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Submission date: 05-Jul-2023 03:10AM (UTC-0400)
Submission ID: 2126708364
File name: 2023.4.3_Study_of_Paratransit_Transport_Tragel_Model_as....pdf (337.99K)
Word count: 4630
Character count: 22481

Journal of Mechanical, Civil and Industrial Engineering
ISSN: 2710-1436
DOI: 10.32996/jmcie
Journal Homepage: www.al-kindipublisher.com/index.php/jmcie

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| RESEARCH ARTICLE

Study of Paratransit Transport Tragel Model as a Feeder in Tamalanrea District, Makassar City

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ABSTRACT

Transportation has an important role in people's lives, where the rate of population growth is getting higher, which results in an increase in people's need for transportation. This can increase the use of public transport transportation; this problem is closely related to the traffic flow network, especially in the city of Makassar in the Tamalanrea sub-district. The application of the feeder transport line in the city of Makassar is one form of solution to the problems that occur in the city of Makassar, namely the traffic flow network. Based on the results of the planning of the Feeder Transport Route Model, the route that has been researched can be a solution to reduce congestion on the main road, where public transportation types Metromini can be diverted to local routes with planned routes and road types, which can meet the type of public transport Metromini. For public perception, it is more dominant to agree if the feeder system is implemented in Makassar. The purpose of this study was to determine the performance of feeder transport if applied in the city of Makassar. It can be seen from the number of conflicts that have occurred due to the increasing number of public transport vehicles on the main roads of the city of Makassar.

KEYWORDS

Route Models, Feeder Transport, Metromini Public Transportation, Travel Time, Headway, Load Factor

ARTICLE INFORMATION

ACCEPTED: 23 June 2023 **PUBLISHED:** 04 July 2023 **DOI:** 10.32996/jmcie.2023.4.3.2

1. Introduction

Transportation has an important role in people's lives, where the rate of population growth is getting higher, which results in an increase in people's need for transportation (Ayu, D.N.S. and Armaeni, N.K., 2016) (Department of Public Works Director General of Highways, 1997). This can increase the use of public transport transportation is higher; this problem is closely related to the traffic flow network, especially in the city of Makassar in the Tamalanrea sub-district. The application of the feeder transport line in the city of Makassar is one form of solution to the problems that occur in the city of Makassar, namely the traffic flow network [Hukmia, n.d]. This can provide optimum service to traffic flow which can reduce congestion due to the large number of public transportation on the main road of Makassar city.

According to Harvey and Clark (1971), urban sprawl refers to the continuous expansion around large cities, where there is always a zone of land that is in the process of being converted from rural land to urban land use or non-built-up land to built-up. The development of the outskirts of Makassar City is followed by the development of trade, commercial and infrastructure activities to support community activities [Harvey, 1971].

According to the Central Statistics Agency (BPS, 2020), population growth in the Tamalanrea sub-district, Makassar City, South Sulawesi province with a population of ±142,000 people with a density of 534,460 people/km2 [Civil, 2017]. In planning feeder transport routes, especially for public transportation types of public transportation. the number of angkot (Metromini) in Makassar reaches 2,500 units (Dishub Makassar, 2021) [Directorate General of Land Transportation,, 2022],[Erlangga, 2022]. Various human

activities cause them to be interconnected. For this, a connector is needed. One of them and the oldest is transportation (Tamin, 2000).

According to Kalsum, transportation networks cause a displacement that can trigger various relationships that require traveling and ultimately create traffic flows [Kalsum, 2017]. According to Morlok, a collection of related components is called a system. The system will not work optimally if one component does not operate properly [Rahma, 2014]. Based on the Law of the Republic of Indonesia No. 22 of 2009 concerning Road Traffic and Transportation, which was promulgated after Law No. 38 defines, roads are all parts of the road, including complementary buildings and equipment intended for public traffic, which are on the ground level, above ground level, in below the ground and water surface as well as above the water surface except for rail and cable roads [Sugiyono, 2016],[Suraharta, 2020].

Public transportation is passenger transportation which is carried out with a rental or payment system. Included in the definition of passenger public transportation are city transportation (buses, minibuses, etc), trains, water transportation and air transportation [Hukmia,n.d]. According to Suwardi (2010) in Gea and Harianto (2011), road performance is the ability of roads to serve the needs of traffic flows according to their functions which can be measured and compared with road service level standards [Tahir, 2024].

The purpose of this study was to determine the performance of feeder transport if applied in the city of Makassar. It can be seen from the number of conflicts that occur due to the increasing number of public transportation on the main road in Makassar. With these problems, it is necessary to study the planning of feeder transport routes for public transportation in the city of Makassar, especially in the Tamalanrea sub-district, in order to find out whether this planning condition can match the characteristics of the existing road capacity and can overcome the problems that occur in the city of Makassar.

2. Literature Review

2.1 Feeder Transport

The Ministry of Transportation of the Republic of Indonesia (2012) defines a feeder as a public transport service that uses vehicles with a smaller capacity for areas with lower density[Ministry of Transportation, 2012]. Feeder transport usually refers to a particular mode of transport that serves as a link between a larger transport network and a smaller, more localized area. These are typically used to transport goods or passengers from suburban or less accessible locations to major transportation hubs, such as seaports, airports, or major train stations. The goal of feeder transport is to improve connectivity and enable efficient movement of cargo or people between different modes of transport.

2.2 Public transportation

Public Transportation is passenger transportation carried out by means of a rent or payment system. Included in the definition of public passenger transportation are city transportation (buses, minibuses, etc.), trains, water transportation and air transportation (Rahma et al., 2014) [Morlok, 1978]. Public transportation functions in the form of efforts to meet the need for safe, secure, comfortable and affordable transportation.

2,3 Routes

Public transport routes/routes are defined as places where public transport regularly serves passengers by raising and lowering them (Ministry of Transportation, 1996). Public transport routes/routes are usually placed at locations where it is estimated that there will be potential passengers. Vehicle routes refer to the paths or journeys taken by vehicles from one location to another. This involves selecting the path, the distance traveled, and the sequence of points to be visited during the journey. Choosing the right route is very important to reach your destination with maximum efficiency, such as saving time, fuel and vehicle operating costs.

2.4 Paratransit

Paratransit is a transportation system designed to meet the needs of individuals with limited mobility or special needs. Paratransit is very responsive to consumer needs (demand responsive), which is able to fill the void in formal transportation so that it continues to grow. Paratransit is a flexible alternative mode for passengers and does not follow fixed routes and schedules. According to Tahir (2012), a paratransit is a vehicle that is operated with no definite schedule and route and can stop (pick up and drop off passengers) along its route [Tamin, 2000].

2.5 Road Performance

According to Suwardi (2010) in Gea and Harianto (2011), the performance of road sections is the ability of road segments to serve the needs of traffic flow according to their function, which can be measured and compared with road service level standards[Tahir, 2012]. The road service level value is used as a road segment performance parameter.

3. Methodology

3.1 Research Time

This research begins with conducting a preliminary survey first. To obtain survey data on a predetermined route, this research was carried out on 23 – 29 July 2022. Data collection was carried out for 1 week, namely during peak hours (*peak hours)* Monday to Friday during *weekday* and *peak hours*) on Saturday to Sunday during the *weekend*. Surveys were conducted in the morning (07.30 to 09.30), afternoon (12.30 to 14.00), and afternoon (16.30 to 18.00).

3.2 The Research Locations

Research limits the points or locations to be studied and located in. The research area is in the Makassar city area, which is on the Tamalanrea sub-district road, namely, Jl. Pioneer of Independence 1 (next to UD. Sumber Karya) – Jl. Pioneer of Independence VII - Jl. Door II Unhas (Wahidin Hospital) – Jl. Tamalanrea raya (Earth Tamalanrea Permata) – Jl. Nusa Tamalanrea Indah (NTI).

3.3 Data Collection Methods

The evaluation of this study consists of the following data:

1. Primary Data, namely data obtained when conducting a survey when research will be conducted in the field. This data includes:
    a. Road geometric conditions, road type, traffic volume, and capacity [Ministry of Transportation, 1996].
    b. Speed, travel time (*travel time),* waiting time, time between vehicles (*headway).*
    c. Mileage
    d. Load factor is the ratio between the number of passengers who are in public transport with the loading capacity of public transport.
2. Secondary Data and supporting data taken in this study are:
    a. Population data were obtained from relevant agencies and regulatory books that apply in Indonesia, which is the reference in conducting this research, namely the Indonesian Road Capacity Manual (MKJI 1997).
    b. Number of community respondents to find out people who want to switch to using public transportation Metromini. [Rahma, 2014].

3.4 The Research Implementation

Results of the implementation of this research include background, preparation, data collection and analysis of traffic movements on predetermined roads [Morlok, 1978]. Therefore, the researchers conducted a study of the background related to the problems that occurred in the Tamalanrea sub-district of Makassar City, in addition to conducting a literature review related to the research to be carried out, then conducting a field survey to determine the performance condition of the existing road segment, the research location was also to determine the location of the equipment placement.

4. Results and Discussion

4.1 Route Plan for Feeder Transport

This research was conducted in several road sections that are planned to be passed by feeder transportation [Harvey, 1971], where the selected route is only classified for local routes in the Tamalanrea sub-district, while the selected routes are:

Route 1: Jl. Perintis Kemerdekaan 1 – Jl. Perintis Kemerdekaan 3 – Jl. Perintis Kemerdekaan VII
Route 2: Jl. Pintu 1 Unhas – Jl. Pintu II Unhas
Route 3: Jl. Tamalanrea Raya (BTP)
Route 4: Jl. Nusa Tamalanrea Indah (NTI)

Table 1. Data on Alternative Route Selection Criteria for the Tamalanrea Sub-district (KPA)

No	Name of Route	Criteria	
		Length (m)	Number of Intersection
1	Jl. Tamalanrea Raya (BTP)	4379	13
2	Jl. Pintu I Unhas - Jl. Pintu II Unhas	4547	14
3	Jl. Nusa Tamalanrea Indah (NTI)	2267	17
4	Jl. Perintis Kemerdekaan 1 - Jl. Perintis Kemerdekaan VII	3351	18

1). Route 1: Jl. Perintis Kemerdekaan 1 – Jl. Perintis Kemerdekaan 3 – Jl. Perintis Kemerdekaan VII
Based on the planned Route / Route Jl; Pioneers of Independence 1 to Jl. Pioneers of Independence VII, where the plan for this route was obtained with a line length of 3351 m with jl. Pioneer of Independence VII as a starting point with a point value of 5°08'29.1"S 119°29'014"E and jl. Pioneer Independence 1 as the end point of the route with the Coordinate Point Value of 5°08'34.0"S 119°28'35.4"E, which is where 18 intersections are marked with red dots in the picture above. Jl. Pioneers of Independence 1 to Jl. Pioneer of Independence VII is the village of Tamalanrea Indah, with a population of 18,176 people. On this route, there is no public transportation (Metromini). There is only a motorcycle taxi base [9][20].

2). Route 2: Jl. Tamalanrea Raya (BTP)
Based on the planned route/route Jl. Door 1 Unhas to Jl. Gate II Unhas, where the route plan is obtained with a length of 4547 m with Jl. Door 1 as the starting point with a point value of 5°08'26.4"S 119°29'20.6"E and Jl. Door II Unhas as the end point of the route with a Coordinate Point Value of 5°08'08.3"S 119°29'46.2"E, where there are 14 intersections marked with red dots in the picture above; this route is an existing route that currently exists for classification of local routes in the Tamalanrea sub-district. Jl. Door 1 Unhas to Jl. Pintu II Unhas is the village of Tamalanrea Indah, with a population of 18,176 people.

3). Route 3: Jl. Tamalanrea Raya (BTP)
Based on the planned Route / Route Jl. Tamalanrea Raya (BTP), where the route plan is obtained with a line length of 4379 m with the BTP Gate as the starting point with a Coordinate Point Value of 5°07'54.3"S 119°29'54.0" E and the BTP Roundabout as the end point of the route with a Point Value, The coordinates are 5°08'15.4"S 119°30'57.6"E where there are 13 intersections marked with red dots in the image above. This route is an existing route that currently exists for the classification of local routes in the Tamalanrea District area. Jl. Tamalanrea Raya (BTP) is a Tamalanrea village with a population of 24,805 people.

4). Route 4: Jl. Nusa Tamalanrea Indah (NTI).
Based on the planned Route / Route Jl. Nusa Tamalanrea Indah (NTI), where this route plan obtained a line length of 2267 m with the NTI Gate as the starting point with a Coordinate Point Value of 5°07'38.5"S 119°30'05.2"E and back again to the NTI Gate as a point the end of the route with a Coordinate Point Value of 5°07'38.5"S 119°30'05.2"E where there are 17 intersections marked with red dots in the picture above. Jl. Nusa Tamalanrea Indah (NTI) is a Kapasa village with a population of 19,328 people. On this route, there is no public transportation (Metromini); there is only an ojek base.

4.2 Determining travel time (travel time), time between vehicles (headway), and load factor (load factor) Feeder Transport
1) Travel Time
Travel time data is obtained from research data processing obtained from existing routes that already exist today [25], namely segment Jl. Tamalanrea Raya (BTP) and Jl. Door 1 Unhas to Jl. Door II Unhas, as in Tables 2 and 3.

$$\text{Travel Time (CT)} = \frac{\text{Route length (L)}}{\text{Speed (V)}} \quad \text{.....(1)}$$

Table 2. Data of Metromini Travel Time

Route Jl. Tamalanrea Raya (BTP)				
Day	Time	Route Length (km)	Speed (km/hour)	Travel Time (hours)
Saturday/ 23 July 2022	07.30 - 09.30	4.3	31.92	0.13
	12.30 - 14.00	4.3	21.27	0.20
	16.30 - 18.00	4.3	34.12	0.13
Sunday/ 24 July 2022	07.30 - 09.30	4.3	28.31	0.15
	12.30 - 14.00	4.3	30.76	0.14
	16.30 - 18.00	4.3	25.66	0.17
Monday/ 25 July 2022	07.30 - 09.30	4.3	39.01	0.11
	12.30 - 14.00	4.3	22.65	0.19
	16.30 - 18.00	4.3	26.78	0.16
Tuesday/ 26 July 2022	07.30 - 09.30	4.3	29.43	0.15
	12.30 - 14.00	4.3	21.66	0.20
	16.30 - 18.00	4.3	20.43	0.21
Wednesday/ 27 July 2022	07.30 - 09.30	4.3	26.87	0.16
	12.30 - 14.00	4.3	24.67	0.17
	16.30 - 18.00	4.3	20.43	0.21
Thursday/ 28 July 2022	07.30 - 09.30	4.3	30.41	0.14
	12.30 - 14.00	4.3	23.55	0.18
	16.30 - 18.00	4.3	25.43	0.17
Friday/ 29 July 2022	07.30 - 09.30	4.3	27.69	0.16
	12.30 - 14.00	4.3	22.54	0.19
	16.30 - 18.00	4.3	20.56	0.21
Nilai Rata - Rata				0.17

Table 3. Data Travel Time Metromini

Route Jl. Pintu 1 Unhas - Jl. Pintu II Unhas				
Day	Time	Route Length (km)	Speed (km/hour)	Travel Time (hours)
Saturday/ 23 July 2022	07.30 - 09.30	4.5	27.05	0.17
	12.30 - 14.00	4.5	25.11	0.18
	16.30 - 18.00	4.5	20.43	0.22
Sunday/ 24 July 2022	07.30 - 09.30	4.5	28.04	0.16
	12.30 - 14.00	4.5	25.77	0.17
	16.30 - 18.00	4.5	24.65	0.18
Monday/ 25 July 2022	07.30 - 09.30	4.5	35.87	0.13
	12.30 - 14.00	4.5	27.86	0.16
	16.30 - 18.00	4.5	23.76	0.19
Tuesday/ 26 July 2022	07.30 - 09.30	4.5	30.31	0.15
	12.30 - 14.00	4.5	22.56	0.20
	16.30 - 18.00	4.5	25.87	0.17
Wednesday/ 27 July 2022	07.30 - 09.30	4.5	29.07	0.15
	12.30 - 14.00	4.5	25.12	0.18
	16.30 - 18.00	4.5	24.77	0.18
Thursday/ 28 July 2022	07.30 - 09.30	4.5	37.31	0.12
	12.30 - 14.00	4.5	28.42	0.16
	16.30 - 18.00	4.5	24.77	0.18
Friday/ 29 July 2022	07.30 - 09.30	4.5	32.08	0.14
	12.30 - 14.00	4.5	29.55	0.15
	16.30 - 18.00	4.5	27.54	0.16
Nilai Rata - Rata				0.17

Based on tables 2 and tables 3, the average value of metromini travel time data from the current existing route, namely the Jl. Tamalanrea Raya (BTP) and Jl. Door 1 Unhas - Jl. Gate II Unhas, which is 0.17 hours.

2) Time between vehicles (headway)

Time data between vehicles (*headway)* is obtained from research data processing, yes ng obtained from the existing routes that already exist today [14], namely the Jl. Tamalanrea Raya (BTP) and Jl. Pintu 1 Unhas - Jl. Pintu II Unhas, as in table 4.

$$\text{Headway (h)} = \frac{60}{\text{Number of vehicles (Q/jam)}} \quad \text{.....(2)}$$

Table 4. Time data between vehicles (*headway)*

Route Jl. Tamalanrea Raya (BTP)			
Day	Time	Q/Hour	Headway
Saturday/ 23 July 2022	60	5	12
Sunday/ 24 July 2022	60	3	20
Monday/ 25 July 2022	60	4	15
Tuesday/ 26 July 2022	60	6	10
Wednesday/ 27 July 2022	60	6	10
Thursday/ 28 July 2022	60	6	10
Friday/ 29 July 2022	60	6	10
Route Jl. Pintu 1 Unhas - Jl. Pintu II Unhas			
Day	Time	Q/Hour	Headway
Saturday/ 23 July 2022	60	3	20
Sunday/ 24 July 2022	60	4	15
Monday/ 25 July 2022	60	6	10
Tuesday/ 26 July 2022	60	7	9
Wednesday/ 27 July 2022	60	5	12
Thursday/ 28 July 2022	60	5	12
Friday/ 29 July 2022	60	6	10

Based on the results of the time between vehicles (headway) in Table 4, the largest headway value is obtained on Jl. Tamalanrea Raya (BTP), which is 20 minutes on Sunday/24 July 2022 and the lowest is 10 minutes on Tuesday/26 July 2022, to Friday/29 July 2022. Meanwhile, the largest headway value is on Jl. Door 1 Unhas to Jl. Pintu II Unhas is 20 minutes on Saturday/23 July 2022, and the lowest is 9 minutes on Tuesday/26 July 2022.

3) Load factor

Transportation plan *feeder*, the type of feeder transportation vehicle that is examined is Metromini, with a capacity of 10 passengers, as in Table 5.

Table 5. Data Load factor

Route Jl. Pintu 1 Unhas - Jl. Pintu II Unhas			
Day	Demand (max)	Line Capacity (C)	Load Factor (LF)
Saturday/ 23 Juli 2022	28	30	0.9
Sunday/ 24 Juli 2022	36	40	0.9
Monday/ 25 Juli 2022	59	60	1.0
Tuesday/ 26 Juli 2022	72	70	1.0
Wednesday/ 27 Juli 2022	46	50	0.9
Thursday/ 28 Juli 2022	52	50	1.0
Friday/ 29 Juli 2022	61	60	1.0
Route Jl. Tamalanrea Raya (BTP)			
Saturday/ 23 Juli 2022	49	50	1.0
Sunday/ 24 Juli 2022	30	30	1.0
Monday/ 25 Juli 2022	37	40	0.9
Tuesday/ 26 Juli 2022	56	60	0.9
Wednesday/ 27 Juli 2022	62	60	1.0
Thursday/ 28 Juli 2022	61	60	1.0
Friday/ 29 Juli 2022	56	60	0.9
Saturday/ 23 Juli 2022	49	50	1.0

Based on the results of the analysis in Table 5 in the Jl. Door 1 Unhas to Jl. Door II UnhAs then the load factor (*load factor)* is the result <1 Ok.

4.3 Questionnaire Survey Data

To obtain *demand*, questionnaires were first distributed to obtain the number of car and motorcycle drivers who are willing to move using Feeder *Transport* [6]. The number of questionnaire respondents is a sampling using the Slovin formula with the Error Level value (Error level) is 10%. The number of questionnaires distributed is 100 with the following [12] calculation:

$$\text{Number of samples } (n) = \frac{\text{Total Population } (N)}{1+(\text{Total Population}(N)\ x\ \text{Error level } (\varepsilon)^2)} \quad \text{.....(3)}$$

$$n = \frac{N}{1 + (N\ x\ \varepsilon^2)}$$

$$n = \frac{142.000}{1 + (142.000)\ x\ (0.1^2)}$$

$$n = \frac{142.000}{1421}$$

$$n = 100 \text{ Respondents}$$

Table 6. The Proportion of Respondents' Data

Activities	Total (people)	Percent
Work	31	31%
Lecture	37	37%
Spending	10	10%
Schools	22	22%
Total	100	100%

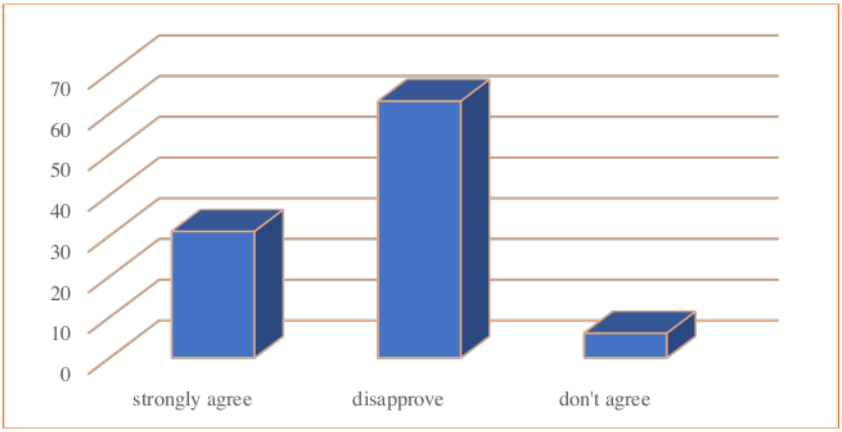

Figure 1. A diagram of the feeder transport system is applied in Makassar City

Based on the results of the questionnaire distribution, it was found that from 100 questionnaire respondents there were 31 (31%) respondents strongly agreed, 63 (63%) respondents Disagreed, and 6 (6%) respondents did not agree if the *feeder* implemented in Makassar City.

5. Conclusion

Based on the results of the analysis and discussion of the data, it was concluded that the average value of Metromini travel time data from existing routes is currently 0.17 hours. While the time data between vehicles (headway) is obtained starting from 9 minutes to 20 minutes. Then the results of the analysis of the load factor (load factor) is < 1 Ok.

The route that has been researched can be one solution to reduce congestion on the main road, where public transportation types Metromini can be diverted to local routes with routes that have been planned and types of roads that can meet the type of public transportation Metromini.

People need to reduce using private vehicles at certain hours and should switch to using public transportation that already exists in Makassar in order to reduce the congestion in the Makassar city area.

We recommend that the relevant agencies can add or improve supporting facilities for public transportation. For example, repairing existing bus stops and also increasing the level of comfort for public transport users.

Funding: This research received no external funding.
Conflicts of Interest: The authors declare no conflict of interest.

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