International Journal of GEOMATE, Dec., 2017, Vol. 13, Issue 40, pp. 112-117
Special Issue on Science, Engineering & Environment, ISSN: 2186-2990, Japan
DOI: https://doi.org/10.21660/2017.40.86678

ANALYSIS OF TRAFFIC CHARACTERISTICS AND GOODS TRANSPORT IN MANADO, INDONESIA

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ABSTRACT: The economic growth of a region is strongly influenced by the smooth flow of traffic. The movement of freight by highway in Manado leads to the problem of traffic jams. To solve the congestion, it is necessary to know the traffic characteristics and the pattern of the origin of the destination. Through a curbside survey in which the respondents were freight drivers, the origin - destination matrix (OD matrix) was created. The traffic characteristics and the pattern of origin of the goods transport were analyzed. The results of the research showed that the total movement was dominated by entrance to exit of Manado from Kairagi to Tuminting with the movement of freight vehicles amounting to 27.03% of the total movement of goods transport in the study area. It was concluded that the users should operate at night for reduce a congestion and that a goods-holding zone should be established.

Keywords: Traffic characteristics, Destination patterns and roadside survey

1. INTRODUCTION

The economic growth of a region is strongly influenced by how the distribution system of goods and services is provided and operated [1]. The movement of freight transport in Manado city by using the highway mode causes the problem of traffic congestion. The main cause of congestion is the mixing of all types of vehicles, transporting both goods and people, by arterial, collector, and local roads, so the road network is not functioning efficiently. Truck are important vehicle type for transporting of goods [2].

Awi [3] shows in general the way of freight is large, and the increasing flow of goods transport traffic will have a direct impact on the ability of the service on the street. Accessibility (or just access) refers to the ease of reaching goods, services, activities and destinations, which together are called opportunities. It can be defined as the potential for interaction and exchange [4]. The existence of the large-freight mode usually causes disruption to other transportation modes, thus increasing the saturation of traffic flow on road segments that become freight routes. The large number of freight vehicles requires the support of a road infrastructure with a large capacity. To reduce the impact of traffic flow saturation, the system or operational pattern of goods transport must be well planned so that the goods distribution runs smoothly. Increased traffic jam saturation will lead to congestion, which will raise the price of goods [5]. In his editorial in the Manado Tribune concerning the congestion in Manado [6] stated "congestion has indeed been getting worse lately. New congestion points increase from day to day. Some of the most disturbing traffic jam points are on Sam Ratulangi Street, Pierre Tendean, Hasanuddin Street and now Ahmad Yani Street, precisely in Sario village". Manado can be regarded as a destination city as well as a transit city, so continuous traffic passes through the entrance - exit in Manado. Access to entrance - exit in Manado there are five, which are in Kairagi (A. A. Maramis Street), Teling (Tololiu Supit Street), Winangun (Sam Ratulangi 2 Street), Malalayang (Wolter Monginsidi Street), and Tuminting (Molas-Tongkaina Street). Of the five routes will get a more optimal path, one of the efficiencies that can be done through efficiency on the operational side [7].

The limitations of the scope of the study are as follows: 1) The research location is in Manado; 2) A traffic volume survey consisting of roadside interviews (RSIs) regarding the origin and destination of the movement of goods transported was carried out at five access points going in and out of Manado; 3) The type of land transportation model observed is the goods transport vehicle; the type of vehicle and the type of cargo load were not distinguished.

The purposes of this study are as follows: 1) to find out the characteristics of traffic and the pattern of origin of the current freight destination in Manado; 2) to provide recommendations for handling and strategies related to the operational patterns of freight forwarding in the future.

2. METHODOLOGY

This study was conducted in Manado. Primary data such as Average Daily Traffic Volume (ADT)

data, represented by volume, speed, and density, are required to assess the characteristics of the traffic flow. The survey was conducted at five access points where traffic enters and leaves Manado City. The survey was carried out at each survey point for three days that is Monday, Wednesday, and Thursday, and observations were made for 16 hours from 06.00 a.m. until 10.00 p.m. In the ADT survey, tools that support the process of surveying, such as video cameras as a tool for recording vehicle traffic data, were also required.

Data of Origin Matrix. The objective of the survey at five access points for entrance to and exit from Manado City was achieved by using the interview method with the respondents being the goods transporters. Sampling was based on the purposive sampling method, where the sampling process is based on the considerations of the researcher. Samples for the analysis of the origin–destination matrix (ODM) are goods vehicles passing in and out at the five entry/exit points of Manado City. The spread of travel in the origin–destination survey will determine where the trips generated by each zone will go to and volume of traffic flow between zones within the study area [8]. The output of this procedure is a set of tables showing the travel flow between each pair of origin–destination zones, referred to as the ODM. Inter-zone travel needs can also be inputted into a map of the area that clearly shows the trip desire line between the zones. Willumsen [9] shows the pattern of movement of people and goods covered in the ODM and the desire line map can be used for modeling the travel needs.

3. RESULTS AND DISCUSSION

3.1 Survey of Traffic Flow

The traffic flow survey data obtained were then analyzed and a graph of the fluctuation of traffic volume with observation times was generated (Figure 1). Changes in travel time can be calculated from volume-delay relationships that are embedded in the traffic assigment element of tranport planning models [10]. From the analysis it was found that the peak hour occurred at Kairagi gate on Monday at 08.00 – 09.00 p.m. With as many as 3442.50 pcu/hour, pcu is short for passenger car unit.

Table 1 Volume of traffic flow at peak hours at all entrance and exit access points and in Manado

Gate	Days	Time	Direction of Enterance (pcu/hour)	Direction of Out going (pcu/hour)	Interflow (pcu/hour)
Kairagi	Monday	08.00 AM – 09.00 AM	1964.90	1477.60	3442.50
	Wednesday	01.00 PM – 02.00 PM	1878.25	1440.30	3318.55
	Thursday	05.00 PM – 06.00 PM	1247.20	1656.65	2903.85
Teling	Monday	07.00 AM – 08.00 AM	374.45	293.90	668.35
	Wednesday	05.00 PM – 06.00 PM	249.75	378.80	628.55
	Thursday	03.00 PM – 04.00 PM	226.00	361.55	587.55
Winangun	Monday	02.00 PM – 03.00 PM	905.95	771.30	1677.25
	Wednesday	10.00 AM – 11.00 AM	775.90	838.90	1614.80
	Thursday	03.00 PM – 04.00 PM	889.85	759.60	1649.45
Malalayang	Monday	02.00 PM – 03.00 PM	635.80	744.40	1380.20
	Wednesday	02.00 PM – 03.00 PM	672.80	650.40	1323.20
	Thursday	01.00 PM – 02.00 PM	598.80	606.10	1204.90
Tuminting	Monday	09.00 AM – 10.00 AM	682.10	824.80	1506.90
	Wednesday	04.00 PM – 05.00 PM	674.15	703.55	1377.70
	Thursday	08.00 AM – 09.00 AM	660.25	594.35	1254.60

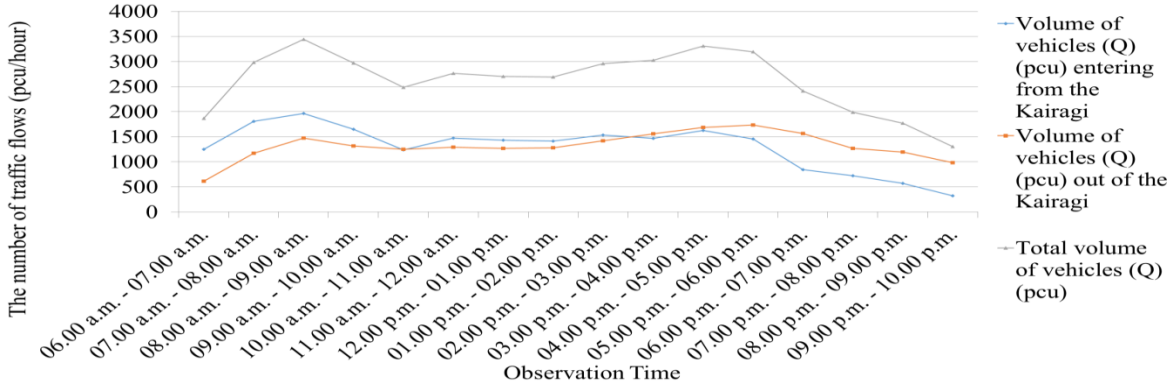

Fig. 1 Graph of fluctuation of traffic volume at the entrance/exit at kairagi in Manado, on Monday

The Average Daily Traffic Volume (ADT) survey also analyzed the fluctuation of traffic volume in the incoming and outgoing directions for Manado City, especially for goods transport vehicles during the most dense period and the composition of goods transport the number of vehicles (pcu/day). A summary of the survey results can be seen in Table 2 below.

Table 2 ADT volume and composition of goods transport of vehicle (pcu/day)

Gate	Days (Time from 06.00 a.m until 22.00 p.m.)	Total Vehicle					Total Vehicles for Goods Transport					Composition of total Vehicles (%)
		Ingoing Direction (pcu/hour)	Outgoing Direction (pcu/hour)	Direction of Entrance (%)	Direction of Out Going (%)	Interflow (pcu/hour)	Ingoing Direction (pcu/hour)	Outgoing Direction (pcu/hour)	Direction of Entrance (%)	Direction of Out Going (%)	Interflow (pcu/hour)	
Kairagi	Monday	20787	21099	50	50	41886	295	301	49.5	50.5	596	1.42
	Wednesday	19918	21498	48	52	41416	532	384	58.08	41.92	916	2.21
	Thursday	20346	20352	50	50	40698	792	709	52.76	47.24	1,501	3.69
Teling	Monday	3448	3895	47	53	7342	62	84	42.47	57.53	146	1.99
	Wednesday	3317	3843	46	54	7161	61	72	45.86	54.14	133	1.86
	Thursday	3131	3410	48	52	6541	46	62	42.59	57.41	108	1.65
Winangun	Monday	11246	10874	51	49	22120	374	304	55.16	44.84	678	3.07
	Wednesday	9219	10474	47	53	19692	332	305	52.12	47.88	637	3.24
	Thursday	10579	10743	50	50	21322	407	390	51.07	48.93	797	3.74
Malalayang	Monday	8542	9010	49	51	17552	212	510	29.36	70.64	722	4.12
	Wednesday	8674	8502	51	49	17176	215	328	39.59	60.41	542	3.16
	Thursday	8327	8355	50	50	16683	354	326	52.06	47.94	680	4.08
Tuminting	Monday	7902	8506	48	52	16408	448	503	47.11	52.89	950	5.79
	Wednesday	7028	5907	54	46	12935	173	289	37.45	62.55	462	3.57
	Thursday	8195	7062	54	46	15256	422	469	47.36	52.64	892	5.84

Based on the above table, Volume ADT Characteristics of the largest freight occurred in Manado City entrance and exit of Kairagi on Thursday with 1501 pcu/day/2 directions with a total vehicle composition of 3.69%.

3.2 Existing Road Capacity

The existing road capacity is calculated based on the *Indonesia Road Capacity Manual* (Ministry of Public Works, 1997). The road capacity refers to the maximum space available for traffic flow within a certain time based on the road conditions. The existing road capacity for the A. A. Maramis road (access to and exit from Manado City in Kairagi) in 2015 was 0.67 [B] (fixed vehicle density level). Furthermore, for capacity and performance of roads to the entrance and exit to other cities.

Table 3 Capacity and performance of roads providing point of entrance and exit from Manado

Access From and To Manado City	V (pcu)	Co	FCw	FCsp	FCsf	FCcs	C (pcu/hour)	VCR	Level of Services	Traffic Conditions
Kairagi (A. A Maramis Segment Road)	3442.50	1500.00	1.09	1.00	0.87	0.90	5120.82	0.67	B	The current is stable, but the speed and motion of the vehicle are controlled
Teling (Tololiu Supit Segment Road)	668.35	1500.00	0.56	1.00	0.92	0.94	2905.73	0.23	A	The current is stable, but the speed of operation begins to be limited by traffic conditions
Winangun (Sam Ratulangi 2 Segment Roads)	1677.25	1500.00	1.00	1.00	0.92	0.94	5188.80	0.32	A	The current is stable, but the speed of operation begins to be limited by traffic conditions
Malalayang (Wolter Monginsidi Segment Road)	1380.20	1500.00	1.09	1.00	0.87	0.94	5348.41	0.26	A	The current is stable, but the speed of operation begins to be limited by traffic conditions
Tuminting (Molas-Tongkaina Segment Road)	1377.70	1500.00	1.00	1.00	0.87	0.94	4906.80	0.28	A	The current is stable, but the speed of operation begins to be limited by traffic conditions

In Table 3 above, it can be seen that the level of service when accessing entrances to and exits from Manado still has a value of A, where the traffic condition is still in a smooth condition, with low volume and high speed. The traffic service level reaches a value of B only at Kairagi gate (on A. A. Maramis Road), where the traffic flow is stable, the speed is limited, and the volume is still suitable for the road within the city.

3.3 Relations Between Traffic Flow, Speed, and Density

The model of traffic characteristic analysis of variables, speed, and density can be determined by deriving the equations of the model of analysis in the form of linear equations. The model equations are the Greenshields model, the Greenberg model, and the Underwood model. Calculation of the regression analysis of the three analytical models shown in Table 4.

Table 4 Traffic volume and density according to calculation results at Manado, entrance/exit access point in Kairagi

Time Period	Traffic Volume (V) (pcu/hour)			Speed (S)	Density (D)
	Ingoing Direcation From Winangun	Outgoing Direction From Winangun	Total of Both Direction in Wiangun	(Km/hour)	(pcu/hour)
1	2	3	4 = 2+3	5	6 = 4/5
06.00 a.m. - 07.00 a.m.	1251.45	617.20	1868.65	54.59	34.23
07.00 a.m. - 08.00 a.m.	1808.85	1172.45	2981.30	53.14	56.10
08.00 a.m. - 09.00 a.m.	1964.90	1477.60	3442.50	42.10	81.77
09.00 a.m. - 10.00 a.m.	1653.25	1317.40	2970.65	36.91	80.49
10.00 a.m. - 11.00 a.m.	1239.90	1248.70	2488.60	32.21	77.26
11.00 a.m. - 12.00 a.m.	1471.95	1293.50	2765.45	30.66	90.20
12.00 a.m. - 01.00 p.m.	1433.00	1270.85	2703.85	49.23	54.92
01.00 p.m. - 02.00 p.m.	1411.35	1282.35	2693.70	29.72	90.64
02.00 p.m. - 03.00 p.m.	1535.60	1422.90	2958.50	18.46	160.30
03.00 p.m. - 04.00 p.m.	1466.50	1559.40	3025.90	40.03	75.59
04.00 p.m. - 05.00 p.m.	1625.95	1684.05	3310.00	16.27	203.45
05.00 p.m. - 06.00 p.m.	1458.75	1736.40	3195.15	39.05	81.82
06.00 p.m. - 07.00 p.m.	846.30	1565.30	2411.60	40.93	58.92
07.00 p.m. - 08.00 p.m.	722.65	1268.65	1991.30	30.80	64.66
08.00 p.m. - 09.00 p.m.	574.65	1196.50	1771.15	26.88	65.89
09.00 p.m. - 10.00 p.m.	321.70	985.50	1307.20	41.20	31.73

The speed and density data shown in Table 4 will be subjected to regression by the Greenshields, Greenberg, and Underwood model equations. Which have been derived as linear equations. After obtaining the quantity of constant a, the coefficient x = b is then included again into the each equation, so that the value identical to the magnitude of the constant a and the coefficient x of each equation model are obtained. The value is included in the formula of each model, the form of the traffic characteristics formulation for the roads studied will be found. The characteristics of the traffic in the form of relationships between volume (flow), speed (speed), and density (density) are found.

Table 5 Result of regression analysis of traffic and volume density at the entrance to excit of Manado in Kairagi

Characteristic Parameters	MODEL		
	Green Shields (Linear)	Green Berg (Logarithmic)	Underwood (Exponential)
Equations of speed and density correlation	y = 52.813 - 0.201 x	y = -1875ln(x) + 116.91	y = 60.341e-0.007x
Equations of volume and density correlation	y = 52.813 - 0.201 x	y = -1875ln(x) + 116.91	y = 60.341e-0.007x
Equations of volume and speed correlation	y = 262.75 - 4.975 x	y = 510.4027 x.e - 0.053333	y = 585.7136 x-142.857 x ln x
R2	0.6312	0.6364	0.7542
Maximum Volume (pcu/hour/two-direction)	3469.17	3520.63	3171.21
Capacity MKJI97 (pcu/hour/two-direction)		5120.82	

From table above can be seen that the maximum volume range is 3171.21 to 3520.63 pcu/hour/two-way. Origin and destination of the traffic and the time of traffic movement, is result 5120.82 pcu/hour/two way. capacity of the road segment Manado entrance/exit in Kairagi gate is smaller than the result according to MKJI 1997, based on the analysis of traffic characteristics. The adjustment factor of the Underwood model MKJI 1997 is result 3171.21/5120.82 = 0.62, and the adjustment factor of the Greenberg model to the MKJI 1997 calculation is 3520.63/5120.82 = 0.69. The range of capacity adjustment factors for Manado entrance/exit access road in Kairagi is 0.62 – 0.69.

3.4 Origin–Purpose Pattern of Goods Transportation

One way to overcome the problem of traffic flow movement is to analyze the pattern of movement that occurs, for example, the origin and destination of the traffic and the time of traffic movement. The analysis of the movement pattern is written in the form of the ODM, In this study, the traffic system is divided into five zones, which become the start and end points of traffic movement within the study area. Origin–destination matrix for entrance and exit freight zones in Manado is given in Table 6 and the lines of goods transport by freight traffic in Manado is shown in Fig.2.

Table 6 Origin–Destination Matrix for entrance and exit freight zones in Manado

Destination Zone / Origin Zone / Row (%) / Coloumn (%)	Teling Gate	Kairagi Gate	Tuminting Gate	Malalayang Gate	Winangun Gate	Origin Destination Row (%)
Gate Teling	1	79	58	100	43	281
	0.36%	28.11%	20.64%	35.59%	15.30%	100%
	1.19%	26.25%	11.53%	19.61%	14.14%	16.51%
Gate Kairagi	38	1	282	257	88	666
	5.71%	0.15%	42.34%	38.59%	13.21%	100%
	45.24%	0.33%	56.06%	50.39%	28.95%	39.13%
Gate Tuminting	25	178	1	75	93	372
	6.72%	47.85%	0.27%	20.16%	25.00%	100%
	29.76%	59.14%	0.20%	14.71%	30.59%	21.86%
Gate Malalayang	10	14	43	1	79	147
	6.80%	9.52%	29.25%	0.68%	53.74%	100%
	11.90%	4.65%	8.55%	0.20%	25.99%	8.64%
Gate Winangun	10	29	119	77	1	236
	4.24%	12.29%	50.42%	32.63%	0.42%	100%
	11.90%	9.63%	23.66%	15.10%	0.33%	13.87%
dd	84	301	503	510	304	1702
Coloumn (%)	4.94%	17.69%	29.55%	29.96%	17.86%	100.00%

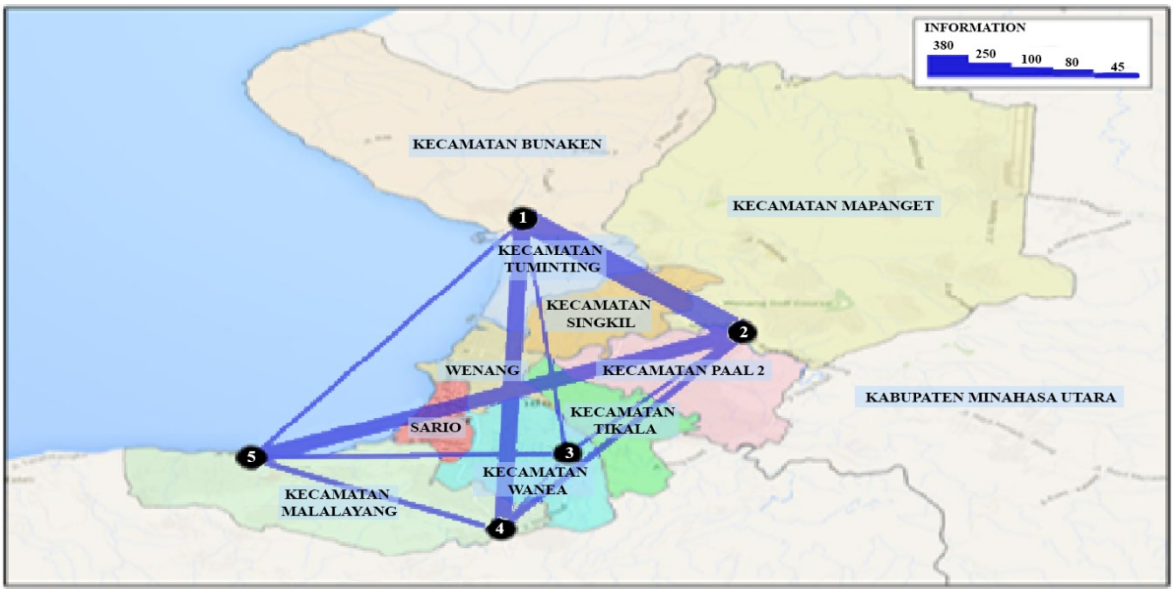

Fig. 2 Lines of goods transport by freight traffic in Manado

The line of freight traffic in Manado in Fig. 2 shows that the movement of freight is dominated by entrance to exit of Manado from Kairagi to Tuminting with the movement of 282 freight vehicles and 178 freight vehicles from access in and out in Tuminting to Kairagi. So the total movement entrance to exit from Kairagi to Tuminting and vice versa amounted to 460 freight movements of goods, which is equal to 27.03% of the total movement of goods transported in the study area. The remaining 72.97% of freight movement took place through the other four entrance/exit points for accessing Manado City.

4. CONCLUSION

From the results, the following conclusions can be drawn:

It was demonstrated that therebwas an increase in the traffic flow attendance on access roads into and out of Manado in Kairagi. The volume of traffic flow was 3442.50 pcu/hour/two-directions. The volume of freight traffic entering and leaving the Manado in Kairagi was 1501 pcu/hour (3.69%) at service level B. The pattern of origin of goods from Kairagi to Tuminting and vice versa was 460 movements of freight vehicles or 27.03% of the total movement of goods transport. It was observed that the peak hour of dominant traffic flow was in the morning. The city government needs to carefully consider the operation of the goods transport in night, that is, between 06:00 pm to 06:00 am. The pattern movement of goods, it was recommended that the city government of Manado should follow the policy of determining the zone of reserved such as storage warehouses. The mode of transportation of goods with large capacity may be distributed into five Manado entry/exit zones to avoid entering in Manado city. These can be transported by freight mode with a smaller capacity for distrinution to/by sellers in both traditional and modern markets.

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