EVALUATION OF THE VIABILITY OF TARIFFS BASED ON TRANSPORTATION EXPENSES FOR CATAMARAN RIVER SERVICES ON THE PARANGLOE - LAKKANG ROUTE

Muh Yusril Syam[1], Ainun Chandra Puspa Nigrum[1]

[1]Department of Naval Architecture, Polytechnic of Batulicin, Tanah Bumbu, Indonesia
E-mail: yusril@politeknikbatulicin.ac.id

Received: June 9, 2025 | **Accepted:** September 17, 2025 | **Published:** October 1, 2025
DOI: 10.12962/j27745449.v6i1.8782 | **Issue:** Volume 6 Number 1 2025 | **E-ISSN:** 2774-5449

ABSTRACT

Establishing ship fares necessitates a thorough examination because it encompasses multiple cost factors, with fuel being the primary expense. For operators, it is crucial to determine fares that not only account for operational expenses but are also competitive and accessible for users of the service. This research investigates the viability of river transport fares using catamaran vessels on the Parangloe–Lakkang route, which can accommodate 12 passengers and 10 motorcycles, with a maximum of 8 vessels in operation. The aim of this research is to assess the minimum fare needed for the vessels to function sustainably by employing the Required Freight Rate (RFR) method, alongside evaluating passengers' ability and willingness to pay through the Ability to Pay (ATP) and Willingness to Pay (WTP) methodologies. The analysis reveals that the lowest minimum fare for passengers is Rp1.910/trip for vessel 3, while vessel 8 has the highest minimum fare at Rp2.442/trip. The ATP for passengers has been noted at Rp2.893/trip, whereas the WTP is recorded at Rp2.000/trip. These findings imply that the RFR fare falls between the WTP and ATP figures, indicating it is within a suitable range for fare policy. This result is significant as it provides a foundation for establishing sustainable fares and promotes enhancements in the quality of river transport services to ensure they are safer and more enjoyable for passengers.

Keyword: Minimum ship rates, required freight rates, ability to pay, willingness to pay, ship operating costs

Introduction

Water transportation is essential to Indonesia's national transportation network, especially as the main method of connecting regions that are separated by water. Given Indonesia's geographical makeup, which includes thousands of islands, water transport is crucial for enhancing community movement, enabling the distribution of goods, and fostering economic development. In many areas, especially in coastal regions, water transportation is not just an additional mode of transport but often the only viable option for navigating short waterways such as lakes, canals, and rivers [1][2].

One of the most frequently utilized methods of river transportation is the classic catamaran, recognized for its shallow draft and high efficiency in carrying both passengers and freight. This type of boat has been adapted by incorporating wooden beams and planks as connections between the two fiberglass hulls, which serve as both the passenger deck and the deck for motor vehicles. The benefits of employing this type of vessel include comparatively lower costs for acquisition and maintenance when using wooden materials rather than other options. Moreover, operators enjoy greater flexibility in arranging the deck layout due to its lightweight and adaptable design. From a technical standpoint, the modification involving wooden planks in the deck construction does not notably impact the vessel's displacement, leading to relatively reduced fuel consumption. Additionally, the catamaran's design offers low wave resistance at lower speeds, making it well-suited for operations along this route.

In South Sulawesi, especially along the Parangloe – Lakkang route, this vessel type has been utilized by around 1.116 inhabitants of Lakkang Island as their main means of transportation to facilitate their everyday economic and social endeavors [3]. The presence of these vessels is crucial for communities residing near river basins, particularly the Tallo and Pampang Rivers in Makassar City. Besides being the main form of transportation, the catamaran significantly contributes to the local transport system, which remains largely disconnected from the land transport network. To facilitate daily operations, the operator offers three primary routes: Kera-kera – Lakkang, Buloa – Lakkang, and Parangloe – Lakkang, as illustrated in Figure 1 [4].

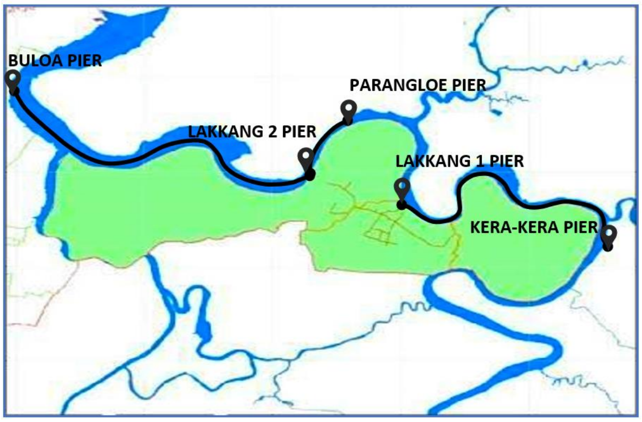

Figure 1. Catamaran sailing route on Lakkang Island

On the Parangloe – Lakkang route, there are currently eight operating vessels. Each vessel can carry 12 passengers and 10 motorcycles, with the exception of one smaller vessel that has a capacity for 10 passengers and 5 motorcycles (refer to Figure 2).

Figure 2. Catamaran Ship on the Parangloe – Lakkang Route

With the rise in population, evolving community engagement, and heightened local economic activity, the demand for dependable catamaran services has grown as well. Nonetheless, this surge in services should be matched with the implementation of fair fare structures for travellers. Fare rates are established by evaluating various factors, including the distance travelled, cargo type, transportation mode utilized, and market demand [5].

The establishment of ship tariffs is closely linked to the composition of ship operating expenses, which are crucial in assessing the economic viability for operators [6][7]. Conversely, ship operating expenses are made up of fixed costs, variable costs, and daily costs such as fuel, maintenance, and port charges [8][9]. Of these elements, fuel usage is recognized as the largest expense, representing about 55% of the overall operational costs [10]. This reality prompts operators to enhance their fuel efficiency by choosing optimal shipping routes and tracking consumption for each journey. Besides technical efficiency, the environmental impact has emerged as a significant issue, as excessive fossil fuel usage can adversely affect water quality [11].

Cost efficiency in operations is crucial for the success of river transport companies, particularly for traditional boats that function on a small scale and often do not fully leverage modern technology. A primary approach to minimizing expenses is to pinpoint the major cost elements and effectively manage cargo to ensure that the vessel's capacity is utilized to its fullest potential [12]. Regarding the operation of catamaran vessels on the Parangloe–Lakkang route, these efficiency measures need to be evaluated systematically to guarantee that fare pricing remains reasonable for the public while still allowing for satisfactory profits for the operators. In essence, it is important to strike a balance between keeping fares affordable and ensuring the sustainability of the business.

In addition to financial factors, the establishment of fair fares is also shaped by the buying power of the public and governmental fare policies [13]. At present, catamaran fares on this route are priced at Rp 2,000 for passengers and Rp 3,000 for motorcyclists. While these prices are fairly low, they still need to account for all operational expenses. As a result, operators must strategically oversee their cost structure, which includes fixed costs like capital expenditures and variable costs such as fuel, lubricants, repairs, maintenance, and additional operational supplies.

Efficient cost management will ultimately decide if the existing fare can be maintained economically and sustainably over time.

Previous studies on setting tariffs for water transportation have primarily concentrated on ferries, fast boats, passenger vessels, barges, and wooden ships. For instance, investigations have focused on the tariff determination for the Bukit Raya passenger ship crossing between Jakarta and Pontianak [14], a feasibility and tariff analysis for inter-island fast boats in the Mentawai Islands Regency [15], an examination of ferry crossing tariffs for Bira–Sikeli–Tondasi using BOK and ATP [16], and a study of the tariff structure for wooden boats on the Makassar–Barrang Lompo route [17][18]. Nonetheless, there remain very few studies that specifically focus on establishing water transport tariffs for traditional raft vessels, such as catamarans operating along river routes. As a result, this research is significant in providing valuable insights for coastal and island communities, particularly because river transport services are typically managed independently by local residents. In accordance with this context, the researcher is motivated to carry out a study on the establishment of river transport tariffs on Lakkang Island, specifically regarding traditional catamarans operating on the Parangloe – Lakkang route.

Methodology

In obtaining the research results, the following steps were taken to complete this research:

1. Ship Capital Costs

The capital cost of a vessel refers to the total amount spent on acquiring the ship, which is determined by the cost of its various parts, including the hull, machinery, equipment, and labor.

2. Ship Operating Costs

Ship Operating Costs (BOK) refer to the expenses associated with running a ship, encompassing both direct and indirect costs. The various cost elements that operators incur within a year of ship operation, as derived from interviews and [19], are outlined below:

a. Fuel Cost

According to [19], the fuel expense for a catamaran is calculated based on the engine power utilized, represented by the equation:

Fuel cost = Number of engines × Engine power/unit × Fuel consumption/HP/hour × Duration of the voyage/trip × Number of trips per day × Number of operating days per year × Fuel price/litre.

From the interview responses, it appears that the fuel cost of a catamaran is influenced by the kind of fuel used, particularly Pertalite, and is computed using the formula:

Fuel Cost = Fuel Consumption × Fuel Price/litre.

b. Lubricating Oil Cost

According to [19], the expense incurred for ship lubricating oil is influenced by the engine's type and size, calculated using the following equation:

Lubricating Oil Expense = Number of engines × Power per unit of engine × Lubricant usage per HP/hour × Voyage/duration of trip × Daily trips × Operating days annually × Cost of lubricant per litre.

From the findings of the interviews, the lubricating oil cost for catamaran vessels is based on the specific lubricating oil utilized, namely Mesran type, and can be expressed as:

Lubricating Oil Expense = Lubricating Oil Usage × Cost of Lubricating Oil per litre.

c. RMS (Repair, Maintenance, and Supply) Cost

According to the findings from the interview, RMS expenses encompass upkeep and repairs for the hull and machinery. Nevertheless, these expenses typically vary for each vessel.

d. Food Cost

The daily food expense incurred by ship operators during their operations is calculated in two ways: according to [20], with a cost of Rp. 60,000 each day. On the other hand, interviews indicate that the daily food expenses for ship operators amount to Rp. 45,000.

e. Capital Interest Cost

According to [19], the expense related to ship capital interest that is utilized for bank interest payments can be calculated using the subsequent formula:

$$\mathrm{C}_{IC} = \frac{\frac{\mathrm{N}+1}{2}(65\% \times \text{ship price}) \times \text{interest/year}}{N}$$

According to the outcomes of the interview, the cost of capital interest for the ship is established by the interest rate from BRI bank, set at 6%, through the application of the following formula:

$$C_{\mathrm{IC}} = \frac{\text{total return of capital payment} - \text{capital cost}}{\text{loan term(year)}}$$

f. Depreciation Cost

According to [19], the depreciation expense of a vessel is calculated based on its useful lifespan, employing the formula below:

$$\mathrm{D}_{C} = \frac{\text{ship price} - \text{residual value}}{\text{depreciation period}}$$

g. Crew Cost

According to [19], expenses related to the crew include salaries and allowances, which can be calculated using this formula:

Crew Expenses = Total Yearly Crew Salaries + Yearly Crew Allowances

3. Required Freight Rate (RFR)

RFR represents the lowest fare that ship owners need to impose on passengers to ensure they cover their expenses while transporting both passengers and vehicles. The dependent variables involved include operating costs (Y), the age of the ship, interest rates (CRF), capital investment costs (P), and the total cargo

(C) carried annually [21][22], as outlined in the following formula:

$$RFR = \frac{Y+(CRF \times P)}{C}$$

4. Ability to Pay (ATP)

The capacity of passengers to afford fares or charges for utilizing the ship is influenced by economic factors, including their monthly income (Irs), overall monthly transportation costs (Pp), and particular monthly transportation expenditures related to catamaran ships (Pt), in addition to the frequency of sailing each month (Trs), as represented by the following formula:

$$ATP = \frac{(Irs \times Pp \times Pt)}{Trs}$$

This research employs a systematic methodology to identify key variables related to the behavior of users of catamaran transportation. The initial phase consists of gathering primary data by administering questionnaires to 65 participants, with the sample size calculated using Slovin's formula, which is often utilized for small populations [23]. Purposive sampling was implemented to choose individuals who have first-hand experience using catamaran services, aligning with the pertinent characteristics for quantitative research [24].

The questionnaire is divided into two primary sections. The first section gathers demographic details, such as gender, age, occupation, and the highest level of education attained. The second section concentrates on economic information and transportation patterns, including monthly income, expenses on public transportation, costs associated with catamaran travel, and the frequency of catamaran usage in the previous month. All items in the questionnaire are arranged in a grouped response format to make data quantification easier [25].

The questionnaire was handed out directly at Parangloe Pier and Lakkang Pier. Respondents completed the questionnaire on their own, with support provided to ensure they understood the questions and that all data was accurately filled out. The gathered data was subsequently reviewed to confirm its validity and completeness. The data was then processed in Microsoft Excel by employing numerical coding and entering the information. The analysis was performed descriptively by calculating the average values of the key variables examined. These findings served as the foundation for the discussion and conclusions of this study.

5. Willingness to Pay (WTP)

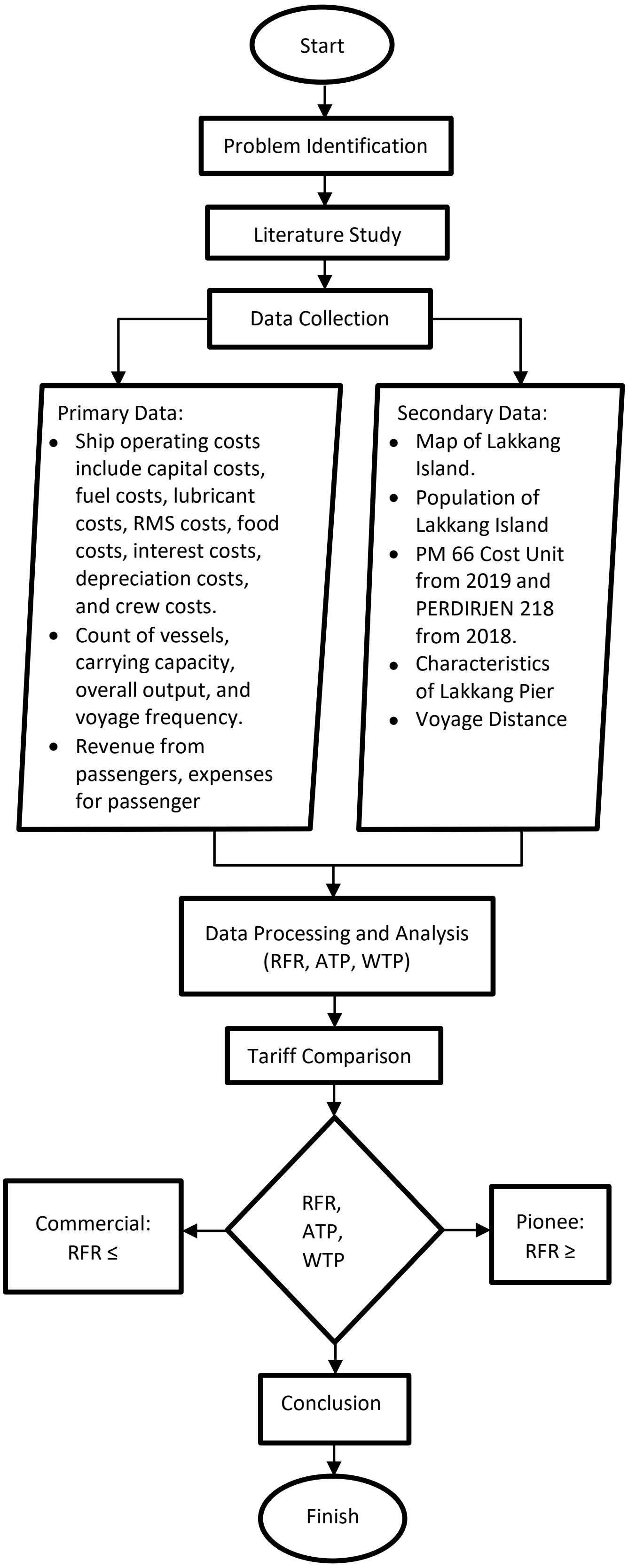

Figure 3. Conceptual Framework

The amount passengers are willing to pay for catamaran fares depends on the personal value they assign to the service.

This value encompasses elements of service quality such as comfort, punctuality, and safety, along with features like onboard facilities, cleanliness, and the vessel's capacity, as well as external influences like market conditions, availability of other transport options, and the competitive landscape.

The sampling method used was non-probabilistic, specifically employing accidental sampling techniques, with 65 participants approached at the location who consented to complete the questionnaire. The gathered data were analyzed using Microsoft Excel, where the collected Willingness to Pay (WTP) figures were input into a spreadsheet for descriptive analysis. This analysis involved calculating the average fare amount suggested by participants based on the benefits they recognized, including comfort, speed, safety, and service quality.

Moreover, the WTP figures were compared with the Ability to Pay (ATP) to assess the disparity between what individuals can afford and what they are willing to spend. The findings from this comparison formed the foundation for evaluating the viability of the catamaran fare. A research framework illustrating the study process is depicted in Figure 3.

Result and Discussion

Ship Capital Costs

The capital expenses for each catamaran are presented in Table 1. The cost of each vessel was determined through discussions with the boat owners.

Table 1. Ship Capital Costs

No	Ship Component	Cost of Capital	
		Ship 1-7 (Rp.)	Ship 8 (Rp.)
1	Hull	20,000,000	20,000,000
2	Machinery	8,000,000	8,000,000
3	Equipment	15,000,000	10,000,000
4	Manpower	2,000,000	2,000,000
Total		**45,000,000**	**40,000,000**

Table 1 of this research outlines the capital expenditures associated with eight catamaran vessels utilized for river transport along the Parangloe – Lakkang route. The capital costs are divided into four primary categories: hull, machinery, equipment, and labor. All the vessels were constructed in 2015, meaning that the analysis takes into account the time frame and possible depreciation of the assets.

Crafts 1 through 7 exhibit consistent capital costs of Rp 45,000,000. This consistency suggests that there was a standard reference used for determining the design and primary size specifications of the vessels during their construction. In contrast, Vessel 8 features smaller overall dimensions, which leads to a reduction in equipment costs by Rp 10,000,000 compared to the other ships, which amount to Rp 15,000,000. This variance is attributable to the decreased requirement for materials like wooden planks and beams needed for the deck and seating for passengers. This indicates that variations in vessel dimensions directly influence the costs associated with non-structural equipment.

All boats utilize fibreglass hulls costing Rp 20,000,000 each. Fibreglass was selected for its lightweight properties, resistance to corrosion, suitability for use in calm rivers, and its potential to decrease maintenance costs by as much as 30% compared to metal materials.

The propulsion system for all vessels consists of outboard engines priced at Rp 8,000,000. This type of engine is regarded as efficient for smaller boats due to its low weight and the simplicity of installation. However, as mentioned by [26], the operational expenses for the engine are still considerable, especially regarding fuel consumption and routine maintenance, which can make up 66,7% of the total operational costs for traditional boats.

The cost of labor in the construction process was recorded at Rp 2.000.000 per unit, suggesting that the expenses related to human resources during this phase were quite low. This was largely due to straightforward working methods and the employment of local workers at PT. Siagang Boat. However, labor expenses are expected to rise during the operational phase, as detailed in [27], because they encompass wages, allowances, and social security for the crew.

While Ship 8 demonstrates initial cost efficiency, its smaller dimensions may lead to a decrease in carrying capacity, travel frequency, and service lifespan. These elements will affect both maintenance costs and operating income.

Ship Operating Costs

The operational expenses of the vessels analyzed in this research were categorized into two segments: one derived from [19] and the other gathered through interviews with ship owners, as illustrated in Table 2.

Table 2. Ship Operating Costs

No	BOK Component/year	Operating Costs (PM. 66 of 2019)		Operating Costs (Interview)	
		Ship 1-7 (Rp.)	Ship 8 (Rp.)	Ship 1-7 (Rp.)	Ship 8 (Rp.)
1	Fuel Oil	1,424,670	1,424,670	8,430,000	8,430,000
2	Lubricant Oil	258,557	258,557	660,000	660,000
3	RMS	820,000	820,000	820,000	820,000
4	Food	16,860,000	16,860,000	12,645,000	12,645,000
5	Capital Interest	1,170,000	1,040,000	1,427,844	1,269,191
6	Depreciation	2,850,000	2,533,333	-	-
7	Ship Crew	53,197,367	53,197,367	22,480,000	22,480,000
Total		**76,580,614**	**76,133,948**	**46,462,844**	**46,304,191**

According to data [19], the annual operating expenses for Ships 1 through 7 totalled Rp76,580,614, while Ship 8 had costs of Rp76,133,948. The most significant expense component was crew costs, which amounted to Rp53,197,367 per year, accounting for approximately 69% of the overall expenses. This amount is derived from regulation [20], which dictates that crew expenditures encompass basic salaries, health benefits, work-related equipment, social security, and holiday allowances, emphasizing a normative approach that values the dignity and welfare of employees.

Nonetheless, insights from the field reveal considerable discrepancies. Based on interviews conducted, the annual crew costs are only Rp22,480,000. This figure is determined using the operator's earnings from the total user fee of Rp80,000 for a single day, excluding the involvement of assistants or additional crew members. The ship owner also serves as the operator, averaging 281 operating days throughout the year. There is no budget for allowances as required by the regulations, indicating a micro-business model rooted in self-management.

There are also variations in the components of fuel and lubricants. According to [19], the projected annual fuel cost is only Rp1,424,670, while lubricating oil costs Rp258,557. However, interviews reveal that the real expenditures amount to Rp8,430,000 for fuel and Rp660,000 for lubricants. This difference arises from varying fundamental assumptions: regulations rely on national standards, while practical applications depend on actual consumption affected by the frequency of vessel usage, engine condition, river currents, and the length of the routes.

Moreover, costs related to crew meals also display discrepancies. While [19] states these costs at Rp16,860,000, actual field data shows them at Rp12,645,000, suggesting a level of operational efficiency in spending. Depreciation expenses are not accounted for in the field data, as there are no records maintained for the depreciation of asset values.

These discrepancies highlight the divide between theoretical models and practical realities. The assertion made by [28] underlines the necessity of integrating actual operational conditions into the calculations of costs and tariffs to guarantee both efficiency and the sustainability of services.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Operating Cost PM 66	12288432.3333	6	21034846.69209	8587440.20221
	Operating Cost Interview	7743807.3333	6	8713882.61791	3557427.68206
Pair 2	Operating Cost PM 66	12266765.6667	6	21048651.98790	8593076.19063
	Operating Cost Interview	7717365.1667	6	8737091.27914	3566902.57834

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Operating Cost PM 66 & Operating Cost Interview	6	.930	.007
Pair 2	Operating Cost PM 66 & Operating Cost Interview	6	.930	.007

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower				
Pair 1	Operating Cost PM 66 - Operating Cost Interview	4544625.00000	13316932.45825	5436614.91030	-9430638.53566				
Pair 2	Operating Cost PM 66 - Operating Cost Interview	4549400.50000	13314870.81696	5435773.24877	-9423699.47581				

Figure 4. Paired Sample T-Test

Statistical evaluation utilizing a paired T-test confirms this distinction. According to [19], the average operational expenditure is Rp12,288,432.33, whereas the results from the interviews show an average of Rp7,743,807.33.

The average variance of Rp4,544,625 highlights a significant disparity between the two approaches, with data showing r = 0.930 and sig. = 0.007. This indicates that, despite the variation in costs, the trends of both methods remain consistent and in line with each other. For more details, refer to Figure 4.

The findings have significant implications for analyzing the feasibility of tariffs, especially regarding the calculation of costs via regulations [19] that focus more on long-term operational sustainability due to their consideration of greater cost burdens. On the other hand, the real costs derived from the interviews are lower and more efficient, yet they may introduce risks to labor and ship maintenance expenses.

Ship Load Capacity

Each catamaran's ability to transport passengers and motor vehicles can be expressed in Passenger Units (SUP) for various cargo types by multiplying the Conversion Index (CI) by the load capacity (people/unit) listed in Table 3.

Table 3. Ship Load Capacity

No	Ship	Conversion Indeks		Load Capasity (Person/Unit)		Load Capasity (SUP)		Total SUP/Trip
		Pnp	Pnp + Mtr	Pnp	Pnp + Mtr	Pnp	Pnp + Mtr	
1	1-7	1	1,5	12	10	12	15	27
2	8	1	1,5	10	5	10	7,5	17,5

Table 3 illustrates the load capacity differences between Ships 1 – 7 and Ship 8, measured in Passenger Unit (SUP) units. The SUP metric is utilized to balance the load between standard passengers and those carrying motorcycles. In this conversion, a standard passenger is valued at 1 SUP, while a passenger accompanied by a motorcycle is equivalent to 1.5 SUP. This index reflects the fare structure, as passengers with motorcycles incur higher charges due to their increased use of space and weight, thus translating to 1.5 SUP for the purposes of comparison. Using this conversion, Ships 1 – 7 have a combined maximum load capacity of 27 SUP, which is made up of 12 SUP from regular passengers and 15 SUP from 10 passengers and their motorcycles. In contrast, Ship 8 can accommodate a capacity of 17.5 SUP, which includes 10 SUP from standard passengers and 7.5 SUP contributed by 5 passengers with motorcycles.

To determine the annual transport capacity, the quantity of SUPs transported per trip is multiplied by the yearly sailing frequency, which is derived from the average number of trips a ship makes per day 6 trip multiplied by the maximum sailing days per ship, totaling 281 days. This results in 1,686 trips each year. Consequently, Vessels 1 – 7 have an annual capacity of 45.522 SUP, while Vessel 8's capacity is limited to 29.505 SUP. This variation in capacity has a direct effect on the cost efficiency per SUP. Although the overall annual operational expenses for Ships 1 – 7 and Ship 8 are quite comparable, the greater capacity of Ships 1 – 7 leads to reduced costs per SUP unit, making these vessels more efficient and allowing them to potentially offer more competitive pricing for their services.

Total Ship Production

The yearly cargo transported by catamarans is calculated by multiplying the annual totals of passengers and motor vehicles by the operating hours of the vessel throughout the year. The comprehensive data regarding passengers and motor vehicles was gathered through direct observations and data collection conducted at Parangloe Pier over the course of one month, from January 15, 2025, to February 11, 2025. A summary of the collected data on passengers and motor vehicles is outlined in Table 4.

Table 4. Total Ship Production

Ship	Parangloe Pier		Lakkang Pier		Total Production	
	Pnp	Pnp + Mtr	Pnp	Pnp + Mtr	Pnp	Pnp + Mtr
1	157	586	141	630	298	1216
2	137	614	130	608	267	1222
3	135	650	141	652	276	1302
4	151	614	116	660	267	1274
5	131	646	135	610	266	1256
6	148	558	131	622	279	1180
7	128	646	134	638	262	1284
8	153	456	149	490	302	946

Table 4 displays statistics regarding the passenger counts for each catamaran operating on the Parangloe Pier to Lakkang Pier route, distinguishing between passengers without vehicles and those with motor vehicles. The information outlines the monthly passenger figures for each vessel, encompassing both departures and arrivals. Additionally, the total number of passengers and the combined total of passengers and motor vehicles are computed by aggregating both categories. Analyzing the data reveals discrepancies in production levels among the various vessels. For instance, Ship 1 carried 298 passengers and a total of 1,216 passengers and motor vehicles in a single month, whereas Ship 3 recorded the highest output with 276 passengers and a total of

1,302 passengers and motor vehicles. In contrast, Ship 8 noted the lowest total of passengers and motor vehicles, reaching only 946 units in a month.

In terms of yearly output, Ship 1 generates 14,592 passenger and motor units annually, while Ship 3 achieves 15,624 units per year. In the passenger sector, Ship 8, which accommodates 302 passengers monthly, produces a total of 3,624 passengers annually. This information highlights the actual service levels of each vessel and is utilized to assess operational effectiveness, especially regarding utilization rates compared to the ship's annual cargo capacity (refer to Table 3). For example, if Ship 3 has an annual loading capacity of 45.522 SUP (similar to Ships 1 – 7), yet it only produces about 15.624 SUP, then its utilization rate is approximately 34%, indicating that capacity is not being utilized efficiently. This situation directly affects the cost per unit of service, resulting in higher expenses.

Passenger Unit (SUP)

When assessing the capacity of cargo space for various cargo types, calculations using Passenger Unit (SUP) are applied. To determine the SUP for each cargo type, one can calculate it by multiplying the cargo conversion index by the total amount of cargo transported by the vessel over the year. The overall production summary in terms of SUP is displayed in Table 5.

Table 5. Total Ship Production in SUP

Ship	Total Production		SUP		Total SUP
	Pnp	Pnp + Mtr	Pnp	Pnp + Mtr	
1	3.576	14.592	3.576	21.888	25.464
2	3.204	14.664	3.204	21.996	25.200
3	3.312	15.624	3.312	23.436	26.748
4	3.204	22.932	3.204	22.932	26.136
5	3.192	15.072	3.192	22.608	25.800
6	3.348	14.160	3.348	21.240	24.588
7	3..144	15.408	3.144	23.112	26.256
8	3.624	11.352	3.624	17.028	20.652

Table 5 illustrates the yearly production of ships measured in SUP (Passenger Unit) units, derived from the passenger and passenger + motorcycle production figures provided in Table 4. The conversion index applied is 1 for standard passengers and 1,5 for those transporting motorcycles. This method aims to standardize load units based on the volume of cargo and their impact on ship revenue, thus facilitating a more equitable and proportional assessment of performance.

For instance, Ship 1 reported an annual output of 3,576 standard passengers and 14,592 passengers + motorcycles, which, when converted, amounts to 3.576 SUP and 21.888 SUP, culminating in a total of 25.464 SUP for the year. Generally, vessels that transport a higher volume of passengers along with motor vehicles will achieve a greater overall SUP.

Vessel 3 stands out with the highest SUP production, totaling 26.748 SUP, which includes 3.312 SUP from standard passengers and 23.436 SUP from passengers + motor vehicles (15,624 units multiplied by 1.5). In contrast, Ship 8 exhibits the lowest total SUP production at 20.652 SUP per year, despite a relatively significant number of standard passengers (3,624 individuals). This highlights how influential the contribution of passengers + motor vehicles is in determining the total SUP and the overall performance of the ship.

This overall SUP data is crucial for assessing a ship's actual workload and determining its capacity utilization rate. By comparing the current total SUP with the ship's annual loading capacity (refer to Table 3), one can calculate the utilization rate. For example, Ship 1, which has a yearly capacity of 45.522 SUP but only generates 25.464 SUP, results in a utilization rate of approximately 56%. This suggests that the capacity is not being fully utilized, which in turn affects cost efficiency.

This rate of utilization has a significant impact on the operational cost per SUP, which is used to establish tariffs. The greater the SUP output, the more the fixed operating costs can be distributed across a higher number of units, thereby lowering the tariff for each unit. On the other hand, low output, as seen with Ship 8, will result in an increased cost per SUP, unless operational efficiencies are adopted.

Load Factor (LF)

The proportion of cargo moved by vessels within a year compared to the total cargo capacity in the SUP is shown in Table 6.

Table 6 illustrates the load factor or capacity utilisation rate for each catamaran operating on the Parangloe – Lakkang route. The load factor is determined by the ratio of total annual production in SUP units to the ship's annual loading capacity (refer to Table 3), and it is represented as a percentage.

Table 6. Ship Load Factor

Kapal	Total Production	Load Capasity	Load Factor (%)
1	25.464	45.522	55,94
2	25.200	45.522	55,36
3	26.748	45.522	58,76
4	26.136	45.522	57,41
5	25.800	45.522	56,68
6	24.588	45.522	54,01
7	26.256	45.522	57,68
8	20.652	29.505	69,99

The value of the load factor indicates how effectively the ship's cargo space is utilised, where a higher percentage signifies a more optimal use of the ship's capacity.

The results of the calculations indicate that among Ships 1 – 7, Ship 3 achieved the highest load factor at 58.76%, with Ship 7 following closely at 57.68% and Ship 4 at 57.41%. In contrast, Ship 2 recorded the lowest utilisation rate at 55.36%, suggesting that nearly half of the ship's capacity has not been fully utilised over the course of a year.

Notably, Ship 8, which has a lower annual cargo capacity (29.505 SUP), reported the highest overall load factor at 69.99%. This demonstrates that even with a reduced production volume compared to other vessels, its cargo loading efficiency is superior, leading to more effective ship operations in terms of space utilisation and service frequency.

The value of the load factor directly affects the operational cost efficiency per SUP and is a crucial benchmark for establishing a sensible tariff structure. Vessels with higher load factors usually incur lower costs per service unit, as both fixed and variable expenses are distributed over a greater number of units. On the other hand, low load factors can lead to increased costs per SUP and diminished operational efficiency.

Generally, while no vessel operates at complete capacity (100%), a load factor between 54% and 70% can still be considered relatively good for catamaran-based river transport. However, these findings highlight the necessity for strategies aimed at improving utilization, such as optimizing sailing schedules, enhancing service quality, and promoting routes to draw in more users.

Required Freight Rate (RFR)

The minimum fare that each passenger must pay can be established by calculating the annual operating expenses along with the investment costs. Table 7 shows the minimum fare for each vessel.

Table 7. Minimum Ship Rates

Ship	RFR	
	Pnp (Rp.)	Pnp + Mtr (Rp.)
1	2,007	3,011
2	2,028	3,042
3	1,910	2,865
4	1,955	2,933
5	1,981	2,972
6	2,078	3,117
7	1,946	2,919
8	2,442	3,663

Table 7 shows the minimum fare rates for each catamaran operating on the Parangloe – Lakkang route. These fares are derived from a comparison of the overall annual operating expenses and the yearly cargo volume measured in SUP units, which are divided into two categories: passengers and passengers with motorcycles, utilizing conversion indices of 1 and 1,5 as previously applied.

The results of the calculations indicate that the minimum fares differ among the vessels. For the passenger category, fares range from Rp1,910 to Rp2,442, while for passengers with motorcycles, they range from Rp2,865 to Rp3,663. Vessel 8 has the highest minimum fares, at Rp2,442 for passengers and Rp3,663 for passengers with motorcycles.

The elevated fare for Ship 8 is attributed to its lower annual cargo volume of 20.652 SUP, as detailed in Table 5. Despite Ship 8 achieving the highest load factor at 69.99%, its overall cargo volume is still less than that of the other ships. This results in operational expenses not being optimally allocated, which leads to higher fares per unit. This suggests that a high load factor may not always be associated with lower fares if the production volume is constrained.

In contrast, vessels that handle high production volumes, like Vessel 3 and Vessel 7, can set their minimum fares at lower rates. For instance, Vessel 3 requires only Rp1,910 for a passenger and Rp2,865 for a passenger with a motorbike, since it generates a total production of 26.748 SUP. This observation suggests that there is an inverse relationship between cargo volume and the minimum fare necessary to cover operating costs. Hence, as cargo volume increases, the required minimum fare decreases. To keep fares accessible for the public, it is essential to focus on optimizing cargo volume and enhancing operational efficiency. Vessels with lower productivity, such as Ship 8, may need to employ additional measures, including increased advertising, changes in sailing frequency, or even subsidies, to sustain a competitive and feasible fare structure. Figure 5 illustrates the connection between minimum fare and load factor level for each vessel, further depicting fare efficiency in relation to capacity utilization.

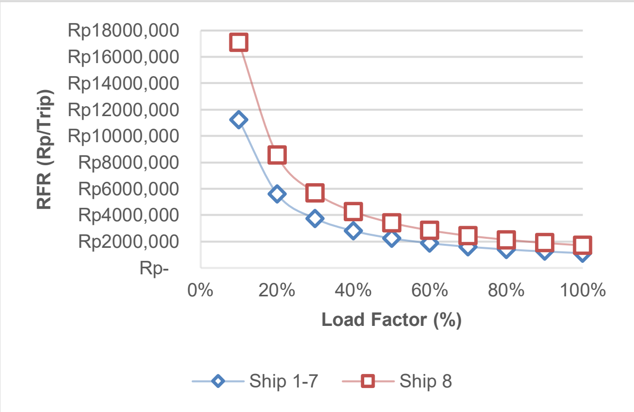

Figure 5. Ship Rates (RFR)

Figure 5 depicts the correlation between Load Factor (%) and the minimal ship rate (RFR) per trip for two groups of vessels, specifically Ships 1 – 7 and Ship 8. This chart demonstrates how the load factor influences the rate that needs to be set for the ship to achieve the break-even point.

In general, it can be seen that Ship 8 demands a higher minimum fare than Ships 1 – 7 throughout the entire range of load factors. When the load factor is low (<30%), the difference in fare is quite marked, with Ship 8 charging more than Rp16,000, while Ships 1 – 7 range around Rp11,.000. Although this gap narrows as the load factor rises, the trend indicates that Ship 8 continues to need a higher fare to manage its operational expenses. This disparity is mainly attributable to Ship 8's limited annual cargo capacity of 29.505 SUP in contrast to Ships 1 – 7, which can handle 45.522 SUP. While the operational costs among the ships are relatively similar, the reduced cargo output of Ship 8 results in expenses being spread over fewer service units, leading to an increased rate per SUP.

This graph indicates that an increase in load factor significantly lowers the minimum fare necessary, in accordance with the principle of economic efficiency. When the load factor approaches 100%, the fares for Ship 8 and Ships 1 – 7 start to align within a range of Rp2,000 – Rp2,500 per trip, signifying optimal operational conditions. Consequently, small-capacity vessels like Vessel 8 need to implement specific strategies to remain competitive in terms of fares, which may involve optimizing load factors, enhancing operational cost efficiency, or seeking fare subsidy assistance. These insights highlight the necessity of taking capacity and load factor into account.

Ability to Pay (ATP)

In the course of analyzing the feasibility of catamaran river transport fares, assessments were conducted to gauge the Ability to Pay (ATP) among users of the service. A survey involving 65 active participants on the Parangloe – Lakkang route was carried out, utilizing a questionnaire that gathered data on transport spending, income levels, and travel patterns. The gathered data was analyzed using the ATP formula, which evaluates the highest amount that users are inclined to pay for a single journey. The findings indicated that the average ATP figure for passengers was Rp2,893 per trip. This figure signifies the average economic capacity of the passengers and acts as a benchmark for setting a fair fare. When assessed against the minimum fare (RFR) displayed in Table 7, it is evident that Ships 1 – 7, which charge passenger fares ranging from Rp1,910 to Rp2,078, remain below the ATP value, thus making them accessible to service users.

In contrast, Ship 8 presents a minimum fare of Rp2,442 for passengers and Rp3,663 for passengers plus motorcycles, resulting in the fare for the passenger and motorcycle category surpassing the ATP value. This situation suggests that the full cost-based fare on Ship 8 may be unaffordable, particularly for individuals traveling with motor vehicles. It can be inferred that the fare structure for large-capacity vessels (Ships 1 – 7) remains aligned with passengers' financial capacity. However, for smaller vessels like Ship 8, policy measures, such as fare subsidies or improvements in operational efficiency, are necessary to ensure that fares stay affordable for the public while also preserving the sustainability of the service.

Willingness to Pay (WTP)

In addition to assessing the ability to pay (ATP), this research also evaluated the willingness to pay (WTP) among catamaran passengers as part of a tariff approach based on user perceptions. Data was gathered through a survey involving 65 respondents, who were asked to specify the fare they would ideally pay for a single trip, along with the reasons that influenced their willingness to pay more. The analysis of the questionnaire results revealed that the average WTP among passengers was Rp2,000 per trip, which is lower than the ATP value of Rp2,893 per trip. This WTP figure reflects the price expectations deemed reasonable by users based on the current service conditions. Nevertheless, the survey results indicated that passengers were prepared to pay a higher price if there were enhancements in service quality. Various service elements identified as factors affecting the increased WTP include comfort of the seats, availability of safety gear such as life jackets and safety vests, protective roofing to guard against rain or harsh sunlight, and suitable boarding and disembarking facilities, like pier steps and secure mooring systems.

The results suggest that fare assessment is influenced not just by the listed price, but also by perspectives on service quality and safety. Consequently, even though the willingness to pay (WTP) is still lower than the minimum fare (RFR) for certain vessels, there is an opportunity for fares to rise gradually if service quality is enhanced. These findings align with studies on public transport cited in [29], which indicate that willingness to pay tends to increase in proportion to improvements in service quality, especially concerning comfort, safety, and accessibility. Therefore, when developing sustainable fare policies, it is advisable to consider not just the operational cost structures but also the preferences and expectations of users. A feasible strategy is to provide a range of services, such as essential options at lower fares and premium options with extra amenities for those willing to spend more. This method strikes a balance between the viability of the business and fare accessibility for the public.

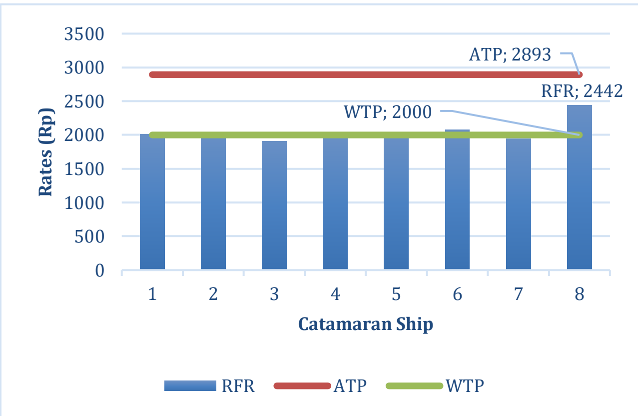

Figure 6. Graph showing the relationship between RFR, ATP, and WTP

Figure 6 illustrates a comparison between the minimum fare (RFR) and two indicators from the perspective of service users, specifically Ability to Pay (ATP) and Willingness to Pay (WTP), within the context of catamaran river transportation along the Parangloe – Lakkang route. The primary aim of this graph is to assess to what degree the fare calculations based on operational costs are acceptable and financially feasible for users of the service.

The findings indicate that the RFR for vessels 1 – 7 varies between Rp1,910 and Rp2,078 per trip, while vessel 8 has the highest RFR at Rp2,442 per trip. In contrast, the average ATP value per passenger derived from the survey is Rp2,893 per trip, which illustrates the financial capacity of users to afford the service fare. Conversely, the determined WTP value is Rp2,000 per trip, representing the expected ideal price based on users' perceptions of the current quality of service.

According to the graph, the RFR for all vessels 1 – 7 is below the ATP and only slightly exceeds the WTP, suggesting that the fares remain within a range that is both economically and socially acceptable for users. Therefore, the proposed fare structure for vessels 1 – 7 can be viewed as viable and likely to be accepted by the public, as long as there is no decrease in service quality.

In contrast to these circumstances, Ship 8 presents an anomaly where RFR (Rp2,442) remains below ATP yet surpasses the WTP value (Rp2,000). This indicates a possible disconnect between the cost structure and the user’s value perception, which might result in a decrease in demand if the fare is fully enforced without enhancements in service. Survey participants stated they would be open to paying more only if there are notable improvements in comfort and safety features, such as sufficient seating, safety gear (life jackets), protection from the elements (ship roof), and secure boarding and disembarkation processes. Moreover, the significant difference between ATP and WTP highlights a gap between the ability to pay and the sense of price fairness. These results emphasize the critical need for a strategy focused on improving service quality as a vital approach to establishing fares that are both affordable and socially acceptable to users.

In summary, Figure 6 highlights the significance of a comprehensive tariff strategy that takes into account the equilibrium between cost efficiency (RFR), users' financial capacity (ATP), and users' readiness to pay

(WTP). For vessels with limited capacity and low production outputs, like Ship 8, enhancing service quality or implementing subsidy interventions is crucial to lower tariffs to a more reachable level while ensuring the continuity of operations

Conclusion

Based on the analysis results, it can be inferred that implementing minimum tariffs for catamaran river transport on the Parangloe – Lakkang route utilizing the Required Fare Rate (RFR) method leads to considerable variations in tariffs among vessels. The least expensive fare was recorded on Vessel 3 at Rp1,910 per SUP, whereas Vessel 8 had the highest fare at Rp2,442 per SUP. This disparity can be attributed mainly to differences in annual cargo capacity, with Vessel 8 having the lowest capacity, resulting in reduced production volume and increased costs per cargo unit (SUP).

From the users' viewpoint, the perception-based assessment reveals that the Ability to Pay (ATP) value is Rp2.893 per trip, contrasting with a Willingness to Pay (WTP) of Rp2,000 per trip. In general, the RFR value falls below ATP and above WTP, positioning the fare within the flexibility zone a price range that remains affordable for users but necessitates enhancements in service quality to meet users' expectations and perceived value. These insights have various strategic implications.

1. For Government and Policymakers: The establishment of tariffs for river transportation should not solely rely on the calculation of operational costs but must also consider the community's purchasing power (ATP) and perceptions of fair pricing (WTP). Implementing cost-based tariffs for low-capacity vessels like Kapal 8 could lead to inequalities in accessibility, thus necessitating policy measures such as operational subsidies, incentives for fleet modernization, or tiered tariff structures.
2. For Vessel Operators: The findings motivate operators to enhance their operational effectiveness, whether by increasing loading capacity, upgrading technical specifications, or optimizing sailing schedules. A higher loading capacity facilitates a decrease in tariffs per unit, which consequently bolsters the competitiveness and affordability of tariffs for users.
3. For Academics and Transportation Researchers: The methodological framework employed in this research, which combines cost analysis (RFR), ability to pay (ATP), and willingness to pay (WTP), may serve as a pertinent and practical model for assessing water transport tariffs, especially in areas with limited demand and infrastructural features. This model also aids in the creation of sustainable service-oriented tariff concepts within public transport policies.

The author suggests prioritizing the enhancement of service quality to bolster the perception of fare affordability, which includes offering comfortable seating that is sheltered from the elements. Full safety equipment, such as life jackets and rescue suits, along with better access to and from the vessel via a safer, more user-friendly pier, is also essential. Making improvements in these service areas is anticipated to boost willingness to pay (WTP), foster customer loyalty, and increase overall demand. Additionally, it is important to consider expanding cargo capacity to overcome efficiency challenges faced by smaller vessels and to lower high unit costs resulting from underutilization. Taking into account these three factors—operational costs, payment capacity, and user perception—it can be determined that the fare structure for the Parangloe–Lakkang catamaran river transport route remains economically and socially feasible. Nonetheless, the long-term sustainability of this fare system critically hinges on the interplay between fare policies, enhancement of service quality, and technical advancements in the vessels to adapt to the changing dynamics of costs and demand in river transport services.

References

[1] Ministry of State Secretariat, Law Number 17 of 2008 concerning Shipping, Pub. L. No. 17 (2008), Jakarta, 2008.

[2] Ministry of Transportation, Minister of Transportation Decree No. 73 of 2004 concerning the Implementation of River and Lake Transportation, Jakarta, 2004.

[3] D. Wisma, Real-Time Data Collection Results for the Makassar City TP-PKK Dasawisma Group, Makassar, 2025. Available from: https://dasawisma.pkk.makassarkota.go.id/rekap

[4] D. Wisata, Map of Lakkang Island, Makassar, 2025. Available from: https://sulsel.jadesta.com/desa/kampung_lakkang

[5] E.K. Morlok, Introduction to Transportation Engineering and Planning, McGraw-Hill,

Chicago, 1978. Available from: https://books.google.co.id/books?id=XGsgAQAAMAAJ

[6] Ministry of Transportation, Minister of Transportation Regulation Number 26 of 2017 PM 26/2017 concerning the Implementation of Public Motorized Vehicle Transportation Services That Do Not Operate on a Fixed Route, Jakarta, 2017.

[7] Ministry of Transportation, Regulation of Minister of Transportation of the Republic of Indonesia Number PM 84 of 2018 on Types, Structure, and Categories of Port Service Tariffs, as well as the Mechanism for Stipulating Tariffs and Services at Ports Serving Ferry Transportation, Jakarta, 2018.

[8] M.Y. Jinca, Indonesian Maritime Transportation: System Analysis & Case Study, 1st ed., Brilian Internasional, Surabaya, 2011. Available from: http://www.perpustakaan-stpbogor.kkp.go.id/index.php?p=show_detail&id=4315

[9] I.L. Buxton, A review of Engineering Economics and Ship Design, 17th ed., British Ship Research Association, Northumberland, 1972. DOI: 10.1080/00137917208902718

[10] Y. Ayutia, O.Y. Irawan, Y. Pahala, Study of Ship Operating Costs in Eastern Indonesia, *J. Manaj. Bisnis Transp. dan Logistik*. **Vol. 5, No. 2**, pp. (2019) 251–257. Available from: http://library.itl.ac.id/jurnal

[11] U. Malchow, Port Feeder Barges as a Means to Improve Intra-Port Container Logistics in Multi-Terminal Ports, Springer Int. Publ., pp. 465–480, 2020. DOI: https://doi.org/10.1007/978-3-030-39990-0_20

[12] N.E. Caicedo Solano, L.E. Ramirez Polo, M. Celin Castro, Toward the optimization of fuel consumption on container-on-barge operations in river transportation, *Case Stud. Transp. Policy*, vol. 14, p. 101087, 2023. DOI: https://doi.org/10.1016/j.cstp.2023.101087

[13] J. Suryoputro, A. Sumarsono, Djumari, Analysis of Public Transportation Fares Based on Ability to Pay (ATP), Willingness to Pay (WTP) and Vehicle Operating Costs (BOK) (Case Study of Trans Jogja Routes 4A and 4B), *e-jurnal Matriks Tek. Sipil*, vol. 3, no. 2, pp. 586–592, 2015. Available from: https://jurnal.uns.ac.id/matriks/article/view/37217

[14] S. Woro Herningsih, Analysis of passenger satisfaction with the services and fare determination of the Jakarta Pontianak cross country Bukit Raya ship, pp. 5–6, 2024. Available from: http://scholar.google.com/citations?user=MISqIQkAAAAJ&hl=id

[15] M.A. Saputra, Study of Inter-Island Fast Boat Fares in Mentawai Islands Regency, Andalas University, 2022. Available from: http://scholar.unand.ac.id/110328/

[16] A. Syamsul, M. Misliah, A.S. Chairunnisa, A.H. Djalante, W. Djafar, Study of Ferry Transportation Tariffs between Bira, Sikeli, and Tondasi Based on Vehicle Operating Costs (Bok) and Ability to Pay (Atp), *Ris. Sains dan Teknol. Kelaut.*, vol. 4, no. 1, pp. 74–78, 2021. DOI: 10.62012/sensistek.v4i1.19414

[17] W. Kristianto, A Study of Inter-Island Sea Transport Tariffs for Makassar City – Barrang Lompo Route During the Covid 19 Pandemic, Universitas Hasanuddin, 2021. Available from: http://repository.unhas.ac.id:443/id/eprint/19052%0A

[18] W. Kristianto, W. Djafar, A.S. Chairunnisa, A.H. Djalante, R. Fitriah, Study of Sea Transportation Fares on the Makassar-Pulau Barrang Lompo Route During the Covid-19 Pandemic, *Zo. Laut*, vol. 4, no. 2, pp. 61–66, 2023. Available from: https://journal.unhas.ac.id/index.php/zonalaut ZONALAUT

[19] Ministry of Transportation, Regulation of the Minister of Transportation Number 66 of 2019 concerning the Mechanism for Determining and Formulating the Calculation of Ferry Transportation Rates, Jakarta, 2019.

[20] Ministry of Finance, Decree of the Director General of Taxes Number KEP-218/PJ/2003 concerning Guidelines for the Implementation of Hostage Taking and Granting of Rehabilitation of the Good Name of Taxpayers Who Are Held Hostage, Jakarta, 2018. Available from: https://datacenter.ortax.org/ortax/aturan/show/16427

[21] M. Stopford, Maritime Economics 3e, 3rd ed. Routledge, 2009. Available from: https://www.routledge.com/Maritime-Economics-3e/Stopford/p/book/9780415275583?srsltid=AfmBOooTG5nPf8KMO8WjSwZ7qGXCiDPq-vYbtEMysaEMmBlMWFVFpPLY

[22] M.N. Nasution, Transportation management, 3rd ed. Jakarta: Ghalia Indonesia, 2008. Available from: https://elibrary.bsi.ac.id/readbook/203957/manajemen-transportasi

[23] I. Machali, Quantitative Research Methods (A Practical Guide to Planning, Conducting, and Analysing Quantitative Research), State Islamic University (UIN) Sunan, 2021.

[24] M. Dr. Drs. H. Rifa'i Abubakar, Quantitative Research Methods, vol. 7, no. 2, 2021.

[25] A. Wicaksono, Educational Research Methodology: A Brief Introduction, Sleman: Garudhawaca, 2022. Available from: https://books.google.co.id/books?id=23SrEAAAQBAJ&printsec=frontcover&hl=id#v=onepage&q&f=false

[26] A.A. Mubarak, The Effect of Machining Cost Components on the Calculation of Traditional Ship Rates for the Baubau – Siompu Route, *J. Mekanova Mek. Inov. dan Teknol.*, vol. 7, no. 2, p. 74, 2021. DOI: 10.35308/jmkn.v7i2.3892

[27] N.S.D. Islami, C. Boyke S.P, F. Zulkarnaen, Analysis of the Impact of Port Development on Transportation Costs: A Case Study of Teluk Prigi Port in East Java, *J. Tek. ITS*, vol. 6, no. 2, 2018. DOI: 10.12962/j23373539.v6i2.27059

[28] T. Notteboom, A. Pallis, J.-P. Rodrigue, Port Economics, Management and Policy, Oxfordshire: Routledge, 2022. DOI: 10.4324/9780429318184

[29] T. Litman, Evaluating Transportation Equity: Guidance for Incorporating Distributional Impacts in Transport Planning, *ITE J. (Institute Transp. Eng.)*, vol. 92, no. 4, pp. 44–49, 2022.