The Study of Household Solid Waste Management at Residential Near Industrial Park. (Study Case: Graha Mattel Residence, Cikarang, Indonesia)

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Abstract. Solid waste management problem is become a big problem that every countries face specially developing countries like Indonesia due to the population growth that increase the waste generation with a various type of composition. For the best solid waste management, the data of solid waste generation and composition are very needed so that when make a plan or design of solid waste management can meet the target. **Objectives:** The objective of this research is to analyze the household waste generation rate, waste composition and propose an alternative waste management method to treat dominated waste composition that produced. This research also wants to find out whether knowledge, attitude and income have influence to the behavior of housewives. **Method and Result:** The method used to measured and analyzed waste generation and composition using SNI 19-3964- 1994 standard While for the awareness, questionnaires using likert scale and the data analyzed using Multiple Linear Regression and Classical Assumptions. The result shows the waste generation is about 1.47 kg/household/day or around 0.3 kg/person/day with composition of 53% organic waste following by plastic 21% and papers 14%. In the social aspect the attitude of housewives have positive significant influence toward behavior. **Conclusion:** in conclusion the dominated waste composition 53% can be treating using anaerobic digestion that will produce 0.084 m3 of Biogas per day.

1 Introduction

Developing economic activities in an area will attract people atention to do an urbanization to that area[1].Therefore causing the increase of population in an area from year to year specially in a big city. The more the number of people, the more greater pressure on the environment due to the greater number of people who need more resources, such as food, water,resources and land availability for agriculture and settlements[2].

Rapid growth of the industrial sector, would attract people of productive age to obtain decent employment in the industrial sector[3]. This certainly causes the level of community migration to the industrial area also increases and also cause around the industrial area is crowded with migrants or workers who need adequate residence, facilities and adequate infrastructure[4].

Graha Mattel Residence is located in RW 012, Simpangan, North Cikarang sub-district, Bekasi regency where the residence is located nearby the Jababeka industrial estate which makes many people want to urbanize and live here, according to the North Cikarang data in 2015 the total population number is 197.671 have increased to 278.421 in 2018 [5,6]. From industrial activities it is possible to give negative impact to environment and social in particular on households[7]. Although based on the policy the development of industrial estate separating industry and housing, community may be affected by industrial activities, such as noise, traffic, pollution, and other environmental problem[8]. Environmental management is very important for the welfare of the environment and the community, such as waste management where waste is increasing by a large amount with various compositions due to activities of resident or workers who live there[7]. Waste generation and composition changes every year and these changes are caused by people's lifestyles, economic growth and so on[9]. Handling of household solid waste in Graha Mattel residence is only carried out by transporting garbage from household using a garbage car then discarded to Landfill.

Basically, the solid waste in Cikarang Utara is collected by the Bekasi municipal service to be further thrown into the Burangkeng landfills and dumps[10]. However, not all the waste are collected and delivered to the final dump site, either because of the financial shortage or inefficient facilities. In other hands because of the waste are thrown into landfill without minimize the waste cause the overload of Burangkeng landfill[11]. To overcome these Environmental services of Bekasi regency already implemented strategies to reduce the waste that sent to the burangkeng landfill by create various program of reducing waste at source. To planning a new waste management strategies and waste management program[12].The data of waste generation and waste composition is needed so that can meet the target of an area, especially in Graha Mattel residence. Because base on the preliminary survey there is no waste management program that implemented yet.

In implementing Household Waste Management requires the active participation of individuals and groups of people so that the government's role implemented is not heavier[13]. Increasing community participation in waste management, can be carried out in involving the community as the largest waste producer, by raising behavior of the community in this research focus on housewives as a person in charge of domestic waste management [14]. Therefore this research wants to know the housewives behavior in household waste management.

Figure 1.1 shown the framework of social aspect of this research. H1 to H4 is the hypothesis of the research where later on after analyzing, the result will compare to the hypothesis, to know whether the result same with the hypothesis or not.

Figure 1.1 Hypothesis of social aspect
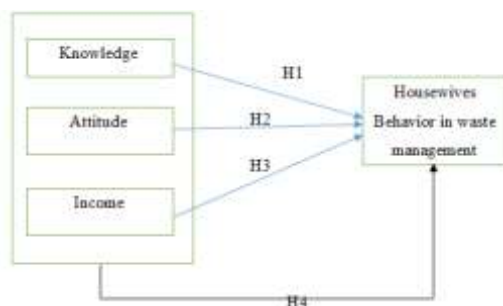
The hypotheses can be stated as follow:

H1 = Knowledge has significant effect towards behavior of housewife in waste management

H2 = Attitude has significant effect towards behavior of housewife in waste management

H3 = Income has significant effect towards behavior of housewife in waste management

H4 = Knowledge, Attitude and Income has significant effect towards behavior of housewife in waste management.

2 Method

In this research, the method, result and discussion will divided into two part which is **Technical Aspect** and **Social Aspect**. Where in the technical aspect will talk about the waste generation and waste composition while the social aspect talks about housewives behavior.

2.1 Population and Sample

2.1.1 Technical Aspect

The population was all the household in Graha Mattel residence and the sampel size were 19 household where determined using the SNI 19-3964-1994 standard. The preliminary survey was conducted first to know the Population size and the household it self. In this research the sampel was choose using purposive sampling method.

The data of the population got from the Head of residencial is 350 household in Graha mattel residence and base on the data from Cikarang utara dalam angka 11,985 household in Desa Simpangan by seeing the table bellow Desa simpangan is categories as a metropolitan[15].

Table 2.1   Clasification of City base on SNI

No	Clasification of the city	Total population	Total sampel people (S)	Total

				household KK (K)
1.	Metropolitan	1000.000-2.500.000	1000-1500	200-300
2.	Big	500.000-1.000.000	700-1000	140-200
3.	Medium,small, IKK	3.000-500.000	150-350	30-70

$$S = Cd \sqrt{Ps}$$

$$S = 1 \sqrt{350}$$

$$S = 18,7 \ = 19 \ households$$

Where :

S = The number of sample (KK)

Cd= residencial coeficient (metropolitan = 1)

Ps= Number of Population (Household)

From the calculation above got 19 household as the sample size and divided into 4 claster which is three claster are 5 household and 1 claster is 4 household.

2.1.2 Social Aspect

The technique of purposive sampling were used. The population were all the housewives in Graha Mattel residence.The formula of cochran used to calculate the sample size [16]. Formula for calculation of a sample size :

$$n = \frac{N}{1+N \ (e)^2}$$ N = Number of total opulation

n = Number of sample size

e = Margin of error (0,1)

The total housewives in Graha mattel was estimated to 350 housewives

$$n = \frac{350}{1 + 350 \ (0,1)^2} = 77,7 = 78 \ housewives$$

2.2 Data Collection

2.2.1 Technical Aspect

Data collection of household waste generation rate and composition are follow the SNI 19-3964-1994. And according to this standard the measurement of waste generation and waste composition method can be done as follows :

1. Distribuiting plastic bags to the household sample that already choose one day before collection.
2. Record the number of household sampel that choose.
3. Collecting the waste that already filled in plastic bag and take to the measurement place.
4. Weigh the measuring box and pour the waste into the box.
5. Stomping 3 times and started weigh.
6. The volume and weight of waste was recorded.
7. Sorting waste depend on each type of waste
8. Weighing the waste and record it.

The materials used to the sampling are Plastic bag to put the waste,stationary to record the weight and volume of waste, hanging scales 100 kg for waste generation rate and cake scales up to 5 kg for weigh the waste composition, meter to measure the volume and the personal protection equipment such as mask and gloves.

2.2.2 Social Aspect

In the social aspect the questionnaire are use to collect the data. The questionnaire was divided into 7 section where in the first section there are two filltering question, second section there are four questions about respondents identity. In third section until sixth section there are several question in each section about Behavior,Knowledge,Attitude and Income. For each variable the questionnarie are using Likert scale.The distribution of questionnarie are used Google form and direct answer in paper.Before data collection, the question in the questionnaire is tested to determine its validity and reliability first.

2.3 Data Analysis

2.3.1 Technical Aspect

The collected data need to be processed and then analyzed for simplified so easily interpreted. The data generated are: waste generation and composition. Analysis of the data using SNI 19-3964-1994 The data is processed and analyzed to determine the amount of generation (kg / day) volume (m3 / day) or (Kg/person/day) and percent (%) of waste weight.

2.3.2 Social Aspect

2.3.2.1 Descriptive Analysis

Data analysis will be done using regression analysis, namely multiple linear regression. Analysis of multiple linear regression is a linear relation between two or more independent variable (Knowledge,Attitude,Income) with the dependent variable (Behavior). The analysis is aims to determine whether the direction of dependent and independent variable is positively or negatively and also to predict the value of dependent variable if independent variable decrease or increase. To do multiple linear regression testing, the author use Microsoft Exel to analize.

$$y = β0 + β1x1 + β2x2 + β3x3 + ε$$
y = Behavior
x1= Knowledge
x2 = Attitude
x3 = Income
β0 = value of y when x is 0 (y intercept)
β1,β2,β3 = partial regression coefficient
ε = residual terms

2.3.2.2 Hypothesis testing

Hypothesis testing to show whether the first hypothesis in the beggining are correct and answer the research objective or not.F-test,t-test and R-squared model were tested in this reseach using Microsoft Exel.F-test is used to determine overall independet variable relationship towards dependent variable.Decision making criteria: H0 is accepted if F count < F table at = 5% H0 is rejected if F count > F table at = 5%. t-test is used to test whether the independent variable individually has a significant relationship or not with the dependent

variable.Decision making criteria: H0 is accepted if t count < t table at = 5%. H0 is rejected if t count > t table at = 5%. The R-square is used to determine how much the model's be able to explain the dependent variable in this research.If R2 gets bigger, it can be said that the variance of the independent variable is large with respect to the dependent variable.This means that the model used is getting stronger to decribe the variance of independent variables towards dependent variable.

3 Results and Discussion

3.1 Technical Aspect

3.1.1 Waste Generation

In determining waste generation rate that produced by household per day, 19 household was choosen as a samples. The waste was took and weigh everyday at 8 am during 8 days started from 21st January 2020 to 28th January 2020.

Table 3.1 Average of Waste Generation per household per day

No	Day	Weight (Kg/household/day)	Volume (m3/Household/day)	Density (Kg/m3/household/day)
1	Tuesday	1.352941176	0.009835294	137.5598086
2	Wednesday	1.494736842	0.007326316	204.0229885
3	Thursday	1.46875	0.0077	190.7467532
4	Friday	1.617647059	0.009325	173.4742154
5	Saturday	1.429411765	0.006870588	208.0479452
6	Sunday	1.525	0.0072	211.8055556
7	Monday	1.394117647	0.006682353	208.6267606
8	Tuesday	1.531578947	0.007473684	204.9295775
Average/day		1.47677293	0.007801654	192.4017006

Table 3.1 shows the avarage waste generation from Graha Mattel residence were the weight of waste generated per household is around 1.47 Kg/household/day and 0.0078 m3/household/day in volume or about 192.40 Kg/m3 in average of density. The waste generated per person per day is around 0.3 Kg/household/day

were the average person per household is 4 people based on primary the data collected.

In National Indonesian Standard SNI 19-3983-1995 the range of waste generation in High Income level 0.35-0.4 kg/person/day, Middle Income level 0.3-0.35 kg/person/day, and Lower Income level 0.25-3 Kg/person/day.However these data is used to predict waste generation in Indonesia when the primary data for the targeted area is not available[16]. The waste in Graha Mattel residence was take not base on the income level but considered all the household are same. However from the result that get compare to the SNI standard it was categories as middle income residence.The waste generation also not to different with the research that conducted in Surabaya where the waste generation rate in residential area is about 0.271 Kg/person/day[17]. Those are because in middle income resident, domestic activities or kitchen waste was produced, where the mass of waste is strongly influenced by food waste (wet garbage) which has the largest composition and mass unit.

The avarege generation rate of waste that produced in Graha Mattel residence per day also different from each day like shown in the Figure 3.1.This is because of some resident are going out during the day like weekend or workdays so the waste that produced from the activities doing at home also different due to the less activities at home.

The volume of the waste are different with the weight of the waste because the volume are got from the lenght of the sampling box X width of the sampling box X Height of the waste that measure in sampling box and it is depend on the density of the waste. However the volume of the waste are measure so that the data can used to determine the area or storage for further waste management design.
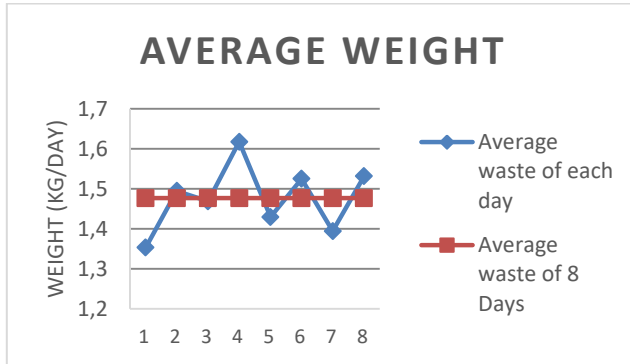
AVERAGE WEIGHT

Figure 3.1. Daily weight Avarage of Graha Mattel residence waste

3.1.2 Waste Composition

Household waste that collected consist several components like Organic waste,plastic,papers,rubber,textile,glass, metal and others. The **Figure 3.2** refered to (Appendix 3) shown the percentage of waste composition that collected.
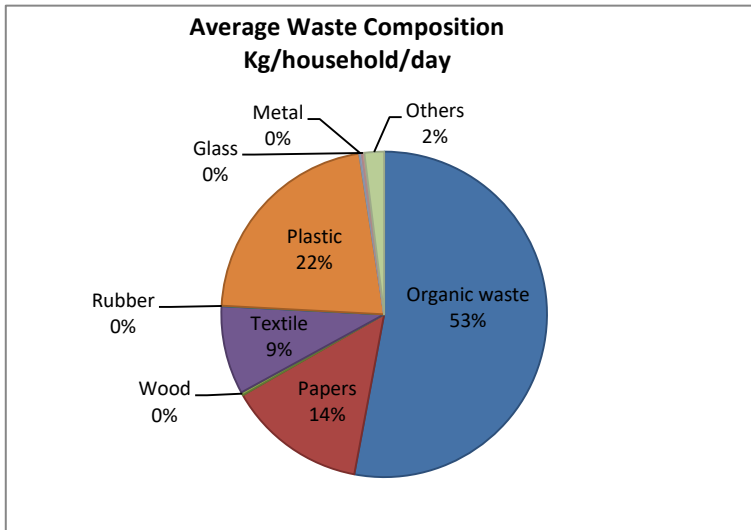

Figure 3.2 Average waste composition per day

The composition of household waste is obtained from the sorting and weighing the result of waste according to each type then expressed as a percentage. The biggest composition of household waste in Graha Mattel residence is organic waste,with a percentage of 53% and following by the Plastic 22% and papers 14%.

The waste composition dominated by Organic waste due to daily activities that produced from Kitchen waste like food waste. Food waste also has a large enough water content that cause it become heavy. Mostly in Indonesia, the composition of solid waste is primarily organic, and depends on the key economic ad social variables. It is expected that cities with high Income level will have lower organic composition and higher plastics and paper content. In contrast, cities with lower income and slower economic growth are expected to have higher organic composition.[18].

In recent years there has been increased interest in diverting the organic waste fraction of the municipal solid waste (MSW), due to the high decomposition potential and production of methane as a final product. Recently, anaerobic digestion (AD) has been recognized as one of the best options for treating this waste stream since it results in two valuable final products, biogas and compost that may be utilized for electricity production, heat for cooking purpose and as soil fertilizer respectively[19].This is why in this research choosen anaerobic digestion as an alternative waste treatment for organic waste in Graha Mattel residence.

3.1.3 Anaerobic digestion

From the analysis data of waste generation in Graha Mattel residence the organic waste is 0.75 Kg/household/day as a dominated waste composition that can be used as a feedstock in anaerobic digestion. For designing Anaerobic digestion assuming that the hydraulic retention time for tropical climate area with a temperature 25-30 degree as Indonesia is 30 days the ratio of feedstock and water mix is 1:1. Total solid for organic waste is 20% = 0.75 Kg/day * 20% = 0.15 Kg Volatile solid for organic waste is 80% = TS*80% = 0.15*80% = 0.12 Kg Vs/day Feedstock = 0.75kg/household/day.

Table 3.2 Calculation of anaerobic digestion

Formula	Result

Feed stock flowrate	Q = Feedstock + Water	1.5 liter/day or 0.0015 m3/day
Volume of reactor	$Vr = Q * HRT$	$Vr = 0.0015 * 30 = 0.045\ m3$
Substrate concentration in Inflow	$S = \dfrac{Vs}{Q}$	$S = \dfrac{0.12}{0.0015} = 80\ kg/m3$
Organic Loading rate	$ORL = \dfrac{Q * S}{Vr}$	$ORL = \dfrac{0.0015 * 80}{0.045} = 3\ KgVs/m3$
Gas Holder Size	$Vg = \dfrac{Vr}{2}$	$Vg = \dfrac{0.0015}{2} = 0.00075\ m3$
Biodigester Volume	$V = Vr + Vg$	$V = 0.045 + 0.00075 = 0.045\ m3$
Gas Production Rate	$GPR = \dfrac{Qbiogas}{Vreactor}$	$GPR = \dfrac{0.084}{0.045}$ $= 1.786\ m3\dfrac{biogas}{m3} reactor\ and\ day$
Specific Gas Production	$SGP = \dfrac{GPR}{ORL}$	$SGP = \dfrac{1.786}{3} = 0.67\dfrac{m3}{kg}Vs$

Food waste taking consideration yield biogas volume of 0.67 m3/kgVs and assuming that the biogas contain 60% of methane[20]. Biogas flow rate or Qbiogas is 0.084 m3/day (Qbiogas = ORL*0.67m3/kgVs*Vr). Anaerobic digestion calculation from waste 0.75 kg/household/day that is produced in Graha mattel residence used to treat using anaerobic digestion will produced 0.084 m3 of Biogas per day. The Biogas produced per day is small due to the feed input with a small amount of organic waste that produced and also depend on the type of organic waste.there are also some other factors that effect the production of biogas that not discribe in this study. In this study only try to calculate the waste treatment using anaerobic digestion for a household, based on Cossman et.Al an average biogas cooking stove consume roughly 0.4 m3 per hour[21]. However from the result of calculation 0.084 m3 will not enough for an hour so anaerobic digestion can be design for communal one residenctial area but for this will need large tank volume and area.

3.2 Social Aspect

Respondent Characteristic that analyze in this study were Age, Number of people in household, Level of education and the family income per month. From the result shown that the majority range of housewives age in Graha Mattel residence is 30-50 years old with 40 % level of education is undergraduate/post graduate. The highest range of family income is Rp.4.000.000 – 6.000.000 and also the people living in a household is majority in a range of 2-4 people per household.

3.2.1 Validity and Reliability

1. Validity test result based on Pearson's R Table for Two-tailed Test, one of the questionnaire are not ok therefore the questionnaire were have to correct.

Table 3.3 Peron's r coefficient value for each question

Label	r value	Coment	r value	Label	Coment
A1	0,42	Ok	C1		0,69 Ok
A2	0,27	Not ok	C2		0,76 Ok
A3	0,52	Ok	C3		0,65 Ok
A4	0,78	Ok	C4		0,73 Ok
A5	0,73	Ok	C5		0,79 Ok
B1	0,66	Ok	D1		0,83 Ok
B2	0,58	Ok	D2		83 Ok
B3	0,62	Ok	D3		0,66 Ok
B4	0,7	Ok	D4		0,79 Ok
B5	0,74	Ok	D5		0,87 Ok
B6	0,45	Ok	r Criteria		0,306
B7	0,8	Ok			

2. The result of the reliability test shown in the following table 3.4

Table 3.4 Reliability Statistics Test Result

Cronbach's Alpha	N of Items
,88	22

Based on table 3.4, it shown the cronbach's alpha of riliability is 0.88. Interpreted to the table Cronbach's Alpha can be conclude that, the questionaries' was category as Good $0.9 > 0.88 \geq 0.8$.

3.2.3 Classical Assumption Test

In Classical assumption test there are three types of test which are Normality test,Heterocedasticity and Multicolinearity Test where tested using exel to see the grafic and the result Shown that data data is normally destributed, the regression *is accepted because* there is no heteroscedasticity because the point spread above and below the number of 0 (zero) on the Y axis and the point not form particular pattern and The multicollinearity test indicates all variables have a VIF that is Bellow 10, so the data is acceptable.

3.2.4 Multiple Linear Regression

Multiple Linear regresion analysis is a linear relation between two or more independent variable (Knowledge, Attitude, and Income) with the dependent variable (Behavior). The analysis is aims to determine whether the direction of dependent and independent variable is positively or negatively and also to predict the value of dependent variable if independent variable decrease or increase.. Table 3.5 below shown the result.

Table 3.5 Multiple Linear Regression

Variables	Coefficient	Standard Error	t Stat	P-value
Behavior (Y)	6.6849	2.7422	2.4377	0.0171
Knowledge X1	0.0337	0.0386	0.8720	0.3859
Attitude X2	0.4903	0.1294	3.7872	0.0003
Income X3	0.0764	0.0752	1.0156	0.3130

The equation of multiple linear regression based on the table 3.5 above is as follows:

$$Y = 6.6849 + 0.0337X1 + 0.4903\ X2 +\ 0.0764X3$$

3.2.5 Hypothesis Testing

3.2.5.1 F-Test

F test is use to find out whether the overall independent variables together can give a significant effect on dependent variable. Based on statistical data, F value is 7.5905 with a significant F of 0.00016 α = 5%. So that if the significant value is less

than 0.05 then the overall independent variables statistically effect the dependent variable. The calculation results show **(Table 3.6)** the significance value is 0.00016 < 0.05. Which said that the independent variable consisting of the Knowledge Attitude and income of Hosewives in Graha Mattel residence is positively influences Housewives behaviour in managing household waste.

Table 3.6 Result of F test

ANOVA of F-test					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	154.2795	51.4265	7.5905	0.00016
Residual	76	514.9079	6.7751		
Total	79	669.1875			

3.2.5.2 T test

The result shown in Table 4.6 the intercept and attitude has shown significant while the knowledge and income prove to be not significant. Which means that the first assumption is not fully accepted.

Table 3.7 Result of t test

	Coefficients	*P-value*
Intercept	6.6849	0.0171
Knowledge	0.0337	0.3859
Attitude	0.4903	0.0003
Income	0.0764	0.3130

3.2.5.3 Coefficient of determinant (R^2)

Coeffient of determinat result show in table 4.8. The R value is 0.4801, R2 is 0.2305, and the adjusted R square is 0.2001. Then the R2 (square) value 0.2305 indicates that Knowledge, Attitude and Income are able to explain Housewives behaviour 23.05%. and the result seems to be very low. However this does not mean our model is not significant. In fact some research said the reason R-square may be low beacause of human is hard to predict [22]. And also there are several

of others factors that not addressed in this research which may be present among the respondents when answering the questionnarie so resulting in a low R square value.

Table 3.8. Coefficient of determinant (R^2)

Regression Statistic	
Multiple R	3,334027778
R square	1,600694444
Adjusted R square	1,389583333

Based on the result the questionnaire that used in this rsearch are already releable an valid and the model used also valid based on classical assumption test that has been done. First hypothesis analysis using F-test was shown that the overall independent variable where in this reasearch knowledge,attitude and income has significant influence towards dependent varaiable Behavior. However using the t-test to analysis the influence of each independent variable towards dependent variable show that the attitude has significant while the knowledge and income prove to not significant. Refer to first assumption the hypothesis 1 H1 and H3 was rejected while the H2 and H4 is accepted. Knowledge and income has not influence the behavior of housewives. Most respondents have a high level of education, that is high school and Undergraduate/Graduate. The high level of education is one of the causes of good behavior towards the household waste that it generates, due to know more of information about waste management[23].This is also related to the result of the questionnarie where most of respodent know about the type of waste and the impact from the waste, the more higher of education of household will have more knowledge about the waste management. Attitude shows someone's ability to act or behave towards waste management,because it is logical that a person's attitude reflected in a form of behavior in objects.In a possitive attitude the tendency for action is to treat all things as expected and vice-versa[24]. Attitude have significant towards behavior based on questionarrie housewives in graha mattel residence still not

separeted their waste and still not give important in treat the waste. If housewife have a good attitude on separeted waste based on each types and give and important to reduce and treat the waste they will be have a good behavior on waste management. Based on the previous study by S.Asti Mulasari about,The value of p = 0.872 with α = 0.05 it can be said that there is no relationship between attitude and behavior of waste management in Benenr Village, Tegalrejo District, Yogyakarta[23]. While the income variable does not influence the bihavior of housewives in Graha mattel residence, this also due to the the family income is dominated in middle income as an esidence that located to the industrial estate. In accordance with some research income or property of people make people not care about the envirnment. People in poor and hungry conditions, dizzy with family needs, education and others, how to think about caring for the environment. However peoples with good income will more considered about the environment.

4 Conclusions

Based on the result of analysis of this paper can conclude that :

1. The waste generation in Graha mattel residence is 1.47 kg/day or 0.3 kg/person/day with a composition dominated by organic waste with amount of 53 %, following by the Plastic 21%,papers 9 %.Anaerobic digestion as an alternative system to treat organic waste. For the calculation will produce 0.084 m3 of Biogas per day from the 0.75 kg/day of waste that produced by the Graha mattel residence.

2. The behavior of housewives in this research has an overall possitive influenced by Knowledge,Attitude and Income but individualy knowledge and income has no influence towards behavior while the attitude has a significant influence. The statistical model in this research show that the model is valid show from the result of classical assumption test of normality,heterodasticity and multicolinearity.

5 Aknowledgement

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