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The Potential of Tondano River Development as a Transportation Alternative in Manado City

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Abstract: *One of the urban transportation problems is traffic jams, including the Manado city which has limited mass transportation facilities and infrastructure in the city. Thias is indicated on the YosSudarsoPaalDua arterial road and the ArieLasutWonasa collector road, where there is the Tondano River Basin which can be alternative urban transportation to reduce traffic density that occurs in the Tondano watershed. This study analyzes land use activities, types of transportation, and physical conditions of rivers and formulates the concept of river transportation development, using qualitative and quantitative descriptive methods, field observations, and mapping the physical conditions of the river. The results showed that the generation and pull of land use around and along the watershed can be a fever for the development of Tondano river transportation. The dominant passenger movement comes from the function of the service and trade areas, as well as culinary. The physical condition of the river, seen from the shipping aspect, has the potential to be developed as water transportation infrastructure in addition to its function as a source of clean water and flood control. Development is directed at the river transportation planning concept for public transport and tourist transportation*

Keywords*: urban transportation, river transportation, land use and tourism*

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I. Introduction

Transportation is a very important and strategic means in accelerating the wheels of the economy, strengthening unity and integrity, and influencing all aspects of the life of the nation and state. The importance of transportation, whether land, sea, or air is reflected in the increasing need for transportation services for the mobility of people and goods. The problem that occurs in urban transportation is traffic jams [1].

Manado city has traffic congestion problems, limited public/mass transportation facilities and infrastructure in the city, causing various classic problems such as increased traffic volume, road shoulder side disturbances, movement delays, traffic jams, and others. Traffic problems are also caused by the increase in the use of private vehicles (2 wheels, 3 wheels, and 4 wheels) which is not proportional to the increase in the capacity of road network infrastructure [2].

Traffic congestion problems are indicated on JalanYosSudarsoPaalDua (Arteri road) and JalanArieLasutWonasa 'Collector road', Manado City. The function of the 2-lane 2-way road, with the function of using the surrounding space, is an industrial, commercial, office, and densely populated residential areas. Types of vehicle movement are trucks for transporting goods and containers, cars, and private motorbikes. Given the magnitude of the transportation problem in many big cities, the potential for less dense rivers to function as transportation arteries was again recognized [3].

The road network contains the Tondano watershed which can be developed and planned as urban water transportation, alternative transportation to reduce traffic density problems that often occur in the Tondano watershed. River transportation can also support environmentally friendly transportation and shorten travel time [4]. The expansion of the transportation network supports good accessibility and is related to the development of an area [5].

It is not easy to solve the problem of road capacity and traffic congestion (transportation inefficiency) by simply relying on road (land) transportation development alone. For this reason, river transportation development can be a solution to reduce the volume of movement, both in terms of economic feasibility, environmental feasibility, river feasibility, and the history of water transportation in Indonesia. The use of watersheds as water transportation infrastructure in the city of Manado is also a very strategic matter, judging

from the aspect of relatively new transportation modes in Manado, the added value in the tourism aspect, and from the urban rejuvenation aspect, as an improvement for the improvement of the socio-cultural and socio-economic communities in along the watershed [1]. The modern level of infrastructure development for water transportation needs to be considered as a system consisting of interconnected elements, and subject to mutual influence [6].

This study aims to analyze land use as a generation of traffic movement that can potentially be diverted to river transportation modes, types of transportation modes in accordance with passenger characteristics and river physical conditions, and alternative concepts of network development and river transportation modes.

II. Material And Method

The location and type of research are located on the TondanoRiver in the Kairagi Bridge-Megawati Bridge segment (Manado Harbor), Manado City, North Sulawesi. This research is descriptive qualitative and quantitative

Figure 1. Research sites

Typesandsources

Primary data were obtained from research locations through observation, interviews, and questionnaires distributed to respondents, and visual observations. Secondary Data were sourced from the Public Works Office of North Sulawesi Province, the Spatial Planning Office, and related agencies. Types and data sources can be seen in Table 1.

Table 1. Types and sources of data

Variable	Indicators	Type of data	Data source	Analysis
Generation	- Occupancy - Hotel	Number of freight requests, peak times	Primary Data Questionnaire	statistic
Pull	- Center for social, economic, education services - Industry, terminals and ports - settlement	- Trip Length (km) - Number and capacity of Units	Primary Data Questionnaire	Statistic
Land use	- dock - Empty land - Building density - Soul density	Need for parking area and jetty	Primary data	Statistics and Descriptive
Modes of transportation	Type of Transportation Origin - Four-wheel vehicle - Kendaraanrodadua - destination - boat	- Total (unit) - Parking area - The modal capacity according to the physical condition of the river (Ton-water depth) - Mode capacity according to passenger characteristics (person / mode)	Primary Data Questionnaire	Deskriptif Deskriptive
Physical Condition of the River	- River width - River depth - River length - tidal - Wind velocity	• The widest distance of the river in meters • The smallest distance of the river in meters	Secondary data from the Department of Public Works or government agencies	Deskriptive

		In meters • Highest tide in meters • Lowest water tide in meters meter/second
Transportation Development Concept	- Travel time - Type of transportation mode	Efficient and economical Environmentally friendly, safe, comfortable and sustainable

Method of collecting data

Data obtained by direct observation and observation, detailed measurement of the physical river as well as observation of ongoing phenomena, questionnaire data distributed directly to respondents, data based on records/literature (Record Analysis), namely historical records and current records, as well as company records. Public or private written and printed from the government or related agencies.

DataAnalysis

The method of analysis for research purposes 1 uses analysis of various land uses by calculating the magnitude of the population movement around the Tondano river and making a diagram [7], for research purposes 2 using analysis of watershed functions and river physical conditions, analyzing the dimensions of water transport modes by calculating water discharge, water level, river width, building height, river length, river boundary conditions and conditions of people who are active around the river and for analysis purposes 3 uses a sustainable concept approach for river transportation development which is categorized into 2, namely public transportation and tourist transportation. The planning concept approach emphasizes the convenience and safety of users for shifting modes of transportation.

III. Results And Discussion

Riverland Use Activities are very important for the formation of lake sediment [8]. The Tondano watershed originates from the watergate of Lake Tondano to the Manado Sea with a length of ± 39.9 km and from the KairagiBridge to the port of Manado ± 7.2 km in length. Based on the results of field observations and data inventory, the land use along the left and right of the Tondano watershed consists of residential buildings, offices, education, shops, and health facilities, terminals, and ports.

The number of movement generators from each land designation activity is office buildings 13 vehicle movements per 100 m2, at the hospital there are 18 vehicle movements per 100 m2, the market has 136 vehicle movements per 100 m2, and settlements in the form of housing units there are 400 total vehicle movements per 100 m2. 10,000 m2, housing in the form of apartments, there are 500 vehicle movements per 10,000 m2, education is assumed to be the same as offices, namely 13 vehicle movements per 100 m2, banks and health centers are assumed to be the same as hospitals, namely 18 vehicle movements per 100 m2 [9].

Based on the literature study above, it can be calculated the number of vehicle movements per area of the function of the buildings located in the area around the Tondano watershed. The results of the calculation of movements associated with activities according to land use show that the generation of movement of people is quite large and has the opportunity to use river transportation to meet their transportation needs, especially low-income people (LIP), tourists, as well as small traders and employees who have activities around the Tondano watershed.

Table 2. Land use activities

No.	Land Use Activities	Activity Area (M^2)	Estimated Resurrection	Explanation
1	Household / Residential			
	- SettlementPaalDua	70.000	2.800	400 perg/ha
	- SettlementWenang	80.000	3.200	400 perg/ha
	- SettlementSingkil	120.000	4.800	400 perg/ha
	- Lantamal VIII Command Headquarters	46.000	1.840	400 perg/ha
	- Riverside hotel	1.300	65	500 perg/ha
	- Celebes hotel	600	28	500 perg/ha
	Total	**317.900**	**12.733**	
2	Offices			
	- PDAM (Local water company)	16.000	2.080	13 perg/100m^2
	- KementerianPerhubungan	3.800	494	
	- Regional Transportation Agency	1.500	195	
	- Food Security Agency	2.300	299	

	- Fishery Marine Agriculture Service	1.900	247	
	- Village of Calaca	1.200	156	
	- Istiqlal village	800	104	
	- Manado Police	5.700	741	
	- The company Jaya SaktiSejati	13.000	1.690	
	- Kombos Post Office	14.000	1.820	
	- Bluebird taxi pool	6000	780	
	- Ternate Village	1000	130	
	- KetangBaru Village	600	78	
	- Head of Singkil District	1.300	169	
	- Water Police	1.800	234	
	Total	**70.900**	**9.217**	
3	Education			
	- Public Elementary School 29 Manado	1.700	221	13 perg/100m^2
	- Public Elementary School125 Manado	1.300	169	
	- Junior high school Muhammadiyah 1	700	91	
	- Junior high school Muhammadiyah 2	1.200	156	
	- Private Junior high school Advent 5 Kairagi	1.700	221	
	- Junior High School KatolikSugiopranoto	2.700	351	
	- Publik Elementary School, Junior High School,	2.000	260	
	Vocational high SchoolCokroaminoto	600	78	
	- Junior High SchoolandYapim Private Islamic	2.300	299	
	Vocational High School	1.000	130	
	- Pertiwi Private Junior High School and Senior	6.800	884	
	High School	700	91	
	- Muhammadiyah high school			
	- MA PKP Manado			
	- Muhammadiyah high school of health sciences			
	Total	**22.700**	**2.951**	
4	Hospitals, Community Health centers and Banks			
	- Siloam Hospital	1.800	324	18 perg/100m^2
	- Medical Center Hospital	2.700	486	
	- Kombos community health center	1.600	288	
	- Wawonasa Community Health Center	3.200	576	
	- BNI Bank	1.900	342	
	Total	**11.200**	**2.016**	
5	Supermarkets			
	- Fresh market	15.000	20.400	136 perg/100m^2
	- Market 45	180.000	244.800	
	- Bersehati Market	60.000	81.600	
	Sub total Total	**255.000**	**346.800**	
	Total		**373.717**	

Source: Analysis results, 2020

Based on the data processing presented in Table 2, a diagram was made to see the comparison of the movement generation in each land use activity.

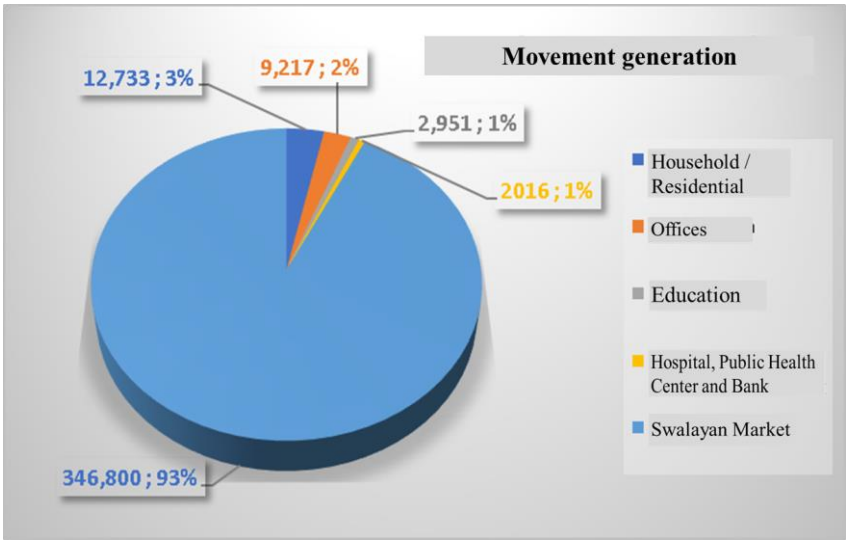

Figure 2. Movement Generation Diagram

For people who live around the river, the majority of types of work are employees of private and government offices, traders, small and medium entrepreneurs, laborers, and others. Whereas for educational land useand the types of work are consist of government employees, private sector, and students. Communities in residential areas are predominantly with high school education and below. The majority of office buildings are undergraduates, the majority of shops are high school seniors and below and the majority of educational function buildings are undergraduate. As a whole, people have an average middle and high education. It is hoped that the water transportation program and the river development plan will be accepted by the community more quickly because basically the people in the Tondano watershed are educated enough to understand the importance of preserving the river environment.

The results of the analysis of the location indicators of the origin of the place of residence and the purpose of the activities indicate the very high potential value of population movement demand, the dominant being the purpose of work. This population has the potential to switch to using river transportation as its main mode of transportation, because the majority of the population uses private vehicles because there is no adequate public transportation available, from a comfortable and safe aspect in Table 3.

Table 3. Potential demand for river transportation

No.	Transportation	Settlement		Office		Shops		Education		hole	
		Total	%	Total	%	Total	%	Total	%	Total	%
1	Origin										
	House	40	100	18	90	20	100	15	75	93	93
	Others	0	0	2	10	0	0	5	25	7	7
2	The destination of the trip										
	a. Work	20	50	20	100	12	60	10	50	62	62
	b. school/college	6	15	0	0	0	0	10	50	16	16
	c. shop	10	25	0	0	8	40	0	0	18	18
	d. Others	4	10	0	0	0	0	0	0	4	4
3	Moda use										
	a. Private transport	22	55	14	70	15	75	10	50	61	61
	b. Publik Transport	10	25	0	0	5	25	4	20	19	19
	C.Online transportation	6	15	4	20	0	0	4	20	14	14
	d. Others	2	5	2	10	0	0	2	10	6	6

Source: Analysis results, 2020

Analysis of the number of days and travel groups in the community who can use river transportation as a mode of their daily activities with the majority of the number of travel days of 3 - 5 days and the majority of travel groups of 2 - 3 people.

Table 4. Movement time in 1 Week and number of people behavior per Travel Group according to the Purpose of the Trip

No.	The destination of the trip	Number of trips	Number of days			Travel Group		
			1-2 day	3-5 day	Every day	1 person	2-3 person	> 3 person
1	Work	62	7	45	10	25	26	11
2	School / college	16	0	16	0	6	7	3
3	Shop	18	15	3	0	8	10	0
4	Others	4	2	0	2	2	2	0

Source: Analysis results, 2020

River Functions and Physical Conditions

River transportation shipping lanes require analysis of watershed characteristics and conditions obtained by direct observation at the study site and comparative analysis related to standards and literature studies [10]. The Tondano River is a river with water flowing from the water gate of Lake Tondano to the Manado Sea, the length of which is ± 39.9 km and the length of the river starting from the Kairagi bridge to the Manado port is ± 7.2 km. Manado's Tondano watershed functions as a source of water for PDAM (Local water company), hydropower, flood control and drainage. In river-lake management systems, rapid decisions are often required to deal with sudden emergencies of dangerous floods and water pollution [11]. The river has a water level of 0.8m-2m, a river width of 14m75m, a river length of 7.2 km, a rainfall of 544 mm, a wind speed of 2.7-7.8 m/sec. Some of the river borders look beautiful, with embankments and are neatly arranged, but some others look dense with slums and the river has no embankments. According to watershed control rules, the river boundary within the city is 10 m distance from the river bank [12]. River embankments and bank protection are known to reduce sediment input from lateral erosion and strengthen riverbank sediment storage [13].

RiverTransportDevelopmentConcept

For a country with an abundance of rivers like Indonesia, many remote rural areas rely on river transportation as the only accessible option. Meanwhile, river transportation in Indonesia is relatively neglected where the number of riverboats and rivers that can be navigated continues to decline, the share of river transportation modes is very small, and river channels are not always navigable [14]. Water transport in river channels tends to develop relative equilibrium in forming relatively stable channels [15].

In the past, several attempts to model river transportation have been made. These models include attributes such as vessel draft, height and length restrictions, thresholds for efficient utilization of various river-sea technologies, restrictions on navigation in rivers, and the possibility of avoiding transshipment[16].

Currently several ships and boats have been used in the Tondano watershed, but management is carried out personally for services, crossings and tours to the islands around Manado. Analysis of river transport types based on river conditions with the lowest water level of 0.8 m and the characteristics of passengers with movement behavior of ± 10 people, it is possible to plan the types of river transportation for 15 passengers as shown in Figure 3.

Figure 3. Ship with a capacity of 15 passengers

The table 5 describes an example of a description of the recommended passenger ship for transportation on the TondanoRiver.

Table 5. Dimensions of Passenger Ship

No.	Explanation	Total	Unit
1	Long	10	Meter
2	Wide	2,6	Meter
3	Ability Limit Requirements	0,45	Meter

4	Passenger capacity	15	Person
5	Power	115 x 2	Hp
6	High	1,2	Meter

Source: PT. Fiberboat Indonesia

With the development of watershed functions for public transportation, riverbanks can be planned as tourist destinations, by providing a variety of culinary tours, activities of local socio-cultural characteristics, unique local confectionary businesses to attract domestic and foreign tourists. Different governance models will certainly have different impacts on the development of inland waterway networks and the economy of shipping on rivers [17].

Providing a wharf and parking lot is also needed to facilitate the shift in modes of transportation. Jetty is a building structure built on the sea to connect the land and the pier which functions as a place to dock or anchor ships/boats for passenger boarding and disembarkation activities, as well as for loading and unloading activities [18]. This pier was built to make it easier for passengers to get on and off the ship/boat. The location/space around the dock can be used as a place for the ship to dock. The location of the pier is determined based on strategic space for passengers [19], namely the Kairagibridge, densely populated areas, locations near tourist attractions and ports.

Vehicle parking can make it easier for passengers to move between modes of transportation. Therefore the parking location is planned as close as possible to the destination of the trip, which is 300m-400m walking distance which meets the standards of the local population and is still considered close [20].

A comfortable and safe, neatly arranged parking area must be built for shifting modes of transportation, access to and from vehicles taking into account the situation of the area's function and the classification of its road network, so as not to cause traffic jams. Considering the location of vehicle parking is planned around the wharf to facilitate the change of transportation modes.

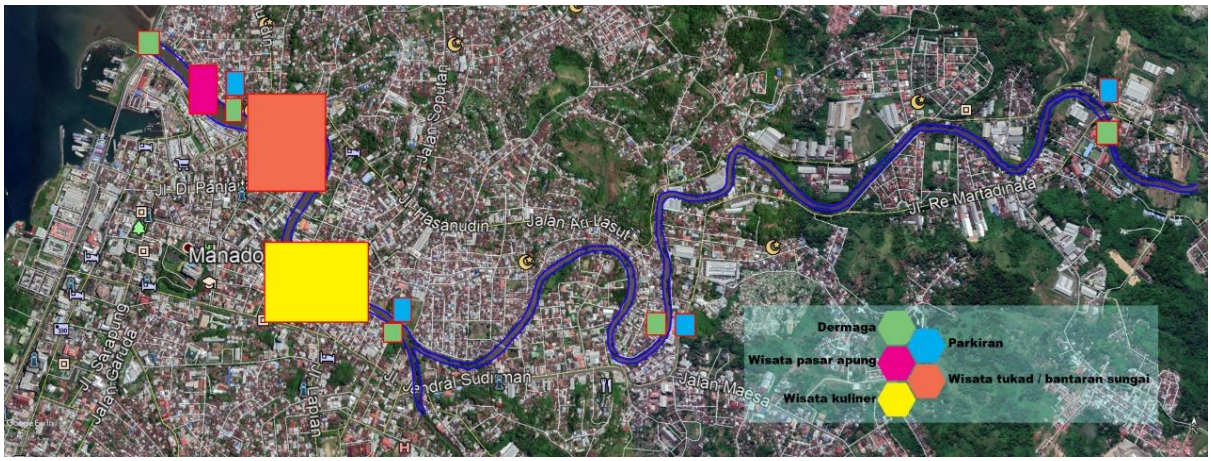

Figure 4. Drawing of the Tondano River Development Plan

IV. Conclusion

The majority of land use activities in the supermarket area have the potential (93%) to generate and attract traffic. The use of private vehicles is still quite high, public transportation is less comfortable to use. Community activities around the Tondano River, which is in the middle of the city of Manado, are a need for river transportation development. The physical condition of the river can have multiple functions, namely, apart from water sources and flood control and drainage, it also has the potential to be developed as an alternative urban transportation solution for river mode transportation.

The concept of developing river transportation for public transportation and tourism can make it easier for people to carry out daily activities such as work, school, trade, shopping, and others, especially activities along the river. In addition, the riverbank area can be used as a tourist attraction in supporting the economy of the city of Manado. The recommended type of river transportation is the use of passenger and cargo riverboats as well as the development of docks and parking lots for changing modes of transportation.

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