

Linkage model between sustainable consumption and waste management system

NiLuhWidyaningsih*

*Environmental Science, University of Indonesia

Abstract- Indonesia as the 4th most populous country in the world, has potential economic growth and also environmental degradation problems. DKI Jakarta Province (capital city) has the most dense area about 30% of the people. East Jakarta has the highest number of unmanaged waste (2,430 m³/day). It is because of the people do not apply the sustainable consumption and they do not obey the law (UU No. 18/2008 on Waste Management). To see the relation between the household income and their consumption (for food and non-food), I used the Spearman's Rho Correlation and to build a linkage model between the household consumption and the waste management system, I used the System Dynamics Analysis. This paper used qualitative approach and used quantitative data also. This paper emphasized on the consumer behavior. The important finding to apply the sustainable consumption are the green motivation and the green lifestyle.

Index Terms- Sustainable Consumption, Household Waste, Spearman's Rho Correlation, System Dynamics

I. INTRODUCTION

Since Industrial Revolution, the development on the knowledge and technology made tremendous improvement on any human life aspects (manufacturing, transportation, healthcare, and others). The increase number of the population increases the need of human beings, such as food, clothes, and shelter. On the other hands, there is limitation on the natural resources to supply the factor of production. This phenomena caused well-being gaps and public problems. For example, poverty (economic side), criminality (social side), and pollution/waste (environmental side).

Indonesia has almost 250 million of people and they centered on the capital city (14,469 people/km²). Jakarta divided into five district areas, such as: North Jakarta, South Jakarta, West Jakarta, East Jakarta, and Central Jakarta. East Jakarta. East Jakarta (Table 1.) has the highest number of unmanaged waste (2,430 m³/day). East Jakarta has ten sub-district areas and Kecamatan Duren Sawit has the highest number of household 94,862 KK (a.k.a. KepalaKeluarga).

The number of household implies the purchasing power of one family, where it includes father/mother, and kid (s). The household expenditure can be approached from their spending because there is no data for consumption for each household. The household consumption expenditure data (Table 2.) from Statistical Office in 2011 and 2012, people in Jakarta consumed more on non-food products (66.24% and 63.01%) than food products (33.76% and 36.99%). It means that the increase of the household income, it will shift the consumption pattern from

food products into non-food products. this phenomena follows the Engel's Law (with the assumption that the household consumption preferences are at the same level).

The change on the household consumption pattern will change the waste volume and the waste characteristics or composition. The waste management system in Jakarta did not integrate yet and it cause many environmental issues, e.g. flooding and health issues. The most risky areas are in the North Jakarta and East Jakarta. The people has low participation level on the environmental awareness.

Table 1. Waste Volume in DKI Jakarta (2011)

No.	District Area	Volume (m ³ /day)	Managed (m ³ /day)	Unmanaged (m ³ /day)
1.	Central Jakarta	5,479	5,479	0
2.	North Jakarta	4,519	4,517	2
3.	West Jakarta	6,490	5,526	964
4.	South Jakarta	5,696	5,642	54
5.	East Jakarta	6,331	3,901	2,430
	Total	28,515	25,065	3,450

Source: Sanitation Department.

Table 2. Percentage of Household Consumption

Province/ National	Consumption on Food		Consumption on Non-Food	
	2011	2012	2011	2012
Jakarta	33.76	36.99	66.24	63.01
Indonesia	49.45	51.62	50.55	48.38

Source: Susenas 2011 and 2012, Statistical Office.

There is linkage between the economic activity and waste management. So, to reduce the unmanaged waste, we focus on the economic side, especially on the consumer behavior on consumption decision making-process.

II. RESEARCH ELABORATIONS

I used the qualitative approach and also used the quantitative data to support the System Dynamics model. The questionnaires are for one hundred households (Slovin) that spread on the seven villages at Kecamatan Duren Sawit, East Jakarta. The questionnaires used the Likert scale (1-5). I used depth interview to eight households at the four villages that already applied the 3R principle (reduce, reuse, and recycle). The seven villages at Kecamatan Duren Sawit are Kelurahan PondokBambu, Kelurahan Duren Sawit, Kelurahan PondokKelapa, Kelurahan Pondok Kopi, Kelurahan Malaka Jaya, Kelurahan Malaka Sari, and

Kelurahan Klender. Samples are being chosen random proportionally.

The housing area divided into two types for the purpose of this research, such as the unorganized and organized housing area. The different between these types are:

1. The characteristics of the unorganized housing area are: the size of the houses are mostly small; less/no trash bin available in front of their house; close distance between houses; and their household income is low.
2. the characteristic of the organized housing area are: the size of the houses are mostly medium and big; they have trash bin; there is space between houses (garden and/or garage); and their household income are medium and high levels.

The housing area types make a bit difference on the way the sanitation officer carry the household waste. For the unorganized housing area, the sanitation officer cannot use the motorcycle bin but they use the wheeled bin. For the organized housing area, the sanitation officer use the wheeled bin. They do not have separated bin to carry the household waste from the house. the distance between the houses gives impact to the social interaction among them. For the unorganized housing area, people communicate more frequent than people on the organized housing area. So, the social interaction becomes informal advertisement media on the smallest level (household).

The variables on the statistical analysis are: household consumption; motivation (the need value and the usage value); lifestyle (other the people influence and advertisement); and 3R principle (reduce, reuse, and recycle). The consumption motivation sub variables are derived from the human needs triangle by Abraham Maslow (Picture 1.)

Picture 1. Hierarchical Theory of Human Needs



Source: Nitisusastro, 2013.

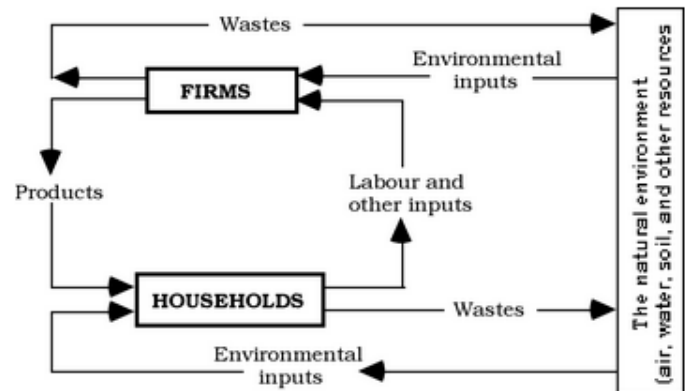
The consumer behavior come from the internal and external factors, such as:

1. Internal factors: perception, personality, experience, motivation, and behavior.
2. External:
 - a. Packaging: product, price, distribution, and promotion.
 - b. Social-culture: demography, family, social class, and group reference.

These all factors combined and mingled in the questionnaires. The household consumption is for food and non-food product (not including the service).

The linkage between economic activities and environment, we can see on the picture below. This paper did not discuss about the producer side because we focus on the consumer side only. I believed that human being can be a homo-economicus and homo-ecologicus. It means that a consumer does not only maximize their utility but they also can preserve the environment condition.

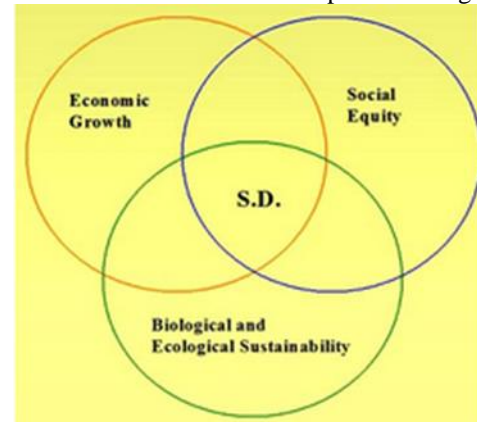
Picture 2. The Relation between Environment and Economic Activity



Source: Thampapillai, 1991.

Sustainable consumption is not only consider the price of the product and the quantity but it also consider the value of the environment on their consumption decision making-process. So, the development will be sustainable if consumer apply the sustainable consumption. The impacts will not only for the environmental condition but also for the social standard of living.

Picture 3. Sustainable Development Triangle



Source: FAO Corporate Document Repository, 2004

On the Picture 3.above, the economic development must consider the environmental value and the social condition to be more sustainable in the future. Having sustainable environmental condition, we have to manage the household waste that starts from reducing the waste from the source (household consumption). So, reducing the household waste will reduce the greenhouse effect gas emission and eliminate the source of the disease (flies, rats, and other insects).

Based on the Organization for Economic Cooperation and Development (OECD), the definition of waste refers to materials that are not prime products (that is, products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose. On this paper, the consumption divided into food and non-food. For food products usually the waste is natural or organic, where it is easy to decompose naturally. For non-food products, the waste comes from the man-made packaging materials (i.e. paper, plastic, glass, metal, and other), which are not easy to decompose naturally. So, this kind of household waste need more process to manage it.

In Indonesia, the waste management system includes collect the waste (usually after the cooking time in the morning); put the trash in the trash plastic (usually they get the plastic bags from the markets/stores); hang it in front of their gate or put it into the trash bin; and the sanitation officer will take the trash once every two days. The sanitation officer will carry the waste to the temporary landfills (TempatPenampunganSementara=TPS) before the dump truck take it to the permanent landfills (TempatPengolahanAkhirSampah=TPA).The problems is, they do not sort the waste into inorganic and organic waste. Based on the secondary data from the Sanitation Department Kecamatan Duren Sawit, there are twenty eight TPS. After I observed, there are more than twenty eight. It is because people at Kecamatan Duren Sawit use illegal property to throw their waste (a.k.a. shadow TPS).

The waste management system paradigm shifted from the end of pipe system paradigm into the goodhouse keeping paradigm. End of pipe system paradigm means that the percentage of the application of the 3R principle (reduce, reuse, recycle, and disposal), the biggest is on the disposal level at the end. Now, the goodhouse keeping paradigm, the biggest percentage emphasizes on the first level (reduce the waste). Reduce the waste starts from the small level or family.

III. RESULTSAND FINDING

The household goods categorized into two groups:

1. Food products are rice, yam/cassava/maize, fish, meat, eggs/dairy, vegetables, fruits, sugar/coffee/tea, cooking oil/spices, beverages, tobacco/betel, and other food stuff/beverages.
2. Non-food products are clothes/shoes/hats, party needs/ceremonies (not including facilities for home/transportation/telecommunications, tax/insurance/savings, education services, security services/household workers, and health service/physician).

Table 3. Spearman's Rho Correlation between Income and Consumption

			Pendapatan	Konsumsi Makanan	Konsumsi Non Makanan
Spearman's rho	Pendapatan	Correlation Coefficient	1.000	.175	.399 ^{**}
		Sig. (2-tailed)	.	.083	.000
		N	99	99	99
	Konsumsi Makanan	Correlation Coefficient	.175	1.000	.248 [*]
		Sig. (2-tailed)	.083	.	.013
		N	99	99	99
	Konsumsi Non Makanan	Correlation Coefficient	.399 ^{**}	.248 [*]	1.000
		Sig. (2-tailed)	.000	.013	.
		N	99	99	99

Source: Data processed using SPSS, 2014.

The statistical analysis showed that there is correlation between income and household consumption with p value is $0.000 < 0.005$. People in Jakarta has bigger percentage of non-food consumption than for food products. Based on the statistical analysis, the non-food consumption has significant correlation with the motivation (especially for the need value). For the lifestyle, non-food consumption has significant correlation with the influence by other people (with p-value is $0.040 < 0.005$). On the interviewed, I found that people who live in the unorganized housing areas, they communicate to their neighbor every morning while they go to the markets. For example, they are being introduced with a new packaging food products (a.k.a. sachet). They buy it and they introduce it to the other family members. So, there is intense relationship between consumer of the households.

The knowledge about environment awareness for people at Kecamatan Duren Sawit is different between people who live at the unorganized and organized housing area. People at the organized housing area mostly are well-educated and have permanent income job, for example a lecturer, a lawyer, and other (housewife). They are already well-known about unmanaged waste problems and how to separate their waste before their throw it but the obstacle that they find is there is no law enforcement.

I interviewed also the closet markets/stores with the housing area. Based on the questionnaires, the average distance between the housing area and the market is less than one kilometer and they can go there by walk or ride a bicycle. The respondents said that they get used to buy something (food and/or food) every week. When I asked about their willingness to bring a shopping bag, they are a bit reluctant because the unpractical reason. The store cashiers (such as Alfamart or Indomaret), they said that they sell the products as a given products, where they do not know about the green product or biodegradable products.

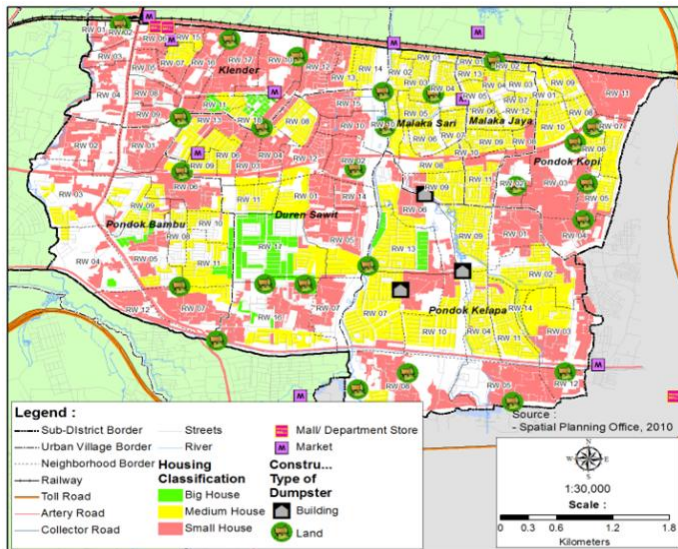
Other interesting findings are: (a) people who live in the unorganized housing area has actualization value that I called here as prestige (gengsi in bahasa Indonesia). Prestige means here is people will feel better if they carry more of plastic bags; and (b) the location of the TPSs do not have standard regulation, such as the TPS location some of them are very close distance with the big size permanent houses. For the gengsi variable, there is significant correlation between income and the non-food consumption based on the actualization value (p value is $0.003 < 0.05$).

For the application of the 3R principle, there is significant correlation between non-food consumption and 2R principle (the reduce and recycle activities). It means that there is potential intervention on the application of the 3R principle. These sub-

variables can become intervention on the System Dynamic analysis.

Picture 4. show the TPS locations and the housing area at Kecamatan Duren Sawit. There are permanent TPS with a building and the non-permanent TPS (which is only on the open space area). On the left side of the map, there are some areas that cannot get the one kilometer radius TPS's service. It creates shadow TPS. The rest of the other areas, there are so many overlapping one kilometer radius TPS's service.

Picture 4. Kecamatan Duren Sawit



Source: Spatial Planning Office, 2010.

The waste composition data is not available on the sub-district or Kecamatan level (only for the province level). Table 4. below show the waste characteristic at DKI Jakarta Province 2010. The organic waste is still the highest percentage (55.37%) compare with the inorganic waste.

Table 4. Waste Characteristic at DKI Jakarta Province 2010

Type	Percentage (%)
Organic	55.37
Inorganic	44.63
Paper	20.57
Plastic	13.25
B3	1.52
Other	9.29

Source: Sanitation Department DKI Jakarta Province.

The System Dynamics analysis is a system to build model the linkage between the sustainable consumption and the waste management system. The household waste increases the unmanaged waste. To reduce the unmanaged waste, people call the sanitation officer to pick it up. So in reality, reducing the unmanaged waste by doing this system is not sustainable in the future because it does not come from inside the consumer. This story becomes CLD structure on the System Dynamics analysis (Picture 5.).

The unmanaged waste degrade the environmental condition and people start to realize that they must change into green

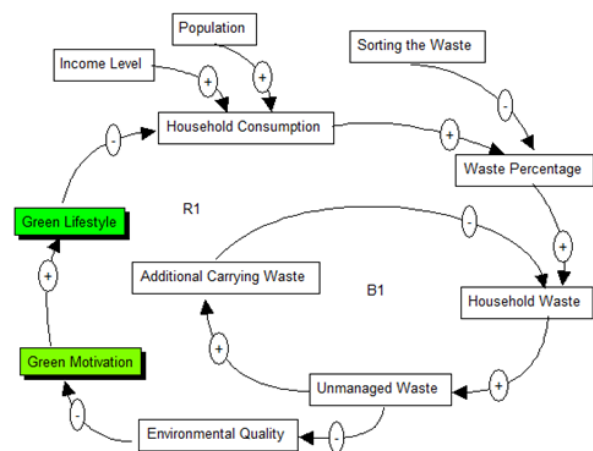
motivation on their consumption behavior. It will shift into the green lifestyle. The green lifestyle will change the household consumption and it will reduce the waste percentage. For example: if people buy a bottle of water every day, it will add the inorganic waste. If people apply the sustainable consumption (reduce the use of a bottle plastic) and they use their own bottle to drink, it will reduce the inorganic waste. It is not only more effective on using the resources but also more efficient on the consumption expenditure.

Other variables that influence the household consumption are the population number and the income level. Based on the validation test (Absolute Means Error or AME < 30%) for the System Dynamics analysis, the increase number of population will increase the waste volume. So, because the unmanaged waste model is valid, we can run the simulation until 2020. The Spearman Rho's Correlation showed that the household income has significant correlation with the consumption.

The intervention that we can do on the System Dynamic analysis are the green motivation level from the needs value and the usage value; and the lifestyle value from the influence of other and advertisement level. All those interventions are from the inside of the System Dynamics analysis (functional intervention). The structural intervention that we can do is the waste percentage that comes from the sorting the waste. This sub-variables is relatively sensitive to reduce the unmanaged waste. The sensitivity test is being conducted on each sub-variable, such as:

1. Motivation: the need value and usage value.
2. Lifestyle: the influence of other and advertisement media.
3. Consumption: food and non-food products.

Picture 5. Causal Loop Diagram (CLD) and Business as Usual (BAU) for the Waste Management System



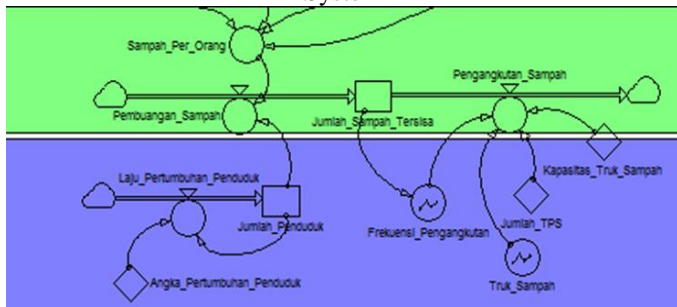
Some basic information that I used to run the model are:

1. The waste management (once every two days).
2. One dump truck capacity is about 6.8-10m³.
3. There are twenty eight TPS locations.
4. Waste volume for one person is about 0.75kg/day (considered the Standard National Indonesia and the interviewed with the Sanitation Department).

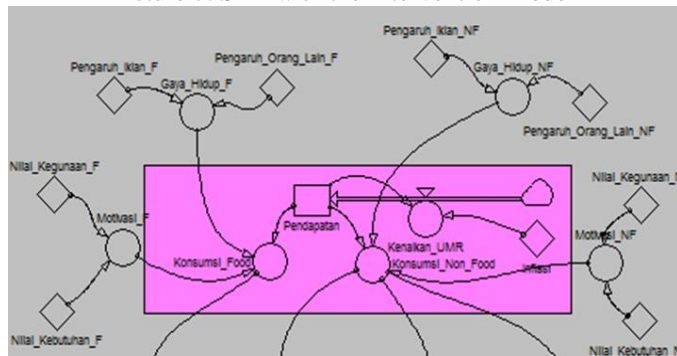
The assumptions are: no adding facility (such as the dump truck) and the waste pickers(a.k.apemulung in Bahasa Indonesia) do not change their work.

Below is some parts of the Stock Flow Diagram (SFD) for the model:

Picture 6. Stock Flow Diagram (SFD) of the Waste Management System



Picture 7. SFD with the Intervention Model



Picture 6., the waste per person (=sampah_per_orang); the waste volume (=pembuangan_sampah); the waste volume (=jumlah_sampah_tersisa); the carrying waste (=pengangkutan_sampah); the population growth (=laju_pertumbuhan_penduduk); the population number (=jumlah_penduduk); the growth rate (=angka_pertmbuhan_penduduk); the frequency (frekuensi_pengangkutan); dump truck number (=truk_sampah); TPSs number (jumlah_TPS); and truck capacity (kapasitas_truk_sampah).

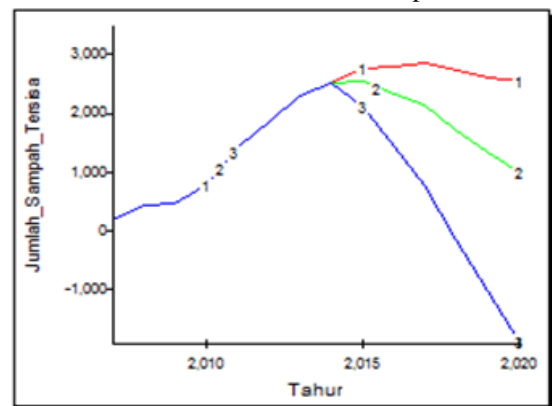
Picture 7., food consumption (=konsumsi food); non-food consumption (=konsumsi_non_food); income (=pendapatan);

minimum wage (=kenaikan_UMR); inflation (=inflasi); motivation (=motvasi); lifestyle (=gaya_hidup); need value (=nilai_kebutuhan); usage value (=nilai_kegunaan); other influence (=pengaruh_orang_lain); and advertisement (=pengaruh_iklian).

Picture 8. showed the intervention on the graphically scenario: (a) the first line id the BAU; (b) the second line is the optimistic scenario; and (c) the third line is the pessimistic scenario. The scenarios are based on the waste processed on the household levels, such as:

1. Organic waste: composting.
2. Inorganic waste:
 - a. Waste can be on sale or reused.
 - b. Waste can on recycled.
 - c. Not processed at all or disposal.

Picture 8. The Scenario Graphs



IV. CONCLUSIONS

The sustainable consumption has correlation with the waste management system and it will be more sustainable in the long run to reduce the unmanaged waste. The green motivation and the green lifestyle are the most crucial parts on the sustainable consumption, especially on the application of the 3R principles.

ACKNOWLEDGMENT

I cannot express enough thanks to Prof. PrijonoTjptoherijanto, S.E., M.A., Ph.D.; Prof. Dr. Ir. SulistyoweniWidanarko, S.K.M; Francisia SSE Seda, Ph.D. for their continued support and encouragement. I offer sincere appreciation for the learning opportunities.

My completion of this project could not have been accomplished without the support of my classmate of Doctoral Program of Environmental Science-University of Indonesia and my dearest family (my husband-IGG Adiwijaya, Ph.D. and my little American sweetheart-IGG Judestra).

Finally, my heartfelt thanks to people in my house.

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AUTHOR

Author – NiLuhWidyaningsih, Ph.D. candidate, University of Indonesia and nhwidya@yahoo.com.

Correspondence Author –
NiLuhWidyaningsih.nhwidya@yahoo.com, (+62) 813-1403-2020