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Component Cost of Fuel Oil of Waste Transportation Cost

Burhamtoro, Achmad Wicaksono, M. Bisri, Soemarno
[1)] *Ph.d Candidate on Environment and Development Studies, Graduate School, University of Brawijaya, Malang, East Java, Indonesia*
[2)] *Department of Civil Engineering, Polytechnic of Malang, Indonesia*
[3)] *Department of Civil Engineering, Faculity of Engineering, University of Brawijaya, Indonesia*
[4)] *Department of Water Resources Engineering, Faculity of Engineering, University of Brawijaya, Indonesia*
[5)] *Laboratory of Remote Sensing, Faculity of Agriculture, University of Brawijaya, Indonesia*

Abstract: - The success of the transportation system can be measured based on four things, namely the efficiency of time, energy and fuel efficiency, environmental impact, and safety. Efficiency of energy and fuel is often stated as part of vehicle operating costs (VOC). So need to know the amount of the percentage of the fuel cost component of vehicle operating costs. The purpose of this study was to determine the percentage of the fuel cost component of the total cost of transportation. Research object is a dump truck or on the SCS transport system that serves the city of Malang. Stages of research begins with getting the data needed to analyze the cost of transporting waste. Furthermore, the analysis performed to determine the percentage of each component of transport costs. Results of the analysis showed that the greatest percentage of the cost of each component of the cost of transporting waste is a component of the fuel, while the smallest percentage of the cost of the mechanical components. For the percentage of fuel costs by 28.90% of the variable cost per kilometer, while the percentage of fuel costs by 27.45% of the total cost of transporting waste on his m^3 each.

Keywords**:** - *Fuel Oil, Vehicle Operating Costs, Costs of transporting waste, percentage, Stationery Container System (SCS)*

I. INTRODUCTION

Calculation of vehicle operating cost (VOC) involves several components, such as fuel, oil, spare parts, tires, mechanic and driver wages. Components are calculated using a specific formula obtained from previous studies. Analysis conducted by descriptive approach, based on quantitative data as a result of calculation of the cost of operating the vehicle. The entire cost of the data collected from the survey activities, will be converted into rupiah per 1000 km mileage (Bina Marga, 1995).

The success of the transportation system can be measured based on four things, namely the efficiency of time, the efficiency of energy and fuel, environmental impact, and safety. The efficiency of energy and fuel are often poured as part of the vehicle operation cost (VOC) (Sugiyanto, 2012). So need to know the amount of the percentage of the fuel cost component of vehicle operating costs.

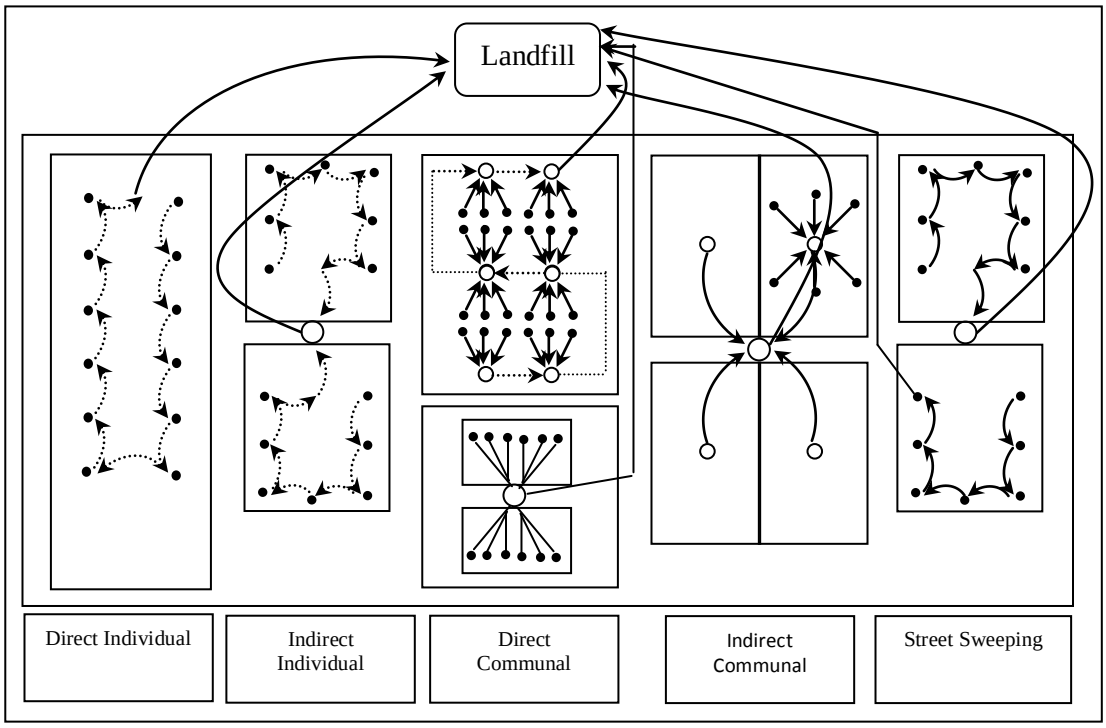
Rise in world oil prices also affected in Indonesia. As a result, vehicle operating costs also increased. But the effect of fuel price increase on vehicle operating costs (VOC) are yet to be in percentage, due to unknown percentage of the cost components of fuel oil to the vehicle operating costs. So that the necessary analysis of the percentage of the cost components of fuel oil to the vehicle operating costs.

Waste transport vehicle operating costs assessed by the volume of waste transported. In the calculation of the transport vehicle operating costs also need to consider the cost of waste fuel used for transporting the waste. Calculation of percentage of fuel cost function of the cost of transporting waste to determine the amount of the percentage of the cost of fuel needed in the services, waste transportation.

II. LITERATURE

2. 1 Garbage Collection Pattern

According to SNI 19-2454-2002 (Indonesia Standart) pattern of garbage collection in Indonesia consists of: individual patterns of direct, indirect individual pattern, the pattern of communal direct, indirect communal pattern, and the pattern of street sweeping. Determination of the pattern of collection of each area is determined by the condition of each region.



Sour ce: SNI 19-2454-2002

Figure 1. Garbage Collection Pattern

2. 2 Waste Transportation System

Based on the mode of operation and equipment used, known 2 system is the system of transporting waste container lift / hauled container system (HCS) and container system fixed / stationary container system (SCS).

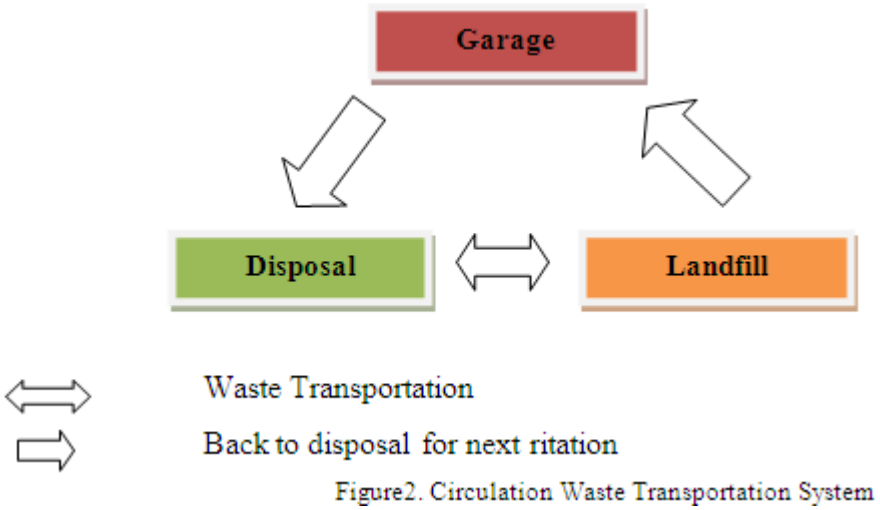


Figure2. Circulation Waste Transportation System

2. 3 Hauled Container System (HCS)

Hauled Container System (HCS) is a system of waste collection by way of container with its contents transported to the landfill, emptied and then returned to its original location (garage) or to a location of the next waste collection (SNI T-13-1990-F).

HCS is suitable for transferring waste from a source with a high level of waste containers used for relatively large size. The use of large containers reduce the handling time so that no unsightly and unhealthy conditions associated with the use of a number of small containers can be prevented. Another advantage of the HCS is their flexibility: containers with different sizes and shapes can be provided for the collection of all types of waste.

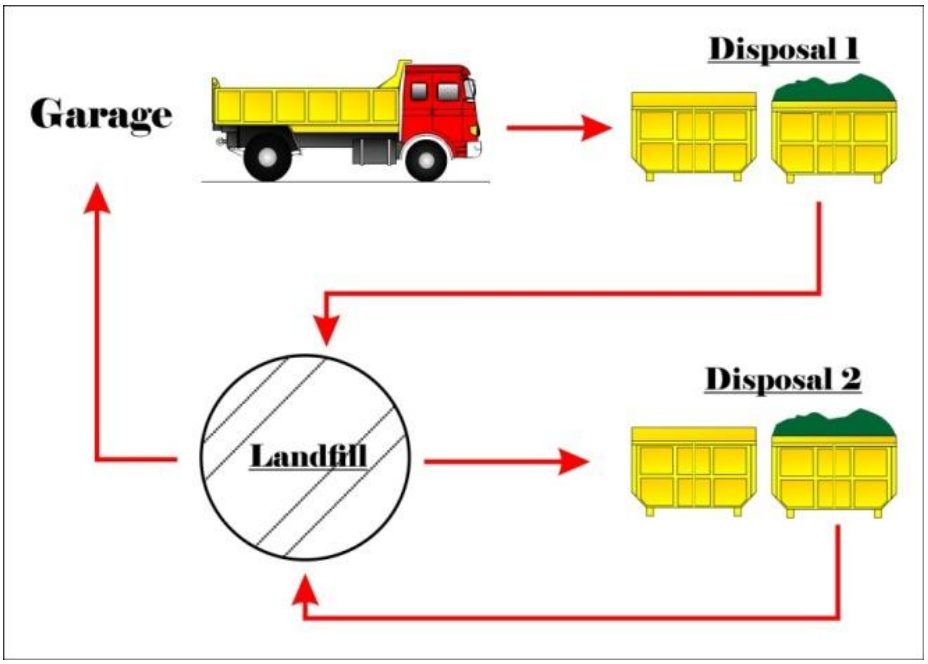


Figure 3. Hauled Container System

Caption:
a. Empty containers taken from the garage to the disposal 1.
b. Containers that have been filled from Disposal 1, was taken to the landfill to be emptied.
c. Containers that have been brought in to replace the empty container in TPS 2.
d. Filled containers of Disposal 2, was taken to the landfill to be emptied, and so on.
e. Truck back to the garage.

2. 4 Stationary Container System (SCS)
Stationery Container System is the waste collection system in a way, the container is left at the point of decision (a). Waste that is transferred into the trucks manually or assisted by mechanical equipment on the trucks (b), and then transported to the landfill.

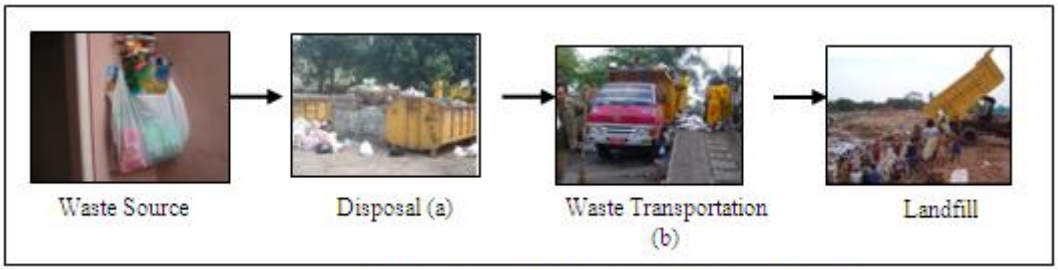


Figure 4. Stationary Container System (SCS)

Collection system at SCS has two main types:
a) Where compaction charging system (self-toading compactor) is used.
b) Where the vehicle charging system manual (manually loaded) is used

2. 5 Vehicle Operation Cost (VOC)
Vehicle operating cost is defined as the cost of all the factors associated with the operation of the vehicle under normal conditions for a particular purpose. Based on economic considerations, the necessary compatibility between the tariff (revenue) (Rahman, 2012). Several methods were attempted to calculate the

VOC component is Transport and Research Laboratory (TRRL) based on research in Kenya, for the calculation of VOC in the road outside the city (rural road) countries - Developing countries, Method Road User Cost Manual, (1992) (RUCM), Methods the Highway Design and Maintenance Standards Model - Vehicle Speeds and Operating Costs, (1987) (HDM-III VOC), Pacific Consultants Internasiona method (PCI) (1990), a method developed by LAPI-ITB (1997) and many more.

Calculation of vehicle operation cost (VOC) are costs that occur with the economical operation of a vehicle under normal conditions for a specific purpose (G Hamidi, 2013). In Indonesia there are two ways commonly used in the calculation of vehicle operating cost (VOC) that are PCI and LAPI-ITB. In the calculation of vehicle operating cost (VOC) is a factor that affects the speed of the vehicle (Levinsion, 2005).
VOC component consists of fixed costs, variable costs and other expenses. Fixed costs include: depreciation expenses, administrative expenses and allowances bus crew salaries, capital interest, vehicle insurance, vehicle crews and employees than management. Variable costs include: the cost of fuel, engine oil costs, tire costs, maintenance costs and the cost of mechanics. VOC component calculation method of PCI is still in units per 1000 km so as to obtain the unit value per km required distance from the road traversed, for speed (running speed) in km / h (Burhamtoro, 2013).

Model PCI (Musashi, 1990), which is used to calculate the VOC is a regression equation with speed as the independent variable. The equation is as follow:

Table 1. Calculation Vehicle Operation Cost (truck)

No.	Parameter Cost	Equations	Informations
1	Fuel Cost	$(0,06427V^2 - 7,0613V + 318,3326)$ x Fuel cost	Fuel Cost (liter/1000km)
2	Oil cost	$(0,00048V^2 - 0,05608V + 3,07383)$ x Oil Cost	Oil Cost (liter/1000km)
3	Tire cost	(0,0011553V - 0,0059333) x Tire cost x n Tire	Tire Cost (1 Tire/1000km)
4	Spare part cost	(0,0000191V + 0,00154) x Vehicle price	Spare part cost (Spare part/1000km)
5	Service cost	(0,01511V + 1,212) x Mechanic wages per hour	Service Cost (Mechanic/1000km)
6	Depreciation	(1/(6,129V + 245)) x Vehicle price	Depreciation cost (Depreciation/1000km)
7	Interest rate	((0,12 x 1000)/(1750V)) x Vehicle price	Interest rate (interest rate/1000km)
8	Insurance	((0,06x1000x0,5)/(1750V)) x Vehicle price	Insurance (Insurance/1000km)
9	Drive wages	(1000/V) x Driver wages	Driver Wages (Wage/1000km)
10	Overhead	Total Cost x 10%	

Information: V = Speed (km/hour)
Source: Yanagiya, 1990

III. RESEARCH METHODOLOGY

Stages of research begins with getting the data needed for the analysis of vehicle operating cost (VOC), including fuel prices, oil prices, tire prices, the price of the vehicle as well as the costs required. The data was obtained through field surveys or primary data. Prices are used as the data is generally accepted price in 2012 in the city of Malang.

The study was conducted on waste transport serving the transport in the city of Malang, in this peneletian research object in dump trucks or vehicles transporting the SCS system. SCS Transportation systems serve 16 temporary shelters (disposal) and spread over 4 districts. The type of vehicle used consisted of four types of brands, that is Cold Diesel, Toyota Dyna By 43 Long, "Toyota Dyna BU 343R" and Toyota New WU 342 R.

Once the data has been obtained, the next step is to conduct an analysis to determine the vehicle operating cost and transportation cost of each vehicle. Next calculate the percentage of each component of the variable costs and freight costs.

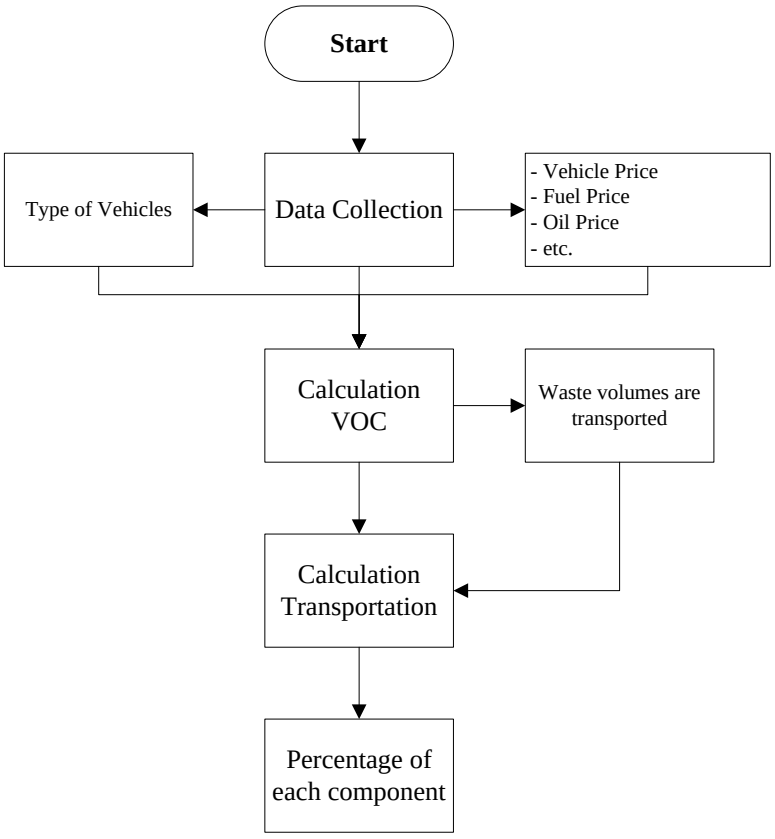


Figure 5. Flow Chart of Research

IV. ANALYSIS AND DISCUSSION

4. 1 Dump Truck vehicle transporting waste

Transporting waste type "Stationery Container System (SCS) in Malang, served 15 fleet serving four districts, that is Lowokwaru, Blimbing, Klojen and Sukun. District Kedungkandang services using system hauled Container System (HCS) with Arm Roll Truck. Initial analysis performed on the movement of the fleet to get the speed of each vehicle. Velocity data obtained by the data in the distance and the travel time for the vehicles transporting. Data distance, time and speed can be seen in Table 2.

Table 2. Distance, travel time and speed of Dump Truck

No	Temporary Disposal	Vehicle	Distance (km)	Time (minute)	Speed (km/h)
1	2	3	4	5	6
1	Cianjur (TMP)	Dump Truck Cold Diesel 1992	40,63	97,73	24,94
2	Sumbersari	Dump Truck Cold Diesel 1992	35,57	84,03	25,40
3	Asahan 1	Dump Truck Cold Diesel 1992	50,79	131,84	23,11
4	Stadin Blimbing	Dump Truck Cold Diesel 1992	38,39	104,59	22,02
5	Rampal Celaket	Dump Truck Cold Diesel 1992	24,88	71,11	20,99
6	Manyar	Dump Truck Cold Diesel 1992	25,41	79,62	19,15
7	Seram	Dump Truck T. New WU 342 R TKMQ AD3 2007	28,87	94,93	18,25
8	Muharto	Dump Truck T. New WU 342 R TKMQ AD3 2007	34,33	93,33	22,07
9	Raya Langsep	Dump Truck T. New WU 342 R TKMQ AD3 2007	34,33	99,43	20,72
10	Borobudur	Toyota Dyna BU 343R 2006	52,46	174,88	18,00
11	Sulfat	Toyota Dyna BU 343R 2006	39,62	141,72	16,77
12	Kartini	Toyota Dyna BU 343R 2005	19,53	42,82	27,37
13	Tawangmangu	Toyota Dyna BY 43 Long/490061 2002	45,84	130,25	21,12
14	Bentoel	Toyota Dyna BY 43 Long/490061 2002	20,79	68,55	18,20
15	Asahan 2	Toyota Dyna BY 43 Long/490061 2002	46,61	147,71	18,93
16	Oro-oro Dowo	Toyota Dyna BY 43 Long/490061 2002	21,87	71,01	18,48

Once known the type and brand of vehicle used, the next is to find the price of fuel, engine oil, tires, vehicle, mechanic wages, salaries and fixed costs of vehicles. Price and cost are used based on the market price in the city of Malang, and the data taken in 2012.

Table 3. List price and the cost of each type of vehicle

No	*Type of Vehicle*	*Price(IDR)*				
		Fuel	*Oil*	*Tire*	*Mechanic*	*Driver*
1	Dump Truck Cold Diesel	4.500	22.500	1.355.000	18.750	10.900
2	Toyota Dyna BY 43 Long	4.500	22.500	1.355.000	18.750	10.900
3	Toyota Dyna BU 343R	4.500	22.500	1.355.000	18.750	10.900
4	Dump Truck Toyota New WU 342 R TKMQ AD3	4.500	22.500	1.355.000	18.750	10.900

Continuation...

No	*Type of Vehicle*	*Price (IDR)*	*Fixed Cost (IDR)*		
		Vehicle	*STNK*	*SWJDKLLJ*	*KIR*
1	Dump Truck Cold Diesel	95.400.000	992.200	163.000	200.000
2	Toyota Dyna BY 43 Long	93.600.000	973.400	163.000	200.000
3	Toyota Dyna BU 343R	110.800.000	1.152.300	163.000	200.000
4	Dump Truck Toyota New WU 342 R TKMQ AD3	112.900.000	1.174.200	163.000	200.000

4. 2 Calculation VOC

The next analysis is to calculate vehicle operating costs (VOC).

Calculation of vehicle operating cost (VOC) can be seen in the following table:

Table 4. Vehicle Operating Cost Calculations (VOC)

Temporary Disposal	Volume (m^3)	Fuel (IDR/1000Km)	Oil (IDR/1000Km)	Tire (IDR/1000Km)	Spare Part (IDR/1000Km)
Cianjur (TMP)	17,30	639.886	44.406,77	186.049,13	192.367
Sumbersari	16,52	625.454	44.080,61	190.315,25	193.195
Asahan 1	11,27	698.007	45.765,37	168.869,15	189.034
Stadion Blimbing	14,82	732.688	46.610,45	158.618,08	187.046
Rampal Celaket	11,15	765.458	47.432,64	148.931,50	185.166
Manyar	23,61	824.053	48.960,00	131.611,57	181.806
Seram	21,80	852.708	49.733,70	123.141,33	213.212
Muharto	9,21	731.204	46.573,77	159.056,71	221.458
Raya Langsep	7,92	774.241	47.656,90	146.335,39	218.537
Borobudur	16,91	860.566	49.948,94	120.818,54	208.723
Sulfat	16,73	899.479	51.034,24	109.316,38	206.131
Kartini	24,37	562.865	42.717,71	208.815,83	228.550
Tawangmangu	21,28	761.508	47.332,33	150.099,00	181.895
Bentoel	12,71	854.278	49.776,59	122.677,33	176.676
Asahan 2	24,19	830.869	49.142,44	129.596,85	177.993
Oro-oro Dowo	11,15	845.279	49.531,42	125.337,32	177.182

Continuation...

Temporary Disposal	Mechanic (IDR/1000Km)	Depreciation (IDR/1000Km)	Interest Rate (IDR/1000Km)	Insurance (IDR/1000Km)	Wage (IDR/1000Km)
Cianjur (TMP)	29.791,89	239.770,45	262.258,13	65.564,53	436.982,34
Sumbersari	29.920,57	238.104,54	257.568,09	64.392,02	429.167,65
Asahan 1	29.273,68	246.722,01	283.011,00	70.752,75	471.561,39
Stadion Blimbing	28.964,48	251.065,31	297.036,06	74.259,02	494.930,37
Rampal Celaket	28.672,30	255.312,34	311.628,92	77.907,23	519.245,43
Manyar	28.149,87	263.275,48	341.639,56	85.409,89	569.250,05
Seram	27.894,38	316.396,31	424.291,87	106.072,97	597.384,66
Muharto	28.977,71	296.896,63	350.779,99	87.695,00	493.883,10
Raya Langsep	28.593,99	303.522,44	373.714,22	93.428,55	526.173,51
Borobudur	27.824,31	311.835,75	422.121,03	105.530,26	605.592,56
Sulfat	27.477,37	318.565,02	452.937,78	113.234,45	649.803,57
Kartini	30.478,61	268.452,06	277.616,11	69.404,03	398.279,72
Tawangmangu	28.707,51	249.985,44	303.949,35	75.987,34	516.188,92
Bentoel	27.880,38	262.531,84	352.715,08	88.178,77	599.006,42
Asahan 2	28.089,10	259.248,60	338.990,98	84.747,74	575.699,16
Oro-oro Dowo	27.960,62	261.259,91	347.309,83	86.827,46	589.826,84

Continuation...

Temporary Disposal	Overhead	VOC (PCI)		Variable
	(IDR/1000Km)	(IDR/1000Km)	(IDR/Km)	Cost
Cianjur (TMP)	209.707,66	2.306.784,25	2.306,78	93.724,64
Sumbersari	207.219,71	2.279.416,81	2.279,42	81.078,86
Asahan 1	220.299,70	2.423.296,73	2.423,30	123.079,24
Stadion Blimbing	227.121,69	2.498.338,62	2.498,34	95.911,22
Rampal Celaket	233.975,48	2.573.730,25	2.573,73	64.034,41
Manyar	247.415,55	2.721.571,03	2.721,57	69.155,12
Seram	271.083,53	2.981.918,85	2.981,92	86.088,00
Muharto	241.652,41	2.658.176,52	2.658,18	91.255,20
Raya Langsep	251.220,28	2.763.423,10	2.763,42	94.868,31
Borobudur	271.296,05	2.984.256,51	2.984,26	156.554,10
Sulfat	282.797,90	3.110.776,88	3.110,78	123.248,98
Kartini	208.717,86	2.295.896,41	2.295,90	44.838,86
Tawangmangu	231.565,31	2.547.218,39	2.547,22	116.764,49
Bentoel	253.371,98	2.787.091,81	2.787,09	57.943,64
Asahan 2	247.437,61	2.721.813,68	2.721,81	126.863,74
Oro-oro Dowo	251.051,42	2.761.565,61	2.761,57	60.395,44

Continuation ...

Temporary Disposal	STNK	SWJDKLLJ	KIR	Fixed	Transportation Cost	
				Cost	IDR/day	IDR/m^3
Cianjur (TMP)	992.200	163.000	200.000	4.706	98.430,20	5.689,61
Sumbersari	992.200	163.000	200.000	4.706	85.784,41	5.193,28
Asahan 1	992.200	163.000	200.000	4.706	127.784,80	11.335,47
Stadion Blimbing	992.200	163.000	200.000	4.706	100.616,77	6.790,78
Rampal Celaket	992.200	163.000	200.000	4.706	68.739,96	6.167,79
Manyar	992.200	163.000	200.000	4.706	73.860,68	3.128,14
Seram	1.174.200	163.000	200.000	5.338	91.425,50	4.193,83
Muharto	1.174.200	163.000	200.000	5.338	96.592,70	10.487,81
Raya Langsep	1.174.200	163.000	200.000	5.338	100.205,81	12.652,25
Borobudur	1.152.300	163.000	200.000	5.261	161.815,55	9.569,22
Sulfat	1.152.300	163.000	200.000	5.261	128.510,44	7.681,44
Kartini	1.152.300	163.000	200.000	5.261	50.100,32	2.056,10
Tawangmangu	973.400	163.000	200.000	4.640	121.404,77	5.705,11
Bentoel	973.400	163.000	200.000	4.640	62.583,92	4.923,99
Asahan 2	973.400	163.000	200.000	4.640	131.504,01	5.436,30
Oro-oro Dowo	973.400	163.000	200.000	4.640	65.035,72	5.832,80

Results of calculation vehicle operating costs, can be described as follows;

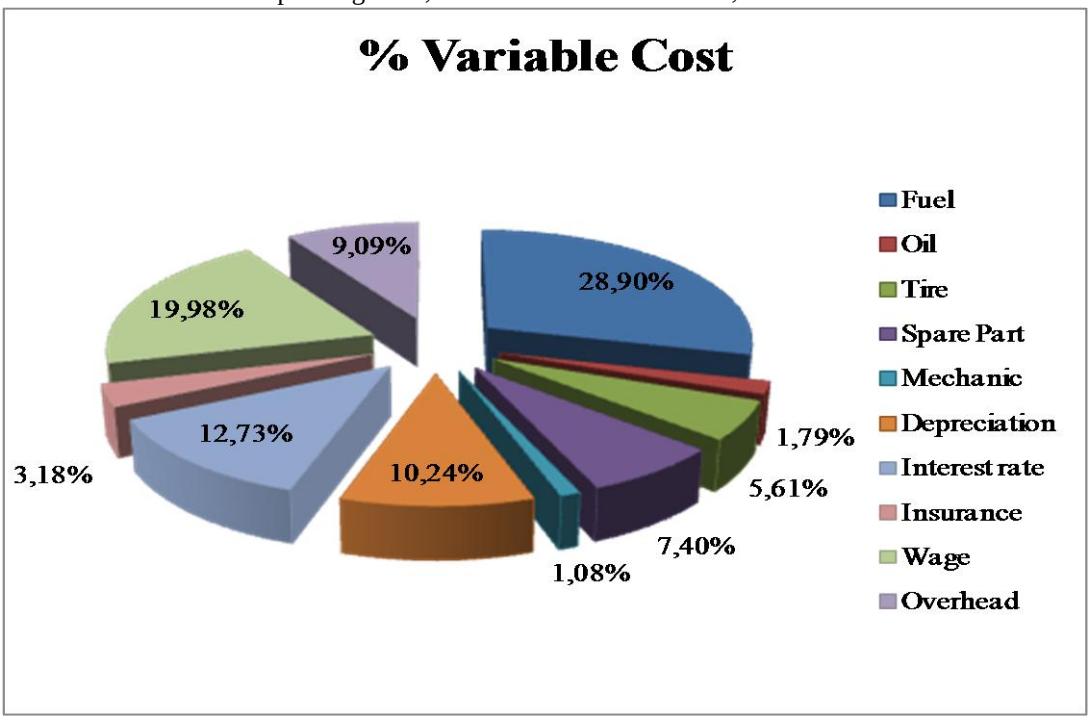


Figure 6. Percentage of the variable cost component of VOC

VOC component percentage is calculated based on the value of the variable cost component of each 1000 km are used as cost per km multiplied by the distance traveled. So as to know the percentage of each component of the variable cost incurred from each vehicle.

On Figure 6, it can be seen that the percentage of fuel (BBM) has the greatest percentage of 28.90% while the smallest percentage was 1.08% for mechanical components. The order of the percentage of each component can be seen as follows;

Component	Percentage
Fuel	28,90%
Wage	19,98%
Interest rate	12,73%
Depreciation	10,24%
Overhead	9,09%
Spare part	7,40%
Tire	5,61%
Insurance	3,18%
Oil	1,79%
Mechanic	1,08%
	100,00%

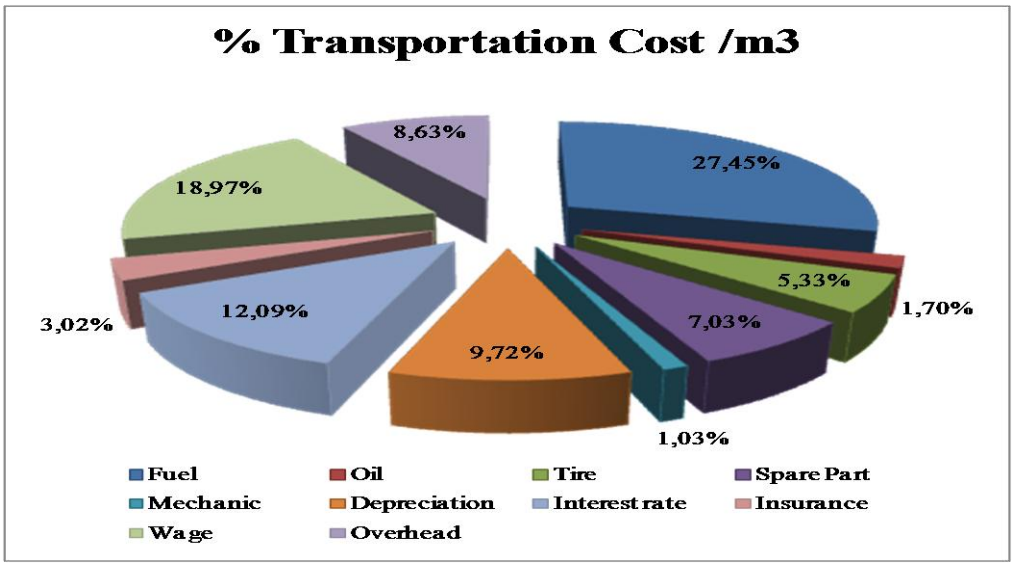


Figure 7. Percentage of the cost of transporting the components VOC

Percentage component of the cost of transporting waste VOC is calculated based on the value of each component of 1000 km which is used as the cost per km to the distance traveled multiplied and divided by the volume of waste transported. So as to know the percentage of each component of the cost of transporting waste. In the calculation of the percentage of components VOC biay waste transportation, it can be seen that the percentage of the cost of fuel oil (BBM) is also the largest that is 27.45%, while the smallest percentage of the mechanical componentsthat is 1.03%. The order of the percentage of each component can be seen as follows;

Component	Percentages
Fuel	27,45%
Wage	18,97%
Interest rate	12,09%
Depreciation	9,72%
Overhead	8,63%
Spare Part	7,03%
Tire	5,33%
Insurance	3,02%
Oil	1,70%
Mechanic	1,03%
Total	94,97%
Fixed cost	5,03%
	100,00%

Based on the analysis of the two can be seen that the fuel component has the largest percentage. Percentage of fuel oil to the calculation of transport costs approximately 27% - 29% of the total cost of transportation.

V. CONCLUSION

Based on the research conducted, it found several conclusions that can be drawn, among others:

1. Percentage of the cost of each component of the cost of transporting waste is the largest component of the fuel, while the smallest percentage of the cost of mechanical components
2. Percentage of the cost of fuel for 28.90% of the variable costs per kilometer.
3. Percentage of the cost of fuel for 27.45% of the total cost of transporting waste on his m^3 each.

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