Safety Evaluation Of River Transportation In Palembang

Dahlia Dewi Apriani, Erika Buchari, Edi Kadarsa

Abstract : The aims of this research is to know the factors that cause the accident of river transportation in Palembang by increasing the safety of river transportation to achieve the safety river transportation. The data were collected by distributing the questioners to the experts of river transportation, and thenit were analyzed by Analytical Hierarchy Process (AHP) method. The result of the research shows that the human factor is the highest aspect that causes the river transportation accident. The highest criteria percentage is the lack of skills of the boat and pier crews. While the highest percentage to improve the safety of river transportation is improving the boat and pier crews skill by carry out the training for them.

Term Index : Safety of river transportation, boat accidents, speedboat, accident causing factors, safety of river transportation system, AHP.

1 INTRODUCTION

Palembang City in South Sumatra province, is divided by the Musi River, the longest river in Sumatra Island, with 750 km of navigable. This river is a reliable transportation infrastructure in the Palembang city. River transportation is used as a step to overcome the problems of public transport and traffic in Palembang. There are many types of boats that operate there, passenger boats such as ketek, speedboat, water bus, freight boats namely Jukung and tourist boats that tourists usually use to visit tourist attractions along the Musi River. Based on data from the Transportation Department of South Sumatera Province in 2018, the number of boats accident was increased. In 2016 the boat accident occurred for 1 (one) time, which was caused by the collision and in 2017 boat accidents in the waters of the Musi River occurred for 2 (two) times which were also caused by the collision, while in 2018, the boat accidents in the waters of the Musi River has occurred for 7 (Seven) times, consequently many loss of death and property suffered by the victims. From such data accidents are often happened through the speedboat. The analysis of sea freight accidents has been carried out much, revealing that marine accidents are often caused by human error (Harahap et al. 2010, Lady DKK. 2014, Faturachman DKK. 2015, Ugurlu. 2015, Altinpinar et al. 2018). The Human error factors are varied such as not complying with the rules, errors in loading, failing to control the ships and misjudge to the surrounding conditions, while the cause of the river accident will be analyzed whether is the Human error as the main cause in river transportation accidents such as the sea transportation, because river transportation design of safety equipment, navigation and communication and regulation is simpler than sea transportation. So that we conducted the research to know the existing conditions of boat safety in Palembang with descriptive method and analyzing the factors that caused the boats accident in Musi River especially through the speedboat and the strategy that prioritized which can create the safe river transportation using the Analytical Hierarchy Process (AHP), so that the Government can determine the priority program to improve the safety of river transportation in Palembang. This research can be used in other locations that have the same river transport characteristics as the survey location.

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1.1 Problem Formulation

The problem formulations are :

a. What are the factors that affected to the boat accident in Palembang?
b. How to improve the safety of the river transportation?

1.2 Research Aims

The research aims are as follow:

a. To know the factors that affected to the boat accident in Palembang.
b. To know the way to improve the safety of the river transportation.

2 MATERIAL AND METHOD

2.1 Population and Sample

Sampling method is using the Random Sampling, the technique is taking samples and members of the population using random without regarding to the strata (actions). The population in this study is speedboats which are berthing pin 16 Ilirpier Palembang. Based on the data that shows the number of the boat which have been recorded by Palembang City Department of Transportation in 2018 with sample calculations using the Slovin technique,the result show 39 units of speedboat as the sample.

2.2 Method of collecting data

Data collection methods used in this researchare as follow:

a. Observation Method
   Conducting direct observation of the object to be observed include:
   1) Structures, which are river safety requirements, receive a Sailing Approval Letter every time they sail, boat safety certificates, navigation and communication equipment.
   2) Infrastructure, which are the condition of the pier and the boatchannel on the river.
   3) Human resources, which are the river transport pier managers, river transportation crews and river boatchannel supervisors.

b. Interview method
Asking some questions to the respondents directly, to get information in accordance with the aims to be achieved. The respondents were considered as an expert in the river transportation both in education and experience consisting of various agencies, such as:
1) Academics from Sriwijaya University and Inland Water and Ferries Transport Polytechnic of Palembang, these respondents have knowledge and expertise about river transportation.
2) Transportation Department of Palembang as the manager of 16 Ilirpier.
3) Regional Land Transportation Management Office Region VII of South Sumatra Province and Bangka Belitung, as representatives of the central government overseeing river and lake transportation activities in Palembang.
4) Speedboat crew, information is needed from their direct experiences related to the river transportation.

c. Regulatory Studies
Learn about regulations of river transportation safety to compare it through the existing condition of river transportation in Palembang.

2.3 Sources and Types of research data

a. Secondary Data
Secondary data is data which is collected from related agencies or other sources that have been provided such as boat data, accident data, rules regarding river transportation safety and other supporting data obtained from relevant agencies.

b. Primary Data
Primary Data is data which is collected directly from the object under the research by conducting surveys, interviews and field observations. The observation technique used was observation and questionnaire filling.

2.4. Data processing

The steps in calculating the Analytical Hierarchy Process (AHP) Method are as follows:

a. Identification of causative factors
Identification of the causal factors was obtained by observing the speedboat at 16 Ilir Port in Palembang, reading other research on river boat accidents and interviews with respondents about the factors causing the speedboat accident in the Musi River.

b. Arrangement of Hierarchy
The arrangement of the hierarchy or decision structure is done to describe the system elements or alternative decisions identified. After the factors that cause the accident then an alternative was arranged to create a safe river transportation system.

c. Priority Determination
Perform the pairwise comparisons between criteria and alternatives by comparing each element with other elements at each level of the hierarchy in pairs, so to obtain the value of the element's importance in the form of qualitative opinions. In order for these qualitative opinions to be quantitative or numeric, a rating scale is also used, so that a numerical (quantitative) opinion value will be obtained. The relative comparison values are then processed to determine the relative ranking of all alternatives.
Qualitative and quantitative criteria can be compared according to predetermined assessments to produce rankings and priorities. Each pairwise comparison is evaluated on Saaty's scale 1-9 as follows:

TABLE 1
AHP SCALES AND ITS DEFINITION

Scale	Definition
1	As important as it is
3	Less more important
5	More important
7	Very important
9	Absolutely more important
2, 4, 6, 8	Median

The pairwise comparison values of all sub-hierarchical elements are transformed in the form of a matrix. For example, there are n objects denoted by (A1, A2 ... An) valued based on their importance, including Ai and Aj, which presented in the Pair-wise Comparison matrix.

TABLE 2
PAIR – WISE COMPARISON MATRIC

	A1	A2	.....	Aa
A1	a11	a12	.....	a1n
A2	a21	a22	.....	A2n
.....	.....	.....	.....	.....
An	am1	am2	.....	Amn

d. Consistency Index
Consistency index (CI) is a mathematical calculation for each pairwise comparison. This CI expresses consistency deviation. The calculation of consistency index is considered as a way to see the relationboat of the consistency of answers to the pair's assessment of the hierarchical structure of the problem. The consistency index calculation formula is as follows:

$$\mathrm{CI} = \frac{(\lambda - n)}{(n-1)} \quad (1)$$

Where:
λ = average of vector consistency
n = number of non-respondent criteria

The consistency ratio (CR) is obtained from a random index (Random index / RI), as a result of an absolute random response divided by CI. The higher CR causes the lower consistency, and vice versa. The consistency ratio must be smaller than 10%, if the consistency ratio is bigger than 10%, the respondent is considered to be inconsistent in answering questions and allowed to make improvements to the answers given.

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}} \quad (2)$$

TABLE 3
RANDOM INDEX VALUE

n	1	2	3	4	5	6	7	8	9
RI	0,000	0,000	0,580	0,900	0,120	1,240	1,320	1,410	1,450

n	10	11	12	13	14	15
RI	1,490	1,510	1,480	1,560	1,570	1,590

3 RESULT AND DISCUSSION

3.1 Determination of Aspects and Criteria of Hierarchy Procedures

The determination of the hierarchy in this study is based on the results of interviews between 16 Ilir Palembang pier officers and some literature on boat accidents. Based on the objectives achieved from this study, two hierarchical procedures were made, namely the results of river transportation accidents and alternatives to creating a sustainable river transportation system. Based on the investigation of the National Transportation Safety Committee (NTSC) the factors that influence boat accidents are human error, technical factors and weather (Hasugi. Et al, Mapping the Characteristics of Boat Accidents in Indonesian Waters Based on NTSC Investigations, 2017). Boat collision is the most common boat accident and mostly causes by human error, then technical factors such as equipment damage, natural factors or weather conditions and overload. According to Harahap, 2017, the chance of human failure is not the main cause of a collision in TanjungPerak, there are also other causes, such as the chance of dangerous environment and the chance of equipment/ boat failure. The main cause of boat accidents is the excess transportation of the specified transport capacity, both boats and person transportation (Faturachman, 2015). Meanwhile, according to Ozdemir, 2018, boat accidents arecaused by travel factors (sea conditions, weather conditions, etc.), lack of management (boat rules, lack of communication, failure to take action, etc.), problems with the boat (boat age, boat conditions, lack of boat equipment and low lighting, etc.), human factors (lack of training, unconsciousness, carelessness, desire to work, fatigue, dangerous movements) and load problems (misplacement, dangerous goods, etc.). According to The Study of the Maritime Traffic Safety System Development Plan, 2002, boat accidents are caused by human factors (41%), natural disasters (force major) 38% and boat structure (hull structure) 21%.The following is the hierarchical structure of the weighting causes of river transport accidents:

TABLE 4
WEIGHTING HIERARCHY STRUCTURE CAUSE
RIVER TRANSPORTATION ACCIDENT

Goal : Causes of River Transportation Accidents	
ASPECT	CRITERIA
A. Human Factor	1.1. Lack of training for crew and pier officers 1.2. Do not obey the rules 1.3. Fatigue 1.4. Alcohol 1.5. Sleepy 1.6. Cannot control the boat 1.7. Lack of supervision
B. Boat borne Trouble	2.1. Boat design and conditions 2.2. Lack of boat maintenance 2.3. Lack of boat equipment 2.4. Boat speed
C. Environmental Factor	3.1. Sailing channel conditions 3.2. Weather conditions
D. Cargo Trouble	4.1. Dangerous cargo 4.2. Incorrect loading 4.3. Overload

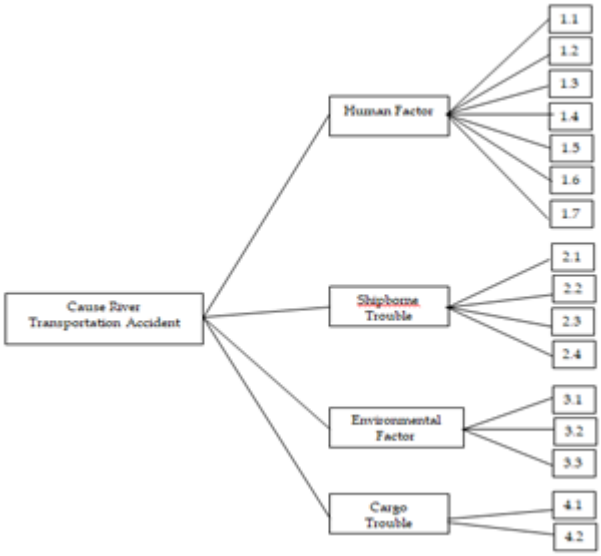

Figure 1*. The root structure of a weighted River Freight accident*

The strategy to minimize boat accidents involves all parties to the cruise, such as the crew must perform the duties based on the predetermined procedures and rules, the operator or the boat owner in order to support all activities on board and provide training to the crews onboard, while the government as the regulator conducts the personnel before issuing the certificate to the operator and boat (Hasugian directly, 2017). According to Faturachman, 2015, attempts to decrease the occurrence of boat accidents are increasing the boat loading check, implementation of boat picking test, monitoring of boat by beach radio, improving sea patrol, improving training and periodically simulating emergency conditions on board, do some counseling to stakeholders and the surrounding community and carry out the safety campaign of the lane. According to Ladi Lovely, 2014, by improving crew skills, appropriate crew recruitment, improving navigation and ship communication conditions can reduce the occurrence of ship accidents, in addition the improvement of the design and construction of ships, The load by taking into account the weight point of the ship and execute the rules well is also an action to prevent ship Accidents (Sutiono, 2010) and according to Susilo, 2014, efforts to realize the safety of passengers of river and lake transportation can carried out by socializing the importance of rivers and lakes transportation to both crew members, passengers aboard and operators and making general guidelines on the safety of river and Lake transportation.

Based on the description of the literature study and the results according to the opinion of the respondents who are experts of river transportation then we can determine that the criteria's

of the procedure to make a safe river transportation system is as follows:

a. Improvement of crew training, such as emergency training, vessel loading technique, boat manning;
b. Increased regulatory oversight against boat and carriers;
c. Fulfill the safety equipment, navigation and communication of boats as per the rules;
d. Implement a cruise safety campaign;
e. comply with applicable rules;
f. prototype boatbuilding;
g. installation of signs;
h. Cleanup the flow.

3.2. Data Processing using AHP

a. The causes of river transportation accident

As mentioned in the previous chapter that the researcher used questionnaires distributed to 10 respondents consisting of academics, officers in ports and crew members. Furthermore, the comparison of pairs against several aspects into Matric Pair Wise can be seen in the following Table 5.

TABLE 5.
MATRIK PAIR WISE CAUSES RIVER TRANSPORT ACCIDENT

ASPECT	A	B	C	D
A	1	2,8808	2,5811	2,4082
B	0,3471	1	2,2206	2,0719
C	0,3874	0,4503	1	2,4082
D	0,4152	0,4826	0,4152	1
Σ	2,1498	4,8138	6,2170	7,8884

The aim is to formulate the cause of boat accident especially speedboat in Palembang. From the assessment result of respondents then calculated the value of the priorities of each aspect so that obtained aspects of priority that become the cause of the river transportation accident in Palembang.

TABLE 6.
MATRIK PRIORITY CAUSES RIVER TRANSPORTATION ACCIDENT

ASPECT	A	B	C	D
A	0,4652	0,5985	0,4152	0,3053
B	0,1615	0,2077	0,3572	0,2627
C	0,1802	0,0935	0,1609	0,3053
D	0,1932	0,1003	0,0668	0,1268
Σ	0,4460	0,2473	0,1850	0,1217

Using the equation (1) and (2), the consistency ratio calculation of a comparative matrix causes a river transport accident of 0.0961 smaller than 10%.

$$\mathrm{CI} = \frac{(4{,}2595 - 4)}{(4-1)}$$

$\mathrm{CI} = 0{,}086$

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}}$$

$$\mathrm{CR} = \frac{0{,}086}{0{,}900}$$

$\mathrm{CR} = 0{,}0961$

Human factor is the main aspect that resulted in a river transportation accident with a percentage of 44.60%, followed by the problem of boat problems (boat trouble) 24.73%, environmental factor (environmental factor) of 18.50% and the aspect that has the least influence on boat accidents is cargo trouble with a weight of 12.17%.Using the same step with the causes of river transportation accident calculation, From the calculation of criteria the human factor criteria known as the largest percentage is the lack of training 15.39%, do not comply with the rules of 8.56%, fatigue 7.35%, due to the influence of alcohol as big as 4.97%, Drowsiness due to 3.44%, unbiased control of 2.69% vessels and a lack of supervision by 2.20%.

TABEL 7
WEIGHT RECAP ASPECTS AND CRITERIA FACTORS CAUSING THE RIVER TRANSPORTATION ACCIDENT IN PALEMBANG

Level	Definition	Weight
Aspect	1. Human Factor	0,4460
	2. Boatborne Trouble	0,2473
	3. Enviromental Factor	0,1850
	4. Cargo Trouble	0,1217
Criteria	1.1. Lack of training for crew and port officers	0,1539
	1.2. Do not obey the rules	0,0856
	1.3. Fatigue	0,0735
	1.4. Alcohol	0,0497
	1.5. Sleepy	0,0344
	1.6. Cannot control the boat	0,0269
	1.7. Lack of supervision	0,0220

b. Safe River Transport System

The priority weights for the safety of the river transportation system are also obtained from the opinions of the same 10 respondents as the search for the cause of river transport accidents. From the calculation of the Pair Wise matrix and the matrix priority in tables 8 and 9 that known as to improve the skills training of crew members is a priority factor in creating a safe transportation system with a percentage of 23.91%, then need to Improved supervision from regulators amounting to 17.16%, fulfillment of safety equipment, navigation and communications according to the rules of 16.71%, conducting safety campaigns on boating of 12.17%, complying with the prevailing rules of 10.73%, determination of Prototype boat was 7.49%, clearing the lane at 6.38% and the latter was mounting a sign with a weight of 5.45%.

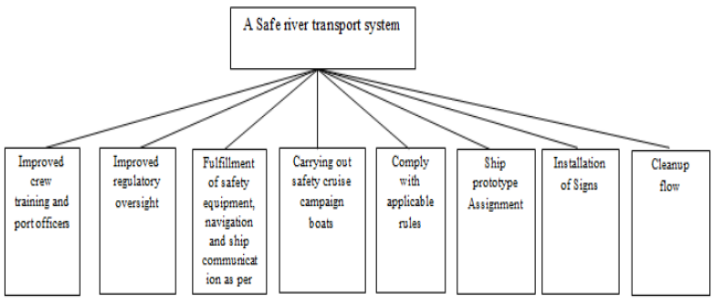

Figure 2*. The root structure of a weighted a safe river transportation system*

TABLE 8
PAIR WISE MATRIK SAFE RIVER TRANSPORT SYSTEM

Criteria	A1	A2	A3	A4	A5	A6	A7	A8
A1	1,0000	1,8228	3,1090	2,6673	2,5150	2,9542	2,5344	2,5344
A2	0,5486	1,0000	2,4786	2,2533	2,1041	2,0189	2,2708	1,7247
A3	0,4035	0,4035	1,0000	3,9061	1,8384	3,0814	2,3485	3,0265
A4	0,3749	0,4438	0,2560	1,0000	3,0553	2,1411	2,4715	1,9332
A5	0,3976	0,4753	0,5439	0,3273	1,0000	2,1411	2,8287	2,7585
A6	0,3385	0,4953	0,3245	0,4670	0,4670	1,0000	1,7776	2,0345
A7	0,3946	0,4404	0,4258	0,4046	0,3535	0,5626	1,0000	0,6444
A8	0,3946	0,5798	0,3304	0,5173	0,3625	0,4915	1,5518	1,0000
∑	3,8522	5,6609	8,4683	11,5430	11,6959	14,3908	16,7834	15,6562

TABLE 9
PRIORITY MATRIK SAFE RIVER TRANSPORT SYSTEM

Criteria	A1	A2	A3	A4	A5	A6	A7	A8	∑
A1	0,2596	0,3220	0,3671	0,2311	0,2150	0,2053	0,1510	0,1619	1,9130
A2	0,1424	0,1767	0,2927	0,1952	0,1799	0,1403	0,1353	0,1102	1,3726
A3	0,1047	0,0713	0,1181	0,3384	0,1572	0,2141	0,1399	0,1933	1,3370
A4	0,0973	0,0784	0,0302	0,0866	0,2612	0,1488	0,1473	0,1235	0,9733
A5	0,1032	0,0840	0,0642	0,0284	0,0855	0,1488	0,1685	0,1762	0,8588
A6	0,0879	0,0875	0,0383	0,0405	0,0399	0,0695	0,1059	0,1299	0,5994
A7	0,1024	0,0778	0,0503	0,0351	0,0302	0,0391	0,0596	0,0412	0,4356
A8	0,1024	0,1024	0,0390	0,0448	0,0310	0,0342	0,0925	0,0639	0,5102
AVERAGE	0,2391	0,1716	0,1671	0,1217	0,1073	0,0749	0,0545	0,0638	1,0000

The result of consistency ratio calculation (CR) is 0.0971, less than 10%, so that respondents answer is consistent.

TABLE 10
CRITERIA WEIGHT RECAP
THE SAFE RIVER TRANSPORT SYSTEM

Criteria		Weight
A.1	Improved training	0,2391
A.2	Improved regulatory oversight	0,1716
A.3	Fulfillment of safety equipment, navigation and boat communication as	0,1617
A.4	per the rules	0,1217
A.5	Carrying out safety cruise campaign Comply with applicable rules	0,0749
A.6	Boat prototype making	0,0638
A.7	Installation of Signs	0,0545
A.8	Cleanup thelane	0,0638

4 CONCLUSION

Based on the results of the Analytical Hierarchy Process (AHP) it can be concluded the following matters:

a. Factor that caused the river transportation accident in Palembang with the highest percentage was the human factor with 44.60%, the second factor was the boat trouble with 24.73%, then the Environmental Factor with 18.50% and the last is the cargo trouble with 12.17%

b. Method with the highest percentage to improve the safety of river transportation is by increasing the skills training for boat crews and officers at the pier with a percentage of 23.91%, then followed by increasing in supervision by the regulator with 17.16%, compliance with safety, communication and navigation equipment according rules with 16.17%, carry out a cruise safety campaign with 12.17%, comply with applicable rules with 7.49%, making a prototype boat with 6.38%, installing signs with 5.45% and cleaning the lane with 6.38%.

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