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Research paper



Assessment of Environmental Management in Lake Toba, Samosir Regency, North Sumatera Province, Indonesia

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Abstract

Earth, water and other natural resources are controlled by government and used totally for society's prosperity. If the problem cannot be anticipated, it will cause conflicts in society by personal or certain group interest when the demand is no longer equal with the supply of water resources. The aim of the study is to examine the Environmental Management in Lake Toba through water quality and waste management system. From 2013 until 2017 showed the increasing of waste management with a sorting method in the polling stations based on services zone priority and the coverage of existing garbage service improve the average to 1.673 %, coverage of existing TPS services an average of 2.07 %, and the scope of service of garbage transport trucks, Garbage Container and Bike Rickshaw average 12.03 %. The value of the investment Cash flow, Net worth by 2020 NPV at 15% interest rate positive value of Rp 2,043,325,165, an IRR of 9.664 % > MARR of 15%, a B/C ratio of 1.13 > 1 and PP 4.4 years (4 years 4 months 11 days), shorter than the 10-year investment period.

Keywords: *Asset; Service; Waste; Quality water; investment period.*

1. Introduction

The area nearly Toba Mount always less of water, due to the fact that 85% of land is rocky hill which periodically gets erosion. The rocky hill in Toba Mount has certain locations which are higher than their surroundings but their height are relatively lower than mount and mountain. The long rocky plateau which are in a row then form a hill. The rocky hill which is located nearly Toba Mount cannot be overgrown by any plants. Although the plants grow, they will not be grown very well. Nearly the plants there are valleys and lower lands than their surroundings. Moreover, the problem is not complete yet. Other problems appear, such as the lack of understanding of dangerous characteristics (hazards), the society actions which cause the decrease of natural resource quality (vulnerability), the lack of early warning which cause the unreadiness, the disability in facing the disasters, and the inappropriateness of local characteristics area development. According Department of Health Samosir Regency, the waste management is still based on final approach with the coverage about 20% of the total area of Samosir Regency [1-4]. The waste management is handles by Division of Health, Parks and Cemeteries, Department of Health Samosir Regency and Health Service Section. The asset of waste management is 14 units of 3 m^3 capacity concrete polling station, 3 units of 3 m^3 capacity knock down, Dump Truck is 9 unit of 6 m^3 capacity containers, Garbage Container is 1 Unit and Motor Bike Rickshaw 27 Unit. Besides that, the waste transported by using 11 vehicles Dump Truck is and Motor Bike Rickshaw 27 Unit. There are have 2 polling stations namely TPS Samosir Regency 1 of 3 ha and TPS Samosir Regency 2 of 2 ha, Regency 3 of 2 ha (not yet operating) and TPS Samosir Regency 4 of 3 ha. The waste disposal method in the TPA by means of open dumping. The planning formulates the document of inventory, of water resource in river area, the availability identification for now and future, the usage of water and the needs estimation both for now and future, and the alternative effort analysis in order to make it better in using of water resource. The water quality of Lake Toba affected of Waste Management and Asset Service Improvement in Samosir Regency, North Sumatera Province. In 2010 recorded only 0.62% of the total budget and waste retribution amounted only 9.53% of the total budget of waste management. The improving waste management and a service strategy is required to increase the capacity of waste handling. [5-9].

2. Methodology

The location of waste management services chosen is Samosir Regency (Figure 1). The data collected are qualitative and quantitative. There are parameters for this study such as the region, administration, population, waste piles, local services, socioeconom-

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ic, financing of waste management, asset management and waste composition. The primary data and secondary data were then compared with the standard NSPM to obtain a general overview of waste management in Samosir Regency, North Sumatera Province. The analysis of technical operation and feasibility using the investment criteria such as the Net Present Value, Payback Period, Benefit/Cost Ratio, and Internal Rate of Return.

Besides that, Figure 2 showed the zone of population of Samosir Regency and Table 1 the total population in Samosir Regency per District on 2017 which covered 9 districts with total population more than 120000 peoples. Table 2 showed a few types of waste generated in each District in Kabuapten Samosir based on waste generator for society, tourist, market and hotel [10-14].



Fig. 1: Map of Samosir Regency, North Sumatera Province



Fig. 2: Zone Population of Samosir Regency, North Sumatera Province

Table 1: Total Population of Samosir Regency, North Sumatera Province, 2017

Sub-Districts	Zone	Population
Pangururan	I	30 468
Simanindo	II	20 190
Palipi	III	16 648
Ronggurnihuta	III	8 632
Onanrunggu	IV	10 687
Nainggolan	IV	12 261
Sianjur Mulamula	V	9 448
Harian	V	8 114
Sitiotio	V	7 341
Total		123 789

Table 2: Types of Waste Generated in Each District in Kabuapten Samosir, Samosir Regency, North Sumatera Province Based on Waste Generator

Junk Waste	Generator
Society	Plastic bags Rotten food ingredients Time paper food, etc.
Tourist	Tissue Plastic Bottles Plastic Bags, etc.
Market	Plastic bags Raw food items Plastic bottles, etc.
Hotel	Tissue Plastic Plastic Bottle Time food, etc.

3. Results and Discussion

3.1. Water Quality and Waste Management Operations

3.1.1. Waste piles

According to [12], there are population of < 100,000 as 2.5 L/person/day which are equivalent to 0.7 kg/person/day. Then, the city recorded populations are 100,000 to 500,000 of 3 L/person/day, equivalent to 0.8 kg/person/day. While, the waste piles in Samosir Regency, North Sumatera Province with the population > 2 million of 1.75 L/person/day, which are equivalent to 0.45 kg/person/day.

The average of household waste density is 255 kg/m^3. The average of piles that generated is equal to 1.75 L/person/day or the equivalent of 0.45 kg/person/day (see Table 3). Total of one day pile is generated in Samosir Regency, North Sumatera Province in 2010 with a population of 2,125,234 is about 3750. 41 m^3/day [15-16].

Table 3: Piles Measurement Samosir Regency, North Sumatera Province

Population	Volume (m^3)	Piles (m^3/person/day)	Density (kg/m^3)	Piles (kg/person/day)
2.342	20,106.250	0.00043	63.750	0.110
2.342	20,387.250	0.00044	63.750	0.220
2.342	21,107.000	0.00045	63.750	0.230
Average		0.00132	127.500	0.560

3.1.2. Composition

Most compositions are leftovers and foliage as 67.67%, plastic as 23.49%, paper as 2.91%, fabric as 0.43%, metal as 0.22%, glasses as 0.32% and the other of 4.96%. The comprising with Wonocolo and Surabaya proved there are similar compositions in the form of leftovers and foliage 73.5%, plastic 12.8%, paper 8.4% and another 5.3% (metal, glasses, wood, cloth, rubber, etc.) [17].

3.1.3. Container

Based on [2], there are some requirements of material. While the characteristics of individual and communal waste container including the box-shaped, bin (barrel), container, cylinder, and is light, covered, easily emptied and easily moved, plastics, various metals, wood, bamboo, fiberglass (GRP) and rattan.

For communal containers, in some locations such as in residential areas and main streets, a polling station (TPS) is built of container and concrete. Besides that, the communal containers generally do not have a cover, so it is very easily disturbed by animals, humans

and others. It is also trash strewn around the TPS, disrupt the aesthetic environment and causing odors [18-20].

3.1.4. Waste collection

3.1.4.1. Residential water quality and waste

The method of residential water quality by waste collection are direct individual, indirect communal and indirect individual. The direct individual is conducted door to door using a dump truck in a residential area along the transport path.
The indirect communal is applied to crow decries dental areas, narrow alley sand cannot be passed by collection vehicles and the indirect individual using a flotation device such as motors and trash cart.

3.1.4.2. Non-residential water quality and waste

The trash collected by the clerk to be taken on the provided containers to the nearest polling stations. The waste collection in the market areas are carried out by market cleaners whereas for particularly directed at the main streets, sweeping, parks, sidewalks and other public places. Then, the waste is collected at the nearest polling stations and then transported to TPA areas.

3.1.5. Transportation

Due to this condition, the requirement for dump truck replacement on 2013 of 9 units, on 2016 of 3 units, on 2013 of 7 units, on 2014 of 3 units, and 4 units in year of 2015. While arm roll truck replacement in 2016 of 3 units, on 2013 of 3 units, and 3 units in year of 2015.
Waste transportation is using two types of vehicles, dump-truck and arm roll-truck. Garbage Container disposable time year of 2016, Motor Bike Rickshaw time for year of 2016, Motor Bike Rickshaw time for year of 2013, Arm roll Truck, disposable time for years of 2016 and Arm roll Truck, disposable time for years of 2013. Based on the provisions study, the minimum trip of dump truck and motor bike rickshaw is 1 to 3 per day with a maximum crew of 1 to 3, whereas arm roll truck and motor bike rickshaw (Table 4) [19-25].

Table 4: Piles Measurement Samosir Regency, North Sumatera Province

Type of Means	Amount
Dump Truck (Unit)	11
Garbage Container (Unit)	1
Motor Bike Rickshaw (Unit)	27
Dump truck officer (Person)	11
Motor Bike Rickshaw (Person)	27
Road Sweeper (Person)	51

3.2. Water Quality and Waste Management Assets Budgeting

Based on the study, budgeting of waste management should receive equal priority with the management of other public services which ranging from 10% regional budget and local government. Then, the budgetary should be resources from the public water quality and waste management costs amounted of 50% and 10% of government.
The waste management budget in 2012 was very low at ± 0.62% of the total budget. Then, if the revenue of retribution compared to waste management budget in the 2012, 24.47% comes from the regional budgeting and 2.53% from retribution [23-25].

3.3. Level of Existing The study Water Quality and Waste Service

Based on the study, the total volume compared with the pile transported to the TPA and the existing services level of waste management in 2012 is ± 11.15%.
The Minimum Service Standards Division of Public Works and Spatial Planning in 2014 recorded the target of waste management in urban areas are 70%. That's means, the service level provided from government are very low (Table 5).

Table 5: Piles Measurement at Samosir Regency, North Sumatera Province

Year	Projection	Growth (%)
2013	5.008	1.110
2014	6.120	1.110
2015	7.230	1.110
2016	8.340	1.110
Sep-17	7.365	1.110

3.4. Level of Existing The study Water Quality and Assets Service

3.4.1. The Existing Level Study of Water Quality and TPS Service

Based on this study, if the total capacity of the existing TPS compared to the projection of handling piles, the TPS existing service levels in 2012 of 16.610 %, 12.705 % in 2013, 10.218 % in 2014, 8.500 % in 2015 and continually dropped to 7.243 % in 2016, with 3.278 % of average annual decline Table 6.
An asset additions program is required to improve service levels to over comet his reduction [26].

Table 6: Level of Existing TPS Services Samosir Regency, North Sumatera Province

Year	Projection (m^3/day)	Total Load (m^3)	Service Level (%)
2013	194.433	197.625	12.705
2014	241.788	197.625	10.218
2015	290.640	197.625	8.500
2016	341.128	197.625	7.243
Sep-17	280.838	197.625	7.088

3.4.2. Level of Existing Trucks and Motor Bike Rickshaw Service

The total capacity of trucks and motor bike rickshaws compared to the projections of handling piles per day, in 2012 as 16.610 %, 12.705 % in 2013, 10.218 % in 2014, 8.500 % in 2015, continued to fall to 7.243 % in 2016 (Table 7).
This shoed the Program asset additions of vehicles are required to improve service levels [8, 28].

Table 7: Level of Existing Truck and Motor Bike Rickshaw Services

Year	Projection (m^3/day)	Capacity (m^3/day)	Service Level (%)
2013	194.433	104.550	13.443
2014	241.788	104.550	10.810
2015	290.640	104.550	8.993
2016	682.255	104.550	7.650
Sep-2017	112.668	104.550	2.055

3.5. The study Water Quality and Waste Management with sorting method

The study water quality and waste management in the TPS determine the amount of waste can be reduced and residual piles discarded (Table 8 and Table 9). Regional Technical Implementation Unit (UPTD) Cipta Karya Samosir Regency, North Sumatera Province divides the waste management service areas in to 5 zones.

Then, the sorting method was implemented through annual priorities based on service areas.

The graduals separation in to TPS /year/zones will increase the services in 2012 about 7.505, 9.730 in 2013, 12.254 in 2014, 13.398 in 2015 and increasing of 13.893 in 2016 (Table 10) [2], [4-6], [29-31].

Table 8: Level of Waste Management Services Based on the Zones on 2013-2016 in TPS with Sorting Method

Service Zone	Year			
	2013	2014	2015	2016
Zone I				
Piles (m^3/day)	272.970	277.748	82.608	287.553
Service Level (%)	13.893	13.893	13.893	13.893
Piles management (m^3/day)	151.690	154.345	157.045	159.793
Piles Management Level (%)	3.908	3.908	3.908	3.908
Reduction (%)	20.183	20.183	20.183	20.183
Piles reduction (m^3/day)	122.460	124.603	126.783	129.003
Residual (m^3/day)	29.230	29.743	30.263	30.793
Zone II				
Piles (m^3/day)	251.335	255.733	260.208	264.763
Service Level (%)	13.893	13.893	13.893	13.893
Piles management (m^3/day)	139.668	142.110	144.598	147.128
Piles Management Level (%)	3.598	3.598	3.598	3.598
Reduction (%)	20.183	20.183	20.183	20.183
Piles reduction (m^3/day)	112.753	114.725	116.735	118.778
Residual (m^3/day)	26.915	27.385	27.865	28.353
Zone III				
Piles (m^3/day)	243.080	247.333	251.663	256.065
Service Level (%)	13.893	13.893	13.893	13.893
Piles management (m^3/day)	135.080	137.443	139.848	142.295
Piles Management Level (%)	3.480	3.480	3.480	3.480
Reduction (%)	20.183	20.183	20.183	20.183
Piles reduction (m^3/day)	109.050	110.958	112.900	114.875
Residual (m^3/day)	26.030	26.485	26.950	27.420
Zone IV				
Piles (m^3/day)	131.345	133.643	135.983	138.360
Service Level (%)	13.893	13.893	13.893	13.893
Piles management (m^3/day)	72.988	74.265	75.565	76.888
Piles Management Level (%)	1.880	1.880	1.880	1.880
Reduction (%)	20.183	20.183	20.183	20.183
Piles reduction (m^3/day)	235,69	59.955	61.003	62.070
Residual (m^3/day)	14.065	14.310	14.563	14.815
Zone V				
Piles (m^3/day)	71.978	73.238	74.520	75.823
Service Level (%)	13.893	13.893	13.893	13.893
Piles management (m^3/day)	39.998	40.698	41.410	42.135
Piles Management Level (%)	1.030	1.030	1.030	1.030
Reduction (%)	20.183	20.183	20.183	20.183
Piles reduction (m^3/day)	32.290	32.855	33.430	34.015
Residual (m^3/day)	7.708	7.843	7.980	8.120

Table 9: Projection of Waste Management in year 2013-2016 Service Zone

Service Zone	Year			
	2013	2014	2015	2016
Zone I				
Piles (m^3/day)	272.970	277.748	282.608	287.553
Service Level (%)	5.008	6.120	7.230	8.340
Piles Management (m^3/day)	54.675	67.993	81.730	95.928
Piles Management Level (%)	1.408	1.720	2.033	2.345
Zone II				
Piles (m^3/day)	251.335	255.733	260.208	264.763
Service Level (%)	5.008	6.120	7.230	8.340
Piles management (m^3/day)	50.343	62.603	75.253	88.325
Piles Management Level (%)	1.298	1.585	1.873	2.160
Zone III				
Piles (m^3/day)	243.080	247.333	251.663	256.065
Service Level (%)	5.008	6.120	7.230	8.340
Piles management (m^3/day)	48.690	60.548	72.780	85.423
Piles Management Level (%)	1.255	1.533	1.810	2.088
Zone IV				
Piles (m^3/day)	131.345	133.643	135.983	138.360
Service Level (%)	5.008	6.120	7.230	8.340
Piles management (m^3/day)	26.308	32.715	39.325	46.158
Piles Management Level (%)	0.678	0.828	0.978	1.128
Zone V				
Piles (m^3/day)	71.978	73.238	74.520	75.823
Service Level (%)	5.008	6.120	7.230	8.340
Piles management (m^3/day)	14.418	17.928	21.550	25.295
Piles Management Level (%)	0.290	0.373	0.455	0.535

Table 10: Level of Waste Management on 2013-2016 in TPS with Sorting Method

Service Zone	Year			
	2013	2014	2015	2016
Zone I				
Sorting	3.908	3.908	3.908	3.908
Zone II, III, IV and V				
Projection of Service Level	3.600	4.400	5.198	5.995
Service Level	7.505	8.305	9.103	9.903
Zone I and III				
Sorting	7.385	7.385	7.385	7.385
Zone II, IV and V				
Projection of Service Level	2.345	2.868	3.388	3.908
Service Level	9.730	10.253	10.773	11.293
Zone I, II, and III				
Sorting		10.983	10.983	10.983
Zone IV and V				
Projection of Service Level		1.283	1.515	1.748
Service Level		12.265	12.498	12.730
Zone I, II, III, and IV				
Sorting			12.863	12.863
Zone II, III, IV and V				
Projection of Service Level			0.535	0.618
Service Level			13.398	13.480
Zone I, II, III, IV and V				
Sorting				13.893
Service Level				13.893

3.6. Level of Existing the Study Water Quality and Assets Service in TPS with Sorting Method

3.6.1. The Existing Level of Water Quality and TPS Service

Based on the study, a gradual sorting method /service zone, there will be decrease on service level in 2012 about 8.475, 6.538 in 2013, 5.098 in 2014, 4.588 in 2015, 4.348 in 2016 (Table 11) [5-7, 32-33].

Table 11: Level of Existing TPS Service on 2013-2016 in TPS with Sorting Method

Service Zones	Year			
	2013	2014	2015	2016
Zone I				
Sorting	151.690	154.345	157.045	159.793
Zone II, III, IV and V				
Projection of Service Level	139.758	173.795	208.910	245.200
Service Level	8.475	7.528	6.750	6.100
Zone I and III				
Sorting	286.950	291.788	296.893	302.090
Zone II, IV and V				
Projection of Service Level	91.068	113.248	136.130	159.778
Service Level	6.538	6.100	5.705	21,39
Zone I, II, and III				
Sorting		433.898	441.493	449.218
Zone IV and V				
Projection of Service Level		50.645	60.878	71.453
Service Level		5.098	4.918	4.745
Zone I, II, III, and IV				
Sorting			517.058	526.105
Zone II, III, IV and V				
Projection of Service Level			21.550	25.295
Service Level			4.588	4.480
Zone I, II, III, IV and V				
Sorting				568.240
Service Level				4.348

3.6.2. Level of Existing Truck and Motor Bike Rickshaw Services

Based on the study, the remaining piles are disposed to TPA, gradual improvement and sorting of existing transportation services, there will be services improvement in 2012 amounted to 15.46, 17.863 in 2013, 19.468. In 2014 with 21.568. Then in 2015 recorded 23.870 in 2016 with sorting in zones I, II, III, IV and V, with the average improvement on the Table 12.

Table 12: Level of Existing Trucks and Motor Bike Rickshaw Services with sorting method in TPS

Service Zone	Year			
	2013	2014	2015	2016
Zone I				
Sorting	29.230	29.743	30.263	30.793
Zone II, III, IV and V				
Projection of Service Level	139.758	173.795	208.910	245.200
Service Level	15.468	12.843	10.928	9.470
Zone I and III				
Sorting	55.260	56.228	57.213	58.213
Zone II, IV and V				
Projection of Service Level	91.068	113.248	136.130	159.778
Service Level	17.863	15.423	13.520	11.990
Zone I, II, and III				
Sorting		83.613	85.075	86.565
Zone IV and V				
Projection of Service Level		50.645	60.878	71.453
Service Level		19.468	17.908	16.540
Zone I, II, III, and IV				
Sorting		99.638	101.380	
Zone II, III, IV and V				
Projection of Service Level		21.550	25.295	
Service Level		21.568	20.633	
Zone I, II, III, IV and V				
Sorting			109.500	
Total of Residual and Piles Management			109.500	
Trucks Service Level (%)			23.870	

3.7. The Study Water Quality and Waste Service Improvement with Sorting Method in TPS

Based on the study, the projected level of water quality and waste management services through graduals sorting in the TPS amounted 2.498 in 2012, there will be services improvement in 2013 amounted to 4.723, 6.145 in 2014, -6.168 in 2015 and 5.553 in 2016, with the average improvement of Table 13.

Table 13: Waste Service Improvement on 2013-2016 in TPS with sorting method

Service Zone	Year			
	2013	2014	2015	2016
Zone I				
Sorting	7.505	8.305	9.103	9.903
Projection of Service Level	5.008	6.120	7.230	8.340
Service Improvement	2.498	2.185	1.873	1.563
Zone I, and III				
Sorting	9.730	10.253	10.773	11.293
Projection of Service Level	5.008	6.120	7.230	8.340
Service Improvement	4.723	4.133	3.543	2.953
Zone I, II, and III				
Sorting		12.265	12.498	12.730
Projection of Service Level		6.120	7.230	8.340
Service Improvement		6.145	5.268	17,56
Zone I, II, III, and IV				
Sorting			13.398	13.480
Projection of Service Level			7.230	8.340
Service Improvement			6.168	5.140
Zone I, II, III, IV and V				
Sorting				13.893
Projection of Service Level				8.340
Service Improvement				5.553

3.8. Existing the Study Water Quality and Assets Improvement in TPS with Sorting Method

3.8.1. The Existing TPS Services Improvement

The projection on water quality and waste management services /zone recorded until -4.230 in 2012, that has improvement of existing TPS service or lowering the declines level of existing service on TPS in 2013 amounted to -6.168, -5.118 in 2014, -2.763 in 2015 and -2.895 in 2016 with the average improvement of Table 14.

Table 14: Existing TPS Service Improvement on 2013-2016 in TPS with Sorting method

Service Zone	Year			
	2013	2014	2015	2016
Zone I				
Sorting	8.475	7.528	6.750	6.100
Projection of Service Level	12.705	10.218	8.500	7.243
Service Improvement	(4.230)	(2.688)	(1.750)	(1.143)
Zone I, and III				
Sorting	6.538	6.100	5.705	5.348
Projection of Service Level	12.705	10.218	8.500	7.243
Service Improvement	(6.168)	(4.118)	(2.795)	(1.893)
Zone I, II, and III				
Sorting		5.098	4.918	4.745
Projection of Service Level		10.218	8.500	7.243
Service Improvement		(5.118)	(3.583)	(2.498)
Zone I, II, III, and IV				
Sorting			4.588	4.480
Projection of Service Level			8.500	7.243
Service Improvement			(2.763)	(2.763)
Zone I, II, III, IV and V				
Sorting				4.348
Projection of Service Level				7.243
Service Improvement				(2.895)

3.8.2. Existing Truck Services and Motor Bike Rickshaw Improvement

The projection of water quality and waste management service per zone until 2.025 in 2012, there will improvement the existing trucks service on 2013 amounted to 4.420, 8.658 in 2014, 12.575 in 2015 and 16.208 in 2016, , with the average improvement of Table 15.

Table 15: Existing Trucks and Motor Bike Rickshaw Service Improvement with Sorting method in TPS

Service Zone	Year			
	2013	2014	2015	2016
Zone I				
Sorting	15.468	12.843	10.928	9.470
Projection of Service Level	13.443	10.810	8.993	7.663
Service Improvement	2.025	2.033	1.935	1.808
Zone I and III				
Sorting	17.863	15.423	13.520	11.990
Projection of Service Level	13.443	10.810	8.993	7.663
Service Improvement	4.420	4.613	4.525	4.328
Zone I, II, and III				
Sorting		19.468	17.908	16.540
Projection of Service Level		10.810	8.993	7.663
Service Improvement		8.658	8.915	8.880
Zone I, II, III, and IV				
Sorting			21.568	20.633
Projection of Service Level			8.993	7.663
Service Improvement			12.575	12.973
Zone I, II, III, IV and V				
Sorting				23.870
Projection of Service Level				7.663
Service Improvement				16.208

3.9. Feasibility Analysis

Based on the calculation of NPV at 15% interest rate, the NPV obtained positive value of Rp 2,043,325,165, IRR of 9.664% smaller than the MARR (Minimum Attractive Rate of Return) of 15%, B/C ratio of 1.13 (greater than1), and PP 4, 4 years (4 years 4 months 11 days) which means shorter than the period of the investment for 10 years, so that investment by sorting waste management in the spoiling stations could be feasible to be implemented. Based on the calculation of the potential revenue from the sale of junk until 2020, reaching Rp 4.535.553, 523. Initial investment cost plan assets of waste management with sorting method in TPS Rp 2,979,900,000, arm roll truck Rp 4,000,000,000, Garbage Container Rp 1.245.000.000 and Motor Bike Rickshaw Rp 825.000.000, so that the total in itial investment costof Rp 10,500,500,000. Operational and maintenance costs at TPS Zone Iine 2013, the equipment cost Rp 272,335,770, operating costs Rp 2,124,924,890, and maintenance costs Rp 66,150,000, bringing the total cost of operation and maintenance is Rp 2,463,410,600 [15-17, 32-33].

4. Conclusion

Based on this study, if the waste management is not done properly, then the level of existing TPS service save rarely decreased 13.11% per year, from 9.730% in 2013 in to 13.893 % in 2016. And the level of existing Truck and Motor Bike Rickshaw services averagely decreased 15.468 % per year, from 17.863 % in 2013 in to 23.870 % in 2016.

The level of existing TPS service averagely decreased 6.538 % per year, for 4.348 % in 2013 to 17.39% in 2016. Then, the level of existing Truck and Motor Bike Rickshaw services averagely increased 17.863 % per year, from 23.870 % in 2013 to 41.733 % in 2016. The improving of service cover age in existing TPS services by 8.29% per year, which is -4.230 % in 2012, -6.168 % in 2013, -5.118 % in 2014, -2.763 % in 2015, and -2.895 % in 2016. Based on the feasibility analysis of waste management until 2020, obtained Net Cash flow Rp 2.180.960.571. in 2020, NPV at 15% interest rate positive value of Rp 2,043,325,165, an IRR of 9.664 % > MARR of 15%, a B/C ratio of 1.13 > 1, and PP 4.4 years (4 years 4 months 11 days), which means shorter than the period of the investment for 10 years, so that investment by sorting waste management in these TPS could be feasible to be implemented.

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