8 is based on data collected from respondents who reported feeling queasy and uncomfortable. According to the evaluation's findings, respondents who experience nauseous and uneasy sensations are more likely to encounter them after frequent travel in a state of weariness (see Fig. 8, aspect C.2) and occasionally feel sick (see Fig. 8, aspect C.1). The average response to the questionnaire reveals a very minor difference in responses, namely a difference of 2% on average; hence, conclusions may be derived from only one group of respondents. In this study, it can be concluded that the MV. Dumai Line is more comfortable than the ships that respondents have been on around the Malacca Straits, as only 13% of respondents are uncomfortable but not seasick, whereas they are all occasionally seasick on average.

4.1.4 Assessment of the general comfort of the ship

The comfort level of the ship as a whole is based on the answers to the last 16 questions about aspect D. There are five assessment scores in Section 2.2 of the questionnaire that show how comfortable the ship is overall. Fig. 9 shows how the three groups of respondents responded based on how comfortable they were with the questions in Aspect A: 17% of respondents experienced queasy conditions, 30% had uncomfortable conditions, and 70% felt comfortable. The findings of the survey indicated that the respondents agreed that the ship is comfortable (point D.1), as the average score for their responses is 4.

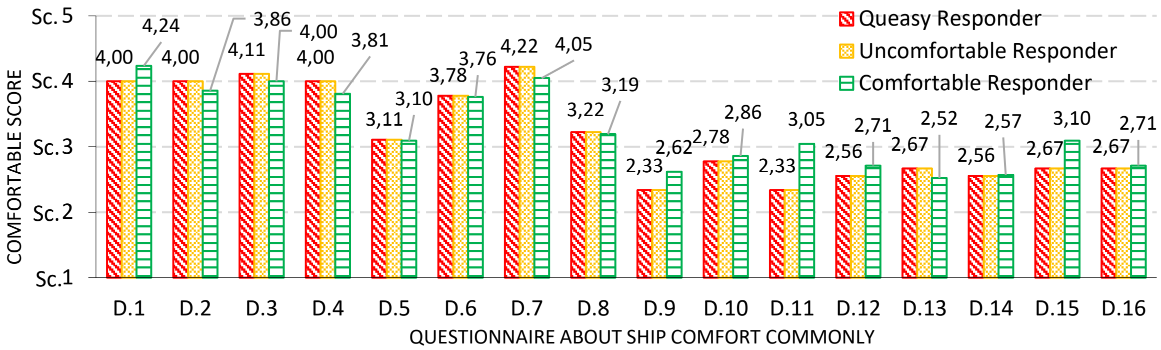

Fig. 9. Comfortable score for the respondent's opinion about the passenger ship

This result correlated with the questionnaire on Aspek B, in which it is said that motion had a significant impact on the ship's discomfort, and this result indicates that respondents believe that this ship is stable (D.2) and comfortable (D.1). Other responses indicated "agree" with the statements that the ship has a decent layout (D.3), is quiet (D.4), and that they enjoy using this ship (D.7). In addition, on average, respondents "disagree" with statements that they dislike the ship's layout (D.9), that passengers are not being cared for in terms of comfort (D.10), that the ship is noisy (D.11), that the passenger room is quite hot (D.12), that the alarm system is confusing (D.13), that some doors were difficult to open (D.14), that some areas of the ship were very noisy (D.15), and that some stairs or steps were too (D.16).

4.2 Analysis of variance and the validity of the questionnaire

The hypothesis about the questionnaire is put to the test so that the analysis of variance can be done and the questionnaire results can be confirmed. This is done by examining the T-value, the F-value, and the P-value. In a similar vein, the findings of the analysis of variance (ANOVA) performed on the responses provided by 30 respondents who were traveling on the Passenger Ship are described in detail in this section.

4.2.1 Questionnaire correlation hypothesis on aspect A

By analyzing the relationship between question A.1 and other variables, the hypothesis of the association in the aspect “A” questionnaire is tested. This investigation aims to determine if there is a correlation between the respondents' level of comfort before and after traveling on the passenger ship ferry from Bengkalis to Batam port.

Table 3. Dunnett simultaneous tests for level mean at questionnaire aspect "A"

Difference of Levels	Difference of Means	SE of Difference	95% Confidence Interval	T-Value	Adjusted P-Value
Aspect $A_{.2}$ – Aspect $A_{.1}$	-0.133	0.247	(-0.761, 0.494)	-0.54	0.977
Aspect $A_{.3}$ - Aspect $A_{.1}$	-0.300	0.247	(-0.927, 0.327)	-1.21	0.624
Aspect $A_{.4}$ - Aspect $A_{.1}$	-0.567	0.247	(-1.194, 0.061)	-2.29	0.091
Aspect $A_{.5}$ - Aspect $A_{.1}$	-0.600	0.247	(-1.227, 0.027)	-2.42	0.066
Aspect $A_{.6}$ - Aspect $A_{.1}$	-0.867	0.247	(-1.494, -0.239)	-3.50	0.003

Individual confidence level = 98.79%

Table 3 demonstrates that aspects A.2 (departure after 10 minutes) and A.3 (departure after 30 minutes) have no influence on the changes in passenger comfort caused by aspect A.1 (boarding); the T-values are -0.54 and -1.21, which are less than 1.96, indicating that there is no significant influence between the two aspects [17]. After 6 hours of travel (aspect A.6), however, a substantial influence between aspect A.1 and aspect A.6 is observed, as shown by a T-value of -3.50, a probability value (P-value) of 0.003, and a significant error rate of less than 3%, or a confidence level of 98.79% (see Table 3). The F-Value serves as the foundation for conducting an analysis to determine how much each variable influenced the test results. Table 4 illustrates that the F-value is 3.44, which indicates that each variable in the questionnaire has a major impact on other variables since it has an F-value that is larger than 1, which is the fundamental minimum criterion [17]. Additionally, because each variable has an F-value that is greater than 1, it satisfies the condition that all variables in the questionnaire have a significant impact. The outcome of conducting an analysis of variance on all of the aspects or variables that make up Aspect A yielded a P-value of 0.005 (see Table 4), and these findings satisfy the analysis of variance because the P-value is less than 5%.

Table 4. Analysis of Variance at Aspect “A” of the Questionnaire

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Aspect	5	15.78	3.1556	3.44	0.005
Error	174	159.80	0.9184		
Total	179	175.58			

4.2.2 Questionnaire correlation hypothesis on aspect B

According to the results of the questionnaire about aspect B, B.1 (vessel’s motion) is the most influential aspect contributing to the discomfort of ship passengers. This is used as a guide when looking at how many hypotheses relate to each other in the questions posed by Aspect B, where Aspect B.1 is compared to other aspects. The analysis reveals no link between the vessel's motion (B.1), vibration (B.2), noise (B.3), accommodation facilities (B.4), and passenger room arrangement (B.7). But aspect B.1 is linked to aspect B.5 (passenger room), and aspects B.6 (passenger seat) give T-values of -2.57 and -2.38, respectively, see Table 5. This means that the passenger room and seat condition can have an impact on the ship's comfort as a result of the vessel's motion. According to Table 6, the F-Value of Aspect B is 3.59, which indicates that each individual question variable in the questionnaire has a significant impact on the overall results. The P-value is around 0.002, which indicates that the aspect B questionnaire can be utilized because it has a probability that fulfills the analysis of variance. This is because the P-value is 0.2%, which indicates that the probability meets the analysis of variance.

Table 5 Dunnett simultaneous tests for level mean at questionnaire aspect "B"

Difference of Levels	Difference of Means	SE of Difference	95% Confidence Interval	T-Value	Adjusted P-Value
Aspect $B_{.2}$ – Aspect $B_{.1}$	-0.067	0.168	(-0.503, 0.369)	-0.40	0.998
Aspect $B_{.3}$ - Aspect $B_{.1}$	0.167	0.168	(-0.269, 0.603)	0.99	0.828
Aspect $B_{.4}$ - Aspect $B_{.1}$	-0.033	0.168	(-0.469, 0.403)	-0.20	1.000
Aspect $B_{.5}$ - Aspect $B_{.1}$	-0.433	0.168	(-0.869, 0.003)	-2.57	0.052
Aspect $B_{.6}$ - Aspect $B_{.1}$	-0.400	0.168	(-0.836, 0.036)	-2.38	0.085
Aspect $B_{.7}$ - Aspect $B_{.1}$	0.033	0.168	(-0.403, 0.469)	0.20	1.000

Individual confidence level = 98.97%

Table 6. Analysis of Variance at Aspect “B” of the Questionnaire.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Aspect	6	9.162	1.5270	3.59	0.002
Error	203	86.367	0.4255		
Total	209	95.529			

4.2.3 Questionnaire correlation hypothesis on all aspect.

By analyzing the correlation hypothesis for all of the questions on the questionnaire, you can find out what kind of connection there is between the different parts of the survey and how big it is. The answer that the respondent gives regarding aspect A is material that can be used to directly evaluate the traveler’s seasickness status. Additionally, this aspect serves as a foundation for the determination of the relationship between the primary aspects that contribute to seasickness and passenger discomfort with regard to aspect B. In addition to this, the relationship between comfort and the behaviors of the respondents when they boarded the ship (aspect C) as well as the comfort of the ship's amenities as a whole were taken into consideration (aspect D).

Based on the answers of 30 people, tests showed that A had the highest standard deviation, which was 0.789, and the highest mean value, which was 4.578. Table 7 shows how to figure out the confidence interval difference. With a standard deviation of 0.325, Aspect B has the lowest standard deviation. This means that there isn't much difference between the answers people gave. Fig. 10 depicts the distribution of means with error bars. The F-value of 68.88 and the P-value of 0.000 with a confidence interval of 98.97% demonstrate that the F-value and P-value results also satisfy the existing criteria, namely the existence of a significant relationship between aspects, as evidenced by the F-value of 68.88 and the P-value of 0.000, as shown in Table 8.

Table 7. One-sample statistics of comfortable aspects on a Likert scale

Aspect	N	Mean	St. Dev	95% CI of the Difference	
				Lower	Upper
Aspect A, Direct evaluation of the seasickness status of the traveller	30	4.578	0.789	4.378	4.778
Aspect B, An analyse of the principal causes of seasickness and passenger uncomfortable	30	4.752	0.325	4.552	4.952
Aspect C, Evaluation of the respondent's habits when boarding the ship	30	3.200	0.575	3.000	3.400
Aspect D, Evaluation of the overall convenience of the ship's amenities	30	3.238	0.404	3.038	3.437

Table 8. Analysis of variance for all aspects of the questionnaire

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Aspect	3	63.21	21.070	68.99	0.000
Error	116	35.42	0.305		
Total	119	98.63			

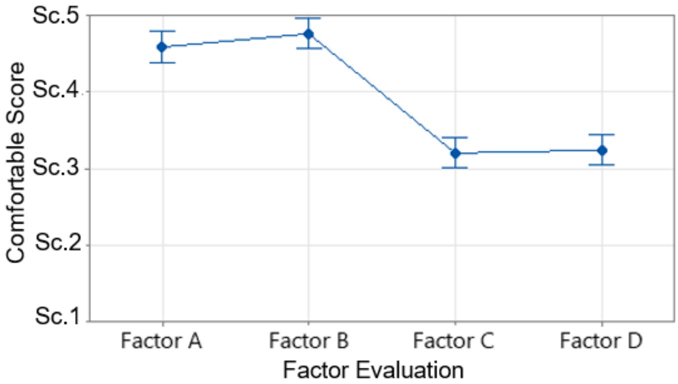

Fig. 10. Comfortable score for Likert-scale evaluation result, interval plot of factors A, B, C, and D

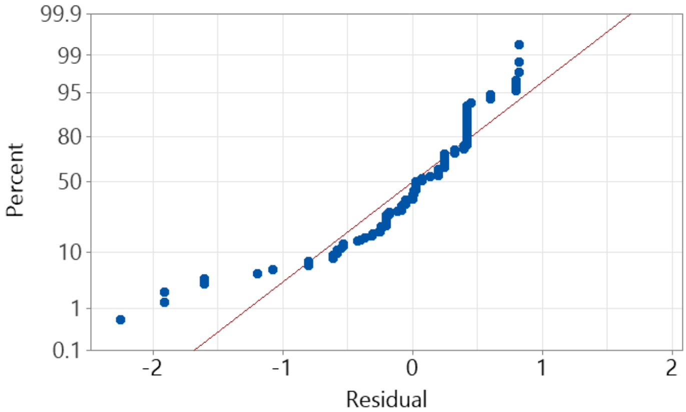

Fig. 11. Normal probability plot for all responses for all aspects

Normal Probability Plot (NPP) is often used in regression analysis to test the assumption of normality, or to see if random mistakes are spread out in a normal way. If the data plot tends to follow a straight line, the error data will have a normal distribution [18]. Fig. 11 shows the normal distributions of the probabilities of all reactions to aspects A, B, C, and D. The distribution of the data looks close to the normal distribution line, meaning that there is no random error in the questionnaire data because it has a small standard deviation [18]. In multiple and simple linear regression analysis, the x value in Fig. 11 explains the difference between the actual and expected values.

5 CONCLUSION

The passenger comfort study for the fast ferry or passenger ship in the Malacca Strait is done through a questionnaire with 30 participants and a sailing time of 6 hours and 15 minutes. There are 34 questions that are meant to measure, among other things, how seasickness passengers are (6 questions), the primary causes of seasickness and passenger discomfort (7 questions), the respondents' boarding patterns (5 questions), and the general comfort of ship facilities (16 question items). To confirm the correctness of this questionnaire approach, the sampling procedure and sample size followed the SLOVINS equation, and the gathered questionnaire data is validated using the Analysis of Variance (ANOVA) method and the Dunnett simultaneous difference between means test, with a P-value of 0.000 and a degree of individual confidence of 98.97%, the results of the questionnaire can be regarded as analytical material. According to the survey results, 70% and 30%, respectively, of the total number of respondents felt comfortable and uncomfortable. In addition, up to 17% of respondents who felt queasy suffered from discomfort. The ship's motion causes the most discomfort for passengers, followed by the ship's housing facilities and vibration

The results of this study in the future can be combined with research on ship motion for fast passenger ships in the Malacca Straits [6]. With all of the research results put together, a passenger comfort criterion can be set. However, the measurement data must be added to several variations of ships and waters in Indonesia according to predetermined shipping route designs [1].

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