

# RIVER TRANSPORT PLANNING STRATEGY ANALYSIS USING SWOT AND AHP METHODS

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**Abstract.** Tangerang City is the largest city in Banten Province and the third largest city in Greater Jakarta area which is split by one of the major rivers on the island of Java, namely the Cisadane River. With the increasing number of population and vehicle ownership, it is necessary to develop a public transportation network to reduce traffic volume and meet the needs of urban public transportation that is fast, easy, safe and comfortable for the citizen. The existence of the Cisadane River in Tangerang City has the potential to be developed into a public transportation route in the form of a waterway. Therefore, the right strategy is needed in the planning of river transportation. This study aims to analyze the influencing factors and strategic priorities in planning river transportation as urban public transportation using the Strength Weakness Opportunity Threat (SWOT) and Analytical Hierarchy Process (AHP) methods. In this study, a questionnaire was given to eight expert respondents related to river transportation. The respondents' answers were tested for consistency with AHP to ensure the accuracy of the answers. From the results of the SWOT analysis, it was obtained the strengths, weaknesses, opportunities and threats in river transportation planning, as well as the ST (Strength-Threat) strategy with the largest weight of 3.99 as the strategy to be used in planning river transportation. Then from the AHP analysis, the strategic priority results in planning river transportation were obtained, namely the safety criteria with a weight of 0.29 and alternative strategy for life jackets with a weight of 0.117853325 as the main priority in carrying out the chosen strategy. Respondents' answers are fairly accurate with a consistency ratio of  $2.58\% \leq 10\%$ .

*Keywords : AHP; alternatives; river transportation; strategies; SWOT.*

## 1. INTRODUCTION

Congestion is a problem that is always faced by big cities in Indonesia. With the continued growth of the population, followed by the rampant of urban development, it will increase the number of trip generators which have an impact on the accumulation of vehicles on a road in a sustainable manner. Vehicle growth that is not matched by an increase in road capacity is one of the factors causing congestion [1].

To reduce the number of motorized vehicles on roads, it is necessary to develop a public transportation network that is fast, easy, safe and comfortable for the citizen. In addition to developing transportation networks in the form of buses and trains, river transportation in the form of boats can also be developed in the Greater Jakarta area which is close to the riverside areas.

The transportation system is a unity of elements and components that support each other and work together in the procurement of transportation that has a certain range of service [2]. The transportation system in an area can be used as an indicator of regional development because in a transportation system there is a need for transportation.

One of the alternative forms of handling the current urban transportation system is to use the Transport Demand Management (TDM) concept. Transport Demand Management (TDM) is the implementation of strategies and policies that aim to maximize the efficiency of the urban transportation system by limiting the unnecessary use of private vehicles and encouraging more effective, healthy and environmentally friendly modes of transportation such as public transportation, walking, cycling and so on [3].

The Cisadane River is one of the major rivers on the island of Java, which divides Tangerang into two parts, and has the potential to be developed as a public transportation route in the form of a waterway. The government can develop the potential for river transportation not only as a means of crossing but can be developed into a means of transportation both for public and for tourism which is an alternative solution to reduce congestion and can attract tourists to support the concept of developing a riverside area as a waterfront city [4].

The purpose of this study is to analyze the right strategy in planning the Cisadane River transportation, and to determine priority strategic steps for planning river transportation as an urban public transportation in Tangerang.

This research is expected to provide benefits to the local government as an effort to solve congestion problems, meet public transportation needs for the citizen and become literature for academics in further research related to river transportation.

Ferry transportation/ river crossing transportation is transportation that functions as a bridge connecting the road network and / or railroad network separated by water to transport passengers and vehicles and their cargo. The function of river crossing as a moving bridge is the movement of traffic and transfer of passengers and vehicles and their cargo by ferry/boat [5].

River fairway are waters of rivers and lakes, river estuaries, a lane that connect two or more river estuaries which constitute a single unit of river and lake fairway which in terms of depth, width and other shipping barriers, it is considered safe to navigate. [6].

Factors that affect the transportation service system are transportation costs, the physical condition of the means of transportation, the route traveled, service crews and others. Estimated transportation demand is used as a basis for determining the means (fleet) of transportation that must be provided in the future and what mode is suitable for a particular activity to be held [7].

SWOT, which stands for strength, weakness, opportunity and threat, was created as a model for analyzing an organization that aims at profit and non-profit as a means to better understand the state of an organization comprehensively [8]

SWOT analysis, which stands for strength, weakness, opportunity, and threat, identifies several factors in a systematic way to formulate a strategy [9]. This analysis is based on logic that is useful for maximizing strength and opportunities, but can also minimize weakness and threats. The success of implementing the strategy is influenced by making the right decision.

To perform a SWOT analysis, it begins with collecting questionnaire data for phase 1, then analyzed by the following steps: Performing IFAS and EFAS calculations; Analyze and interact with the combination of strategies using the SWOT matrix by combining internal and external factors; Formulate alternatives and strategy choices with the SWOT matrix and produce SO, WO, ST, and WT strategies. Then compared the total strategy ratings and sought the largest; And you will get the results of the strategy that will be used.

In essence, the Analytical Hierarchy Process is a model in comprehensive decision making and takes into account various things that have both qualitative and quantitative characteristics. In the decision making model using the Analytical Hierarchy Process, it generally tries to cover the shortcomings of the previous models. Analytical Hierarchy Process also allows the system structure and environment into interconnected components and then unites by measuring and managing the impact arising from system error components [10].

AHP defines multi-factor and multi-criterion problems that depend into a single hierarchy. With a hierarchy, a complex problem can be arranged into each group and then arranged into a hierarchical form until the problem appears more structured and systematic [11].

AHP analysis starts from the results of the second stage questionnaire obtained, the assessment data is entered into the AHP model. The AHP model used is a comparison method for alternative solutions using the basic concept of a matrix.

To get the smoothing of answers from many respondents, the smoothing method is done by using the geometric mean method to get one particular value from all of these values [12]. Here are the geometric mean equations:

$$b_{ij} = (z_1 \times z_2 \times z_3 \dots \times z_n)^{1/n} \quad (1)$$

n fact, absolute consistency will not be obtained. By comparing CR and RI, parameters will be obtained in determining the level of consistency in the matrix, which is called the Consistency Ratio (CR), with the following equation:

$$CR = CI / RI$$

(2)

The tolerance for the consistency of a comparison matrix is 0.1. Thus, a comparison matrix will be called consistent if the CR is less than 0.1 [10]. Consistency testing is also carried out on a hierarchy with the same equations and tolerances.

The final step is to determine the alternative strategy that will be selected by determining the global weight (Wg). The alternative global weight is determined by multiplying the weight of criterion A with each alternative weight in criterion A and is carried out on each alternative for each criterion.

$$Wg_{\text{alternative}} = W_{\text{criteria A}} \times W_{\text{Alternative Strategy A}}$$

(3)

## 2. METHODS

The following are the stages in this research:

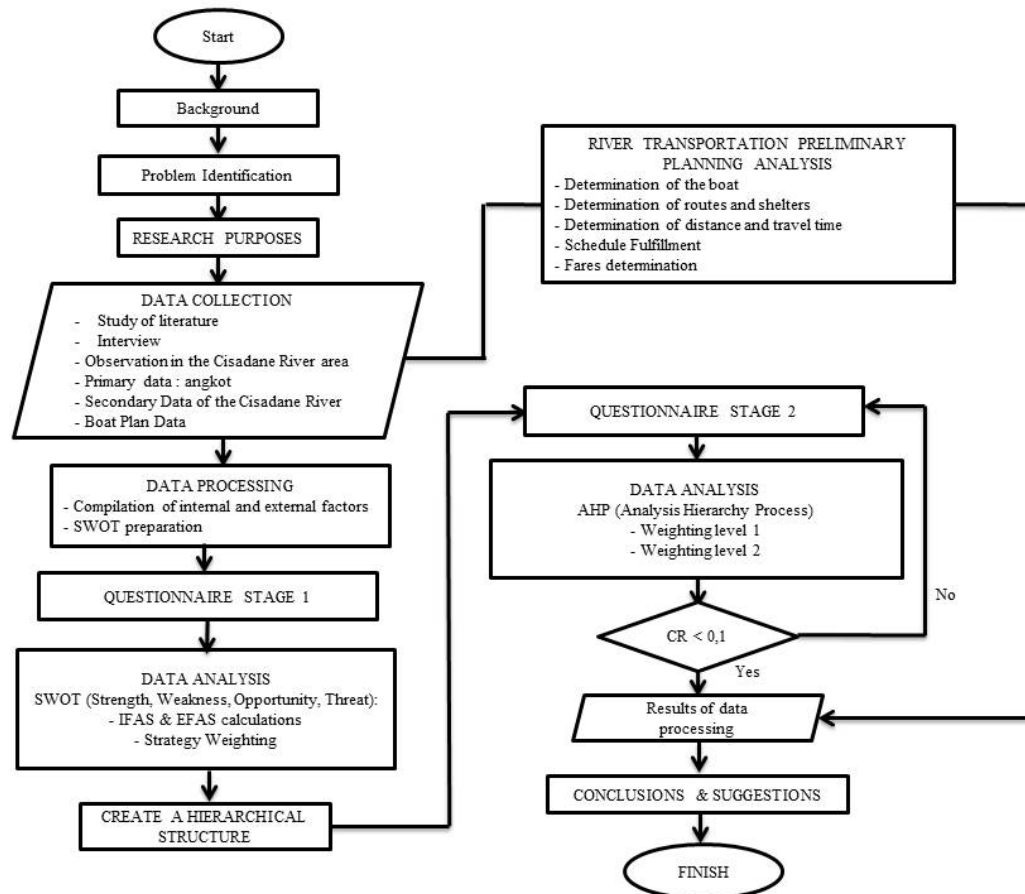


Figure 1. Flow Chart

Based on **Figure 1**, this research begins with determining the background, problem identification and objectives. Data collection was carried out by literature studies, interviews, field observations and data from related agencies. Then the distribution of the first stage questionnaire was carried out, the results were analyzed using the SWOT method and followed by the distribution of the second stage questionnaire, the results were analyzed using the AHP method. From the results of the analysis, it will produce a priority order for river transportation planning strategies. Besides that, an analysis of the initial planning of river transportation was also carried out, so as to obtain a mature strategy in building urban river transportation.

## 3. RESULTS AND DISCUSSION

### 3.1 SWOT Analysis

From the results of the SWOT questionnaire, the weight and rating calculations were carried out through the IFAS and EFAS matrix calculations. From the IFAS and EFAS calculations, the strategic weight values for the four factors can be seen in the following table:

Table 1. Weighed Value of SWOT Strategy

Strategy	Weighted Value
<i>Strength (S)</i>	2.25
<i>Weakness (W)</i>	1.07
<i>Opportunity (O)</i>	1.62
<i>Threat (T)</i>	1.74

After analyzing the factors and weighting it, the next step is to interact with a combination of internal and external strategies to obtain strategic alternatives in river transportation planning. The strategic combination interactions consist of: SO (Strength-Opportunity) strategy which is a combination of strength and opportunity strategies; ST (Strength-Threat) strategy which is a combination of strength and threat strategies; the WO (Weakness-Opportunity) strategy which is a combination of weakness and opportunity strategies; and the WT (Weakness-Threat) strategy which is a combination of weakness and threat strategies. The results of the strategy combination interaction can be seen in table 2.

Table 2. Weighed Value of Strategy Combination Interaction

Strategy	Weighted Value
<i>Strength - Opportunity (SO)</i>	$2.25 + 1.62 = 3.87$
<i>Strenght - Threat (ST)</i>	$2.25 + 1.74 = 3.99$
<i>Weakness - Opportunity (WO)</i>	$1.07 + 1.62 = 2.69$
<i>Weakness - Threat (WT)</i>	$1.07 + 1.74 = 2.80$

From the results of the interaction of the strategy combination, the final result of the ST (Strength - Threat) weight is 3.99 as the highest weight that will be used as a strategy in river transportation planning which will then be calculated priorities through AHP analysis.

The results of the combination of Strength and Threat (S-T) strategies are: implementing a payment system that is cheap, easy and practical; provide comfortable facilities and infrastructure for the passengers; choosing a stopping point in a strategic area; ensure the safety of passengers; as well as anticipating floods / rainy season. Then it is concluded into criteria: payment, facilities and infrastructure, selection of stopping points, safety and security.

### 3.2 AHP Analysis

From the data, the final results of the SWOT analysis are then used as criteria in the AHP analysis. Then, several proposed alternative strategies (sub-criteria) were obtained from literature studies and also the input from respondents.

From the data of AHP questionnaire to 8 selected respondents, a pairwise comparison scale matrix between criteria and between sub-criteria (alternative strategies) is made. The geometric mean answer smoothing method is used in the pairwise comparison of criteria and subcriteria (alternative strategies).

Furthermore, consistency testing is carried out on each comparison matrix, namely the criteria comparison matrix and strategy alternatives. The consistency test of the comparison matrix aims to determine the consistency of a comparison matrix. If the CR (Consistency Ratio) exceeds 10% or 0.1 then the matrix is inconsistent and needs to be corrected or re-questionnaire. In the comparison between criteria, the CR value was 0.03 or 3%, the alternative payment strategy was 0.00021 or 0.021%, the alternative strategy for selecting a stop point was 0.07 or 7%, an alternative safety strategy was 0.04 or 4%, alternative facilities and infrastructure strategy was 0.01 or 1% and alternative security strategy was 0.02 or 2%.

From the results of the hierarchical consistency test, the CRH value was 0.0258 or 2.58%, so the answers from the respondents could be considered consistent (CRH < 0.1).



From the calculation of global weight priority determination, the highest weight was the safety criterion with a weight of 0.29, as well as an alternative life jacket with a value of 0.117853325, so that safety aspects and the availability of life jackets are the most important strategies in planning urban river transportation.

### 3.3 Planning Analysis

River transportation on the Cisadane River (Cisadane Waterway) is planned to be on the Cisadane River flow path in Tangerang City along +/- 11 km from the upstream river at the border of Kota Tangerang and Kota Tangerang Selatan downstream at the Pasar Baru Dam. There are 6 shelters planned with the initial operation of 5 boats.



Figure 2. Shelter Plan (A)



Figure 3. Shelter Plan (B)



Figure 4. Shelter Plan (C)

The boat planned is a passenger boat with a capacity of 50 seated passengers + 18 standing passengers with a maximum speed of 30 knots.

The following is the fairway planned for this river transportation:

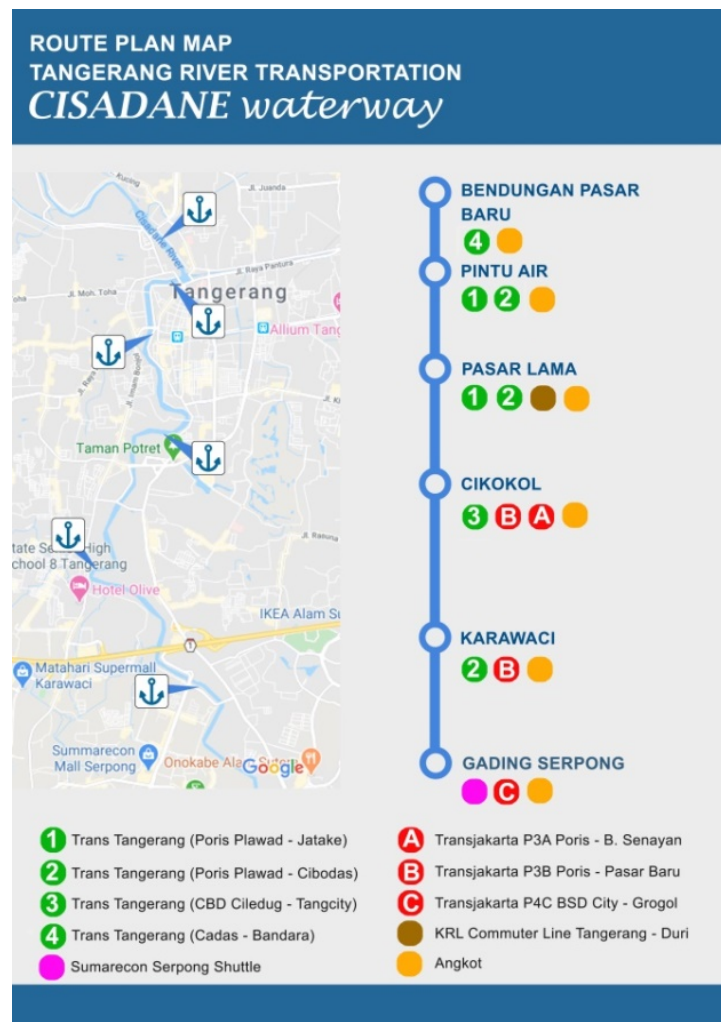


Figure 5. Route Plan Map

Boat travel time is obtained by dividing the distance by the speed and then multiplying by 60 to get the time in minutes. Boat speed is obtained based on boat data. The following is a table of distances and travel times between stopping points / shelters:

Table 3. Distance and Travel Time

Shelters	Distance (km)	Travel Time (minutes)
Bendungan Pasar baru (A)	0.94592	1.135104
Pintu Air (B)	1.30848	1.570176
Pasar Lama (C)	2.13727	2.564724
Cikokol (D)	3.34775	4.0173
Karawaci (E)	3.05004	3.660048
Gading Serpong (F)		
Total	10.78946	12.94735

Taking the example of a river transportation video on the Chao Praya River in Bangkok, an analysis was carried out so that the calculated stop time was obtained from the boat starting to reduce speed then stopping to pick up and drop off passengers until just after the boat had tightened its speed again, which was 1.2 minutes which was then rounded to 1.5 minutes, so the total estimated time for one sailing travel (Bendungan PB Shelter – Gading Serpong Shelter - Bendungan PB Shelter) is 26.447 minutes.

Fulfilment of the schedule is one of the minimum service standards for deployment for ship/ boat operations [13]. Fulfilment of the schedule referred to consists of ship travel schedules, ship operating schedules, operational readiness schedules, rest schedules and docking schedules. Ship operating schedule is for 11 months or 330 days per year and ship dock schedule for 1 month or 30 days per year [14].

During peak hour, the boat heading time is planned every 10 minutes and non-peak hours for every 15 minutes. With 5 boats, 1 boat will start its journey every 50 minutes during peak hours and 75 minutes during non-peak hours, where 26.447 minutes is the time for one sailing travel and the rest is the time for resting the boat at the first shelter.

Fare determination is based on the calculation of the basic fare for ferry transportation, which is the total main cost divided by production over a period of 1 (one) year. Main cost consists of components of direct costs and indirect costs. In accordance with the ferry fare calculation formulation in the Regulation of the Minister of Transportation of the Republic of Indonesia No. 66 of 2019 [14], then the passenger fare per kilometre is obtained of Rp. 993.47 / km. By multiplying the distance with the fare per kilometre, the fare between the shelters are as follows:

### 3.4 Strategy Priority Analysis

Based on the results of the analysis of the five criteria, a strategic priority order is obtained starting from the provision of life jackets, boat maintenance, river discharge control, integrated other modes, safety card, boat facilities, easy access, technical engineering on bridge, river depth control, pedestrian access , activity centers, selection of boat types, practical payments, information systems, low costs, easy payments to waiting room facilities.

#### Life jacket

Life jackets are one of the emergency rescue equipment in a state of danger for the safety aspects of passengers [13]. The life jackets is placed under each passenger seat, under the driver's seat, under the closest seat to the standing passenger and the boat conductor. The available life jackets are 110% of the capacity of the boat [13], which are stored in the storage area on the boat or near the boat conductor.

#### Boat maintenance

Boat maintenance must be carried out regularly to ensure the safety of the passengers. Boat maintenance includes: daily (cabin) maintenance of the boat, maintenance of boat safety equipment, maintenance of boat equipment and supplies, maintenance of boat engines and pumps, periodic painting and cleaning of the hull, periodic replacement of lubricants and grease [14]. There must also be 1 shipyard for maintenance.

#### River discharge control

River discharge control is intended to determine the safety of river discharge for boats to pass through, carried out in collaboration with the Meteorology, Climatology and Geophysics Agency and the Ciliwung-Cisadane River Basin Development Agency to monitor river discharge and rainfall intensity at monitoring posts, because during the flood season and high rainfall intensity, rivers are very dangerous when traversed by boats.

For recommendations to anticipate high river discharge conditions, it can be done by building a dam at the upstream of the Cisadane river in Tangerang City area to reduce the high flow of the Cisadane river during rainy / flood conditions. The dam can also be installed with a net / filter to keep the garbage coming from upstream (South Tangerang and Bogor) before entering the river in Tangerang City area, which can reduce the comfort for cisadane river transportation passengers as applied to the Manggarai dam.

#### Integrated other modes

Each designated shelter point must have integration with other modes so that public transportation in Tangerang City can be connected to each other and make it easier for passengers of public transportation to switch the transportation modes.

#### Safety instruction card

A safety instruction card must be available in each passenger seat pocket which contains the safety aspects in the boat and how to save yourself in a dangerous situation on the boat.

#### Boat facilities

The facilities available on the boat are air conditioning, comfortable seats for passengers, running text and loudspeakers to provide information about stopping points, and comply with the minimum service standards for regular economy passenger's cabin in the comfort category according to Minister of Transportation Regulation No. 62 of 2019 [13] includes: the minimum height of the cabin 1.90 m; passenger seats with at least a width of 50 cm and a length of 50 cm; fan / air conditioner; TV / Video / Audio; trash can; 100% clean area; loudspeaker; and equipped with air vents.

#### Easy to access

The alternative of easy-to-access strategies means that stopping points should be located in locations that are easily accessible to passengers, have close access to the roads and be linked by sidewalks for pedestrians.

#### Bridge technical engineering

During the rainy season or when the maximum flood water level occurs, several bridges along the fairway cannot be traversed by boats so it is necessary to anticipate flood conditions through bridge engineering technical on several bridges. From the type of boat that has been determined, has a height of 1.6 meters. so that the height of the bridge clearance during the maximum flood water level must have a height of > 1.6 meters.

#### River depth control

The control of the river depth is intended to prevent silting in the fairway which can cause the boat hull to get stuck. Previously, it had to be determined in advance the fairway that the boat had to go through. So that the depth can be controlled by periodically dredging the fairway and stopping points.

#### Pedestrian access

In relation to easily accessible alternative strategies, each stop point / shelter must have pedestrian access. Such access must connect the shelter with sidewalk or with integrated stations and bus stops. Canopy pedestrian access is also recommended to protect pedestrians from rain and sun shine

#### The hub

The hub means that the determination of the shelter point must consider the location of the activity center / the hub. At the designated shelter points, the six shelters are located near the activity center (hub) / movement points of Tangerang citizen.

#### Selection of boat types

Selection of boat types is not only based on capacity and facilities provided [13], it is also based on dimensions. The height of the boat must be able to pass the area under the bridges that cross along the fairway or have a maximum height under the bridge clearance height. The dimensions of the hull depth (draft) shall not be greater than the depth of the river along the fairway.

#### Practical

The practical alternative strategy is that the payment system can be carried out with various non-cash payment systems, from card-based electronic money with various types of merchants to application-based electronic money as a form of transportation mode integration development.

#### information Systems

The facilities and infrastructure in the information system are in the form of boat departure information screens such as those already in several Transjakarta bus stops; running text and loudspeakers; information boards, wayfinding signage and mode integration guide as well as the availability of information center officers at each shelter who can assist passengers in providing information. So that the information conveyed on the boat to service users can be read and heard and informed



### Cheap

Ferry transportation fare are set by the Regent / Mayor for ferry transportation within the city [14]. Cheap payments / fares are not only parameterized at a small nominal value, but also in comparison with existing transportation, *angkutan kota* (local transportation).

### Easy

Based on the measurement of the timeliness of queuing in ticket sales services [15], non-cash payment is an easy payment solution for passengers and it will minimize queuing time for ticket purchases. This is accompanied by the availability of self ticket vending machines that make it easier for passengers to buy entrance cards / tickets.

### The waiting room

The waiting room is a place provided for passengers before boarding the boat. The facilities and infrastructure in the waiting room include: waiting room seats, trash cans, information facilities (information boards & departure information screens), air conditioning or fans to meet the comfort aspect for passengers.

## 4. CONCLUSION

Based on the results of the analysis, an appropriate strategy was obtained in planning the Cisadane River transportation to reduce urban traffic congestion, which includes: paying attention to safety aspects by preparing life jackets, safety card in each seat pocket, and boat maintenance; pay attention to security aspects based on the type of boat, river discharge control, bridge technical engineering, and river depth control; provide facilities and infrastructure consisting of boat facilities, waiting rooms, information systems and pedestrian facilities; selecting a stop point based on a location close to the center of activity (hub), integrated with other transportation, and easily accessible; prepare easy, cheap and practical payments. The safety criteria with a weight of 0.29 and the sub-criteria for life jackets with a weight of 0.118 have the greatest weight in the order of priority so that it becomes the main strategy in planning Cisadane River transportation in Tangerang City.

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