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WASTE MANAGEMENT OF TOLL ROADS TOWARDS GREEN INFRASTRUCTURE IN INDONESIA

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ABSTRACT

Waste management is a complex problem in Indonesia. There are waste and waste disposal heaps at many locations, for examples in residential areas, traditional markets, sightseeing locations, unused-land, drains and road sides in the city, and also on toll road side. The aim of this study is to find out how to manage waste and reduce the illegal waste disposal along toll road side in Indonesia. Based on the monitoring data on all 29 toll roads in Indonesia i.e. toll roads in Java island, Sumatra island, Bali island, and Sulawesi island, there are many illegal waste disposal sites found at many locations along toll road sides, especially on the inter-city toll roads. Therefore, waste management of toll road in order to develop green infrastructure in Indonesia is crucial. Waste management could begin with periodic monitoring along the toll road, availability of waste/trash disposal receptacles at each rest-area, cooperation between road authority and the local government to manage waste and educate the society, develop holistic and integrated waste disposal management, regular campaign regarding 3R (reduce-reuse-recycle) until the adherence to public orderliness regulation. Results of this study are beneficial to manage waste and reduce illegal waste disposal locations along toll road side towards green infrastructure, not only in Indonesia but also in other developing countries with similar conditions.

Keywords: Developing countries, Green infrastructure, Indonesia, Toll road, Waste management

1. INTRODUCTION

Waste management is a crucial problem in many countries especially in developing country like Indonesia. In Indonesia, waste and illegal waste disposal are in residential areas, traditional markets, sightseeing locations, unused-land, drains and road sides in the city, and also on toll road side. Periodic monitoring data of toll road to fulfill minimum service standard also indicated that there are many illegal waste disposal sites found at many locations along the toll road side.

The aim of this study is to find out how to manage waste and reduce illegal waste disposal along toll road side in Indonesia. Data used and presented in this study is from all 29 toll roads in Indonesia. Results of this study are beneficial to manage waste and reduce illegal waste disposal locations along toll road side towards green infrastructure, in Indonesia and in other developing countries with similar conditions.

2. WASTE AND WASTE DISPOSAL IN INDONESIA

Waste and waste disposal in Indonesia is a complex, crucial, and not a new problem. The problem is more complicated due to high number of population, limited number of

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waste bin in the public areas, limited number of waste-truck, limited number and location of waste disposal, and poor waste disposal integrated management. If most of 2.461.931 million people (Indonesia Statistics Central Bureau, 2012) in Indonesia do not have a good habit to put the waste in a bin and furthermore have no awareness about the importance of sanitary and the aesthethic of the living space environment, therefore it is a huge problem and crucial to be solved.

In Indonesia, waste is usually piled up at many places including along the toll road side. Waste can be an organic and inorganic waste for example vegetation waste, food waste, plastic bottles, paper, animal carcasses, litter, sediment, and soil material. The condition leads to the overflow and flood in the city if rain occurs. Furthermore, the traffic congestion usually happened and traffic accident can be happened because of the flood.

The environmental issues specific to the construction and operation of roads include the habitat alteration and fragmentation, stormwater, waste, noise, air emissions, and wastewater. Solid waste generation during operation and maintenance may include road resurfacing waste, road litter, illegally dumped waste or general solid waste from the rest areas, animal carcasses, vegetation waste, paint waste, and sediment and sludge from stormwater drainage system maintenance (University of New Hampshire, 2001; World Bank Group, 2007; Austroads, Inc. 2003).

On the toll roads in Indonesia, many bus, trucks, and passenger car drivers throw the waste directly to the road. Waste can be cigarette ash, cigarette stub, tissue paper, and plastic bottle. Awareness of every people for not throwing the waste directly to the road is needed. In this poor condition, waste management problem cannot be ony dependent on the government waste employee. All level of societies are needed to contribute to the efficient and effective process to produce sanitary and pleasant environment, in their own responsibility.

2.1. Waste and waste disposal regulation

In general, it is government's responsibility to solve the problems regarding waste and waste disposal. There is a regulation regarding public orderliness and waste disposal at national and district level. At national level, there is Republic of Indonesia law number 18 year 2008 regarding waste disposal. It states about the kind of waste, location of waste disposal, responsibility and authority of government to assure a good waste disposal management based on the environment concept, society role, and prohibited actions to pollute the environment.

At the district level, there is the governor of special district of Jakarta province regulation number 8 year 2007 regarding public orderliness. Article 21 of the regulation said that each people or corporation is prohibited to: a. scratch, write, draw, attach advertisement on wall, bridge, pedestrian-bridge, bus stop, electric pole, tree, public transportation, and other public means; b. throw away and pile up waste on the street, plant stripe, river, and other places that can impair aesthetics and sanitation of environment; c. throw feces and litter on the road, garden, river, and drain.

2.2. Previous studies

Keep America Beautiful in 2009 indicated that the personal factor (behavior and poor knowledge regarding waste), social factor (daily life to keep living space clean by moving waste into the nearest place), and material factor (availability of trash bin and poor waste management) are factors that influence the availability of waste.

A study on one toll road in West Java, Indonesia, i.e. Purbaleunyi toll road (Utami, Gerienta Putu and Santosa, Wimpy, 2015) indicated that based on the questionnaire results givent to the society living near to the toll road, factors that influence the society behavior for throwing the waste away to toll road site is because the toll road side location is close to the society's living place, usual behavior to throw away waste to toll road site, dirty condition of toll road site, and unavailablity of the trash bin around their living place. On the other hand, the age, education level, and occupation are not related to such behavior.

3. CASE STUDY AND FIELD DATA

Case study id carried out on all 29 toll roads in Indonesia. They located in Sumatra island, Java island, Bali island, Sulawesi island, and connected to Madura island. Routine monitoring regarding the toll road condition to fulfill the minimum service standard also indicated that there are many illegal waste disposal sites found at many locations along the toll road sides.

Figure 1 presented the photos of the illegal waste disposal on toll road side in Indonesia. Table 1 presented the detail location of illegal waste disposal along the 29 toll road sides in both directions in Indonesia and Table 2 presented the number of locations of waste disposal along the 29 toll road sides in both directions.

In more detail, the number of waste disposal is not related to the length of the toll road but related to the location of housing or residential areas along the toll road side. Table 2 also shows that there are no illegal waste disposal locations on 14 out of 29 toll roads, whereas there are illegal waste disposal locations on 15 out of 29 toll roads. In more detail 10 out of the 15 toll roads lie at inter-city.

Figure 1 Illegal waste disposal on toll road side in Indonesia (BPJT, 2014)

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Table 1 Detail location of waste disposal along toll road side in Indonesia (BPJT, 2014)

No.	Toll Road		Detail Location of Waste Disposal
	Name	Length (km)	
1	Jakarta-Bogor-Ciawi	59.00	A direction: km 4+200, km 7+600, km 7+800, km 8+400, km 8+800, km 9+000, km 10+900, km 11+000, km 11+200, km 11+600, km 11+800, km 12+200, km 14+900, km 16+500, km 18+400, km 20+800, km 21+800, km 22+000, km 22+200, km 22+600, km 23+200, km 23+400, km 24+000, km 25+600, km 25+800, km 26+000, km 26+400, km 26+600, km 26+800, km 27+600, km 27+750, km 28+000, km 28+400, km 28+500, km 29+000, km 29+200, km 29+400, km 29+500, km 29+600, km 30+000, km 30+200, km 30+500, km 31+000, km 31+400, km 31+800, km 37+300, km 38+400, km 42+200 B direction: km 47+200, km 46+000, km 45+400, km 44+000, km 36+000, km 31+800, km 30+800, km 30+200, km 28+800, km 28+500, km 27+850, km 27+000, km 25+300, km 25+200, km 24+600, km 23+200, km 23+000, km 21+550, km 18+000, km 12+400, km 11+000, km 10+300, km 9+200, km 8+600, km 8+200, km 6+000, km 5+400
2	Jakarta-Tangerang	33.00	A direction: km 3+650, km 6+300, km 9+800, km 8+300, km 10+200, km 10+600, km 13+100, km 13+800, km 14+800, km 23+400 B direction: km 26+250, km 23+800, km 22+900, km 18+000, km 17+400, km 14+600, km 10+200, km 8+200
3	Cawing-Tomang-Grogol-Pluit	23.55	----
4	Prof.Dr. Ir. Sedyatmo	14.30	----
5	JORR	50.42	A direction: km 2+400, km 3+800, km 4+000, km 25+400, km 39+500, km 45+000, km 45+200, km 47+900, km 48+200, km 49+000, km 56+600 B direction: km 49+200, km 18+000
6	Pondok Aren-Bintaro Viaduct-Ulujami	5.55	A direction: km 1+200, km 2+000, km 2+200, km 3+600 B direction: km 3+800
7	Jakarta-Cikampek	83.00	A direction: km 4+800, km 5+200, km 5+500, km 6+300, km 10+400, km 10+500, km 10+800, km 14+600, km 15+000, km 15+100, km 20+500, km 20+700, km 35+200, km 42+000, km 51+000, km 59+500, km 63+600, km 65+400 B direction: km 71+600, km 54+800, km 37+800, km 37+000, km 34+600, km 23+800, km 16+000
8	Padalarang-Cileunyi	64.40	A direction: on/off ramp Pasteur, km 122+400, km 131+800A, km 134A+600A, km 136+600A B direction: km 147+800, km 146+800, km 144+000, km 138+400, km 133+800, km 128+000, on/off ramp Moh. Toha, on ramp Kopo, on/off ramp Pasir Koja
9	Cikampek-Purwakarta-Padalarang	58.50	A direction: km 85+000, off ramp Padalarang, km 122+400, km 126A+600
10	Palimanan-Plumbon-Kanci	26.30	A direction: km 207+400, km 208+800, km 212+300, km 212+800, km 220+300, km 221+300, km 225+400, km 227+300, km 224+400, km 229+700 B direction: km 226+100, km 225+300, km 220+400, km 218+000, km 217+000, km 215+000, km 211+050, km 209+600, km 209+200

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Table 1. Detail location of waste disposal along toll road side in Indonesia (BPJT, 2014) continue

11	Semarang Section A, B, C	24.75	A direction: km 1+200, km 4+400, km 7+300, km 7+400 Seksi A, km 12+200 Seksi C B direction: km 11+400, km 11+200 Seksi C, km 17+400, km 11+500, km 12+200, km 11+200, km 8+200, km 7+200, km 4+200, km 2+000, km 1+200, km 0+400, km 0+200
12	Surabaya-Gempol	49.00	A direction: km 4+200, km 5+200, km 5+600, km 5+800, km 6+000, km 13+400, km 20+600, km 34+200 B direction: km 33+200, km 22+600, km 7+200, km 7+000, km 6+800, km 6+600, km 6+400, km 6+200, km 5+200, km 4+000
13	Belawan-Medan-Tanjung Morawa	42.70	A direction: km 11+400, km 11+200 Seksi C, km 17+400, km 11+500, km 12+200, km 11+200, km 8+200, km 7+200, km 4+200, km 2+000 B direction: km 11+400, km 11+200 Seksi C, km 17+400, km 11+500, km 12+200, km 11+200, km 8+200, km 7+200, km 4+200, km 2+000
14	Jembatan Surabaya-Madura	5.40	----
15	Cawing-Tj Priok-Ancol Timur-Jbt Tiga/Pluit	27.05	----
16	Tanggerang-Merak	73.00	A direction: km 27+750, km 28+500, km 40+150, km 40+400, km 40+850, km 40+900, km 41+000, km 43+000, km 69+500, km 71+150, km 73+500, km 74+200, km 81+400, km 81+800, km 90+000, km 94+500 B direction: km 98+500, km 96+000, km 94+400, km 94+250, km 94+100, km 94+000, km 83+000, km 82+200, km 82+100, km 82+000, km 81+750, km 80+000, km 76+750, km 68+750, km 65+ 250, km 57+600, km 27+650
17	Surabaya-Gresik	20.70	A direction: km 2+200, km 4+300, km 13+200, km 13+600, km 14+700, km 15+100, km 17+800, km 18+000 B direction: km 17+400, km 13+200, km 12+800, km 12+600
18	Serpong-Pondok Aren	7.25	A direction: km 7+200, km 8+400 B direction: km 10+400, km 8+400, km 8+000
19	Ujung Pandang Seksi I dan II	6.05	A direction: km 1+200, km 1+250, km 2+000, km 2+400, km 3+500, km 4+400, km 5+400
20	S S Waru-Bandara Juanda	12.80	----
21	Makassar Seksi IV	11.60	----
22	Bogor Ring Road Seksi I	3.85	----
23	Kanci-Pejagan	35.00	----
24	JORR W1(Kebon Jeruk-Penjaringan)	9.85	----
25	Surabaya-Mojokerto	1.89	----
26	Semarang-Solo Seksi I	11.00	----
27	Cinere-Jagorawi Seksi I	3.70	----
28	JORR W2 Utara	7.70	A direction: km 12+700
29	Nusa Dua-Ngurah Rai-Benoa	9.70	----

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Table 2 Number of waste disposal location along toll road side in Indonesia (BPJT, 2014)

No.	Toll Road		Location	Number of Location of Waste Disposal	
	Name	Length (km)	1: urban 2: inter city	A direction	B direction
1	Jakarta-Bogor-Ciawi	59.00	2	48	27
2	Jakarta-Tangerang	33.00	2	10	8
3	Cawing-Tomang-Grogol-Pluit	23.55	1	0	0
4	Prof.Dr. Ir. Sedyatmo	14.30	1	0	0
5	JORR	50.42	1	11	2
6	Pondok Aren-Bintaro Viaduct-Ulujami	5.55	1	4	1
7	Jakarta-Cikampek	83.00	2	19	7
8	Padalarang-Cileunyi	64.40	2	5	9
9	Cikampek-Purwakarta-Padalarang	58.50	2	4	0
10	Palimanan-Plumbon-Kanci	26.30	2	10	9
11	Semarang Section A, B, C	24.75	1	5	12
12	Surabaya-Gempol	49.00	2	9	10
13	Belawan-Medan-Tanjung Morawa	42.70	2	9	10
14	Jembatan Surabaya-Madura	5.40	2	0	0
15	Cawing-Tj Priok-Ancol Timur-Jbt Tiga/Pluit	27.05	1	0	0
16	Tanggerang-Merak	73.00	2	16	17
17	Surabaya-Gresik	20.70	2	8	4
18	Serpong-Pondok Aren	7.25	1	2	3
19	Ujung Pandang Seksi I dan II	6.05	1	7	0
20	S S Waru-Bandara Juanda	12.80	1	0	0
21	Makassar Seksi IV	11.60	1	0	0
22	Bogor Ring Road Seksi I	3.85	1	0	0
23	Kanci-Pejagan	35.00	2	0	0
24	JORR W1(Kebon Jeruk-Penjaringan)	9.85	1	0	0
25	Surabaya-Mojokerto	1.89	2	0	0
26	Semarang-Solo Seksi I	11.00	2	0	0
27	Cinere-Jagorawi Seksi I	3.70	2	0	0
28	JORR W2 Utara	7.70	1	1	0
29	Nusa Dua-Ngurah Rai-Benoa	9.70	1	0	0

4. ANALYSIS AND RESULTS STUDY

Although there are public orderliness regulations as mentioned in section 3.1, the implementation of the regulation was very low and furthermore, the punishment regarding this regulation is also not consistent. If this case occurs continuously, then the waste and illegal waste disposal problems cannot be solved and can cause disturbance for the aesthetics, environment, healthy, overflow, and flood. On the other hand, good society habit of reduce, reuse, and recycle (3R) principle of waste are also important. Therefore, in order to have a good solution, a consistent implementation of the regulation as well as the implementation of 3R including using reuse things need to be done holistically.

Data of illegal waste disposal locations in Table 1 and Table 2 is an initial step to develop waste management problem along toll road side in Indonesia. The availability of the accurate, complete, and up to date recorded data of road and traffic conditions (Sutandi, A. Caroline, 2015) is needed to support implementation of green infrastructure. Based on the detaied data, further simultaneous steps of good waste management to overcome illegal waste disposal problem along toll road side are as follows:

- Periodic monitoring to collect the real accurate and continuous data of illegal waste disposal condition and location along toll road side. The application of the traffic camera as a part of intelligent transportation systems (ITS) will be beneficial. The main purpose of ITS implementation is to increase the safety aspect and to support actions and steps towards green infrastructure (Ghosh, Sumit, Lee, Tony S., 2010).

Furthermore, the availability of trained personnel, required and maintained equipment, and standard operating procedure is needed;

- Rather than do nothing, it is better that at the meantime, the societycollect all the waste/trash along toll road side using available waste-truck and take them to waste disposal. Cooperation among road authority and government at national, province, regency, and city level along toll road location is needed;
- The availability of waste/trash disposal receptacles at parking area at each rest area and residential area along toll road;
- Finding out reasons regarding the habit of the society to litter along toll road side (BPJT, 2014);
- Cooperation with mayor, regent, village chief, and neighborhood association to educate society and inform them about the importance of sanitation, healthy life habit and also bad impact of waste on environment around them;
- Enhancement of right of way esthetics especially at potential illegal waste disposal locations along toll road side (BPJT, 2014);
- Develop holistic and integrated waste disposal management. It can be started with the availability of waste dump with an adequate number and capacity at the residential areas and public areas, availability of government waste employees with adequate number and competency, periodic waste collecting schedule, last waste disposal, waste management with technology that can produce fertilizer and electrical energy as a renewable energy;
- Regular campaign to society regarding the importance of 3R (reduce, re-use, recycle) program. Society has to be involved in order to keep and remind each other about their responsibility in order to have their own sanitary and healthy living space. Continuous and consistent campaign will lead to a good result;
- Adherence to public orderliness regulation, especially regulation regarding waste disposal. For example restriction to littering along the road and river, availability of small waste bin in the car. Another important thing is a consistent implementation of punishment to the offender;
- Do the simultaneous steps continuously in order to have healthy life habit of the society. Time is needed to make society aware about the sanitary and healthy life;

Simultaneous steps of good waste management mentioned earlier can also be implemented in other road side locations beside toll road side. Furthermore, the good waste management also supports the action to decrease the number and severity of accident before, during, and after the accident occurs (Sutandi, A. Caroline, 2015).

5. CONCLUSION

Waste management is a complex, crucial, and not a new problem in Indonesia as a developing country. Waste and illegal waste disposal are not only located at the residential areas in the city but also located along toll road side. The condition leads to the poor sanitary and healthy living space. Good waste management regarding simultaneous steps to overcome illegal waste disposal problem along toll road side begins with the periodic monitoring along toll road and then continued by a number of actions involving government and society, in their own responsibilities to make an efficient and effective process. Results of this study are beneficial to manage waste and reduce illegal waste disposal locations along toll road side towards green infrastructure,

not only in Indonesia but also in other developing countries with similar conditions towards sanitary and pleasant of environment living space.

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