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CARBON TAXONOMY MODELLING BASED ON *THEORY PLANNED BEHAVIOUR*

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Abstract

The increasing of human activity has an impact on the environment; waste, greenhouse gases, global warming, and climate change. This research tried to design a waste management model based on individual behavior and economic values. The approach used is a mixed method using SEM PLS as a quantitative analysis tool and descriptive analysis and literature study as a qualitative analysis. The conclusion obtained is that in the consumption behavior variables, the factors age, education, food consumption, energy consumption and residues have a positive impact on awareness of managing waste, in the waste management variables education, individual benefits and values have a significant impact on awareness of managing waste, this finding then became the basis for the development of carbon taxonomy.

Keywords; Green Economy, Waste Management, Carbon Tacsonomy, Circular Economy

1. INTRODUCTION

Climate change, global warming and household waste are important parts of modern society's issues. In Indonesia itself, the impact of global warming and human activities has massively disrupted the ecology. The increase in greenhouse gases, especially carbon dioxide (CO2) in the atmosphere, has brought negative side effects and disrupted the general ecological balance (Adrian, M. A, 2024). According to records from the Intergovernmental Panel on Climate Change in 2006, the waste sector contributed 3-4% of global greenhouse gas emissions (Adrian, M. A, 2024). Widiyanto et al (2015) found that 47.62% of household waste contributed to groundwater pollution. Data from the Ministry of Environment and Forestry shows that there is a growth in plastic waste piles between 2019 – 2021, from 67 tons to 68.5 tons (Mustopa, B. A. B., & Sulistiyorini, D. (2022), this finding is consistent with research by Lamb (2018) which reported that Indonesia has become one of the largest contributors of waste in the oceans in the period 2010 - 2025. The rate of population growth and environmental damage continues to run linearly, if the attention were decreasing, Indonesian would not be able to live in a livable environment in the future.

The rubbish heap where concentrated near by to the environmental living and the dislocation of rubbish so that it is thrown into the sea and pollutes the environment cannot be separated from the individual's behavior in managing their household waste. Several studies in Indonesia at different time periods show patterns regarding waste management behavior. Junardi, Asrinawaty, and Ilmi (2020) found that the variables that influence waste management in Kalimantan are; knowledge, facilities and infrastructure, and regional regulations. Fadhilah and Wijayanti (2023) who conducted research in Karanganyar stated that knowledge, facilities and community behavior influence waste management. Wogo et al (2023) in research conducted

in Malang found that education, knowledge and facilities had a significant influence on waste management, while behavior did not have a significant influence.

The most important thing about environmental awareness is consumption patterns and behavior, household waste is a residual product from human consumption activities, unconscious consumption behavior often also has an impact on carbon emissions which will damage the environment (Kirikkaleli et al, 2021). From this it can be understood that there are two main human activities that have a big impact on the ecology, namely consumption activities (of course production definitely involves consumption) and management of remaining consumption products (waste) which if not managed properly will multiply environmental damage. Based on this framework of thinking, this future research will further explain how the relationship between consumption behavior and waste management will become the initial foundation for designing a waste classification and its impact on the environment, as well as providing adequate guidance as a knowledge base for developing waste management technology.

2. METHODOLOGY

This research uses a Mixed Method approach, namely a research method that integrates qualitative and quantitative approaches based on the objectives and form of the research object/model itself to be able to promise a better understanding of the subject under study (Taherdoost, 2022). In mixed methods, it is permissible to use two different research approaches, such as phenomonology, narrative, case study, content analysis, ethnography along with experimental, correlational and descriptive.

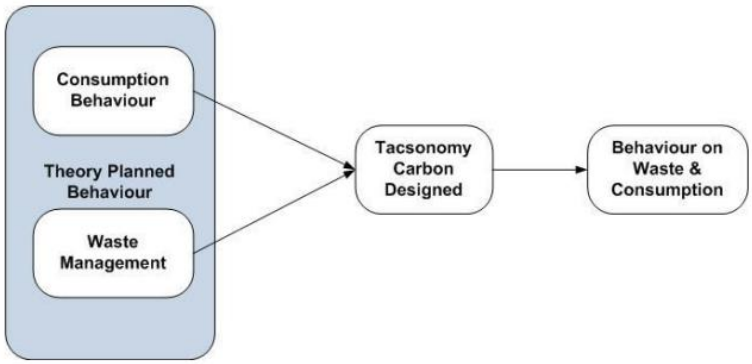
2.1. Hypothesis Development

This research try to elaborate and discovering how did the phenomena of waste managament and economy circular as an interplay entity by using Theory Planned Behaviour that disclosed by Ajzen (1985) about how behavioral intentions arise which are determined by three main determinants, namely attitude, subjective norms, and control over behavior (Larasati, 2022; Menuntung , 2018), in anodther hand the circular economy as an economic paradigma that belief to economic cyccle should be rely ono the product life cycle into renewable resources (Stahel 2016; Urbinati et al, 2017; Ferasso et al, 2020). These two point of view should be useful to analyze how does the economic cycle should be run. Standing over the theory as a thinking framework, this research try to emphasys the waste management by classifiing to the carbon effect and the economic cost. Based on the conceptual thinking, this research clarify the problem that would be disclosed as follow;

1. How will people's consumption behavior affect waste management?
2. How will society's perspective on the environment influence waste management behavior?
3. What is the formula for classifying waste based on consumption behavior, environmental impact of waste, and waste management behavior in society?

To make it easier to understand the thinking mechanism in this research, this research further has a thinking framework as follows;

Figure 1. Research Thinking Framework



Source: Data from researchers

In this article, the hypothesis tested as part of the development of a carbon taxonomy is the significance of the variables Consumption Behavior (X1) and Waste Management (X2) on Waste Management Awareness/Behavior (Y).

H0: Consumption Behavior and Waste Management have a significant effect on Waste Management Awareness/Behavior

H1: Consumption Behavior and Waste Management Do not have a significant effect on Waste Management Awareness/Behavior

2.2. Data analysis

As with the research approach chosen, the data used in this research is also diverse, primary data in the form of individual behavior and secondary data in the form of statistical data and literature. Data collection methods used in this research were survey and literature methods. As for the data analysis method in the context of this research, individual behavior towards waste management will be reviewed using a quantitative approach which will be analyzed using SEM-PLS, the model formed from this analysis will be developed in narrative form in a review of other supporting theories in the literature study.

3. DISCUSSION

3.1. Understanding Individual Behavior in Consumption Activities and Household Waste Management

Carbon emissions are defined as the release of gases containing carbon (CO) into the earth's atmosphere, this occurs due to the burning/use of carbon either in single or compound form (Martinez, 2005). The release of carbon originating from human activities makes carbon dioxide levels denser so that nature cannot absorb all the carbon dioxide (Ministry of the Environment, 2012). In efforts to reduce carbon emissions, Weyant (1993) stated that there are at least three assumptions that must be considered; population and economic activity, availability of energy resources, and technology availability and costs, this is in line with Purwanta (2010) who classifies carbon emissions based on activity and total exhaust gas. Song et al (2023) classified the effects of agricultural urban areas based on the impact of carbon

emissions. Waste/carbon classification models were developed to be able to identify and develop reductions in the impact of waste from human activities.

Starting from the basic assumptions built by Weyant (1993), the classification of Purwanta (2010) and the model of Song et al (2023) as one of the references that support this research, this article proposes a Carbon Taxonomy model which begins the classification of Carbon from population and economic activities, which is represented by individual behavior in consumption and household waste management.

In statistical tests regarding the influence of consumption behavior and waste management on awareness of construction waste, the variables analyzed in this research are as follows;

Table 1. Research Variable

Laten Variable	Indicator
Awareness/ Waste Management Behavior	Waste Sorting (X1) Waste Categorizing (X2)
Consumption Behaviour	Age (X1) Education (X2) Food Consumption (X3) Energy Consumption (X4) Residual Consumption (X5)
Waste Management	Knowledge (X1) Information (X2) Facilitiy (X3) Benefit (X4) Norm Value (X5)

Source: Data from researchers

The data used in this research is primary data obtained through distributing questionnaires to 111 respondents from the 150 questionnaires that were distributed.

Validity Test

In SEM PLS, a latent variable is said to have met validity if the latent variable indicator value is > 0.5. The following is a tabulation of the validity test values for the indicators in the latent variable;

Table 2. Validity Test

VARIABEL	X1. Consumption Behaviour	X2. Waste Management	Y. Awareness
X1.1.Age	0.812		
X1.2.Education	0.712		
X1.3.Food Consumption	0.876		
X1.4.Energy Consumption	0.822		
X1.5.Residual	0.868		
X2.1.Knowledge		0.815	
X2.2.Information		0.849	
X2.3.Facility		0.826	
X2.4.Benefit		0.720	
X2.5.Individual Value		0.799	
Y.1.WasteSeparation			0.970
Y.2.Categorization			0.784

Source: Data from researchers

From the tabulation above, it can be seen that all indicators in the latent variable have a value > 0.5. Thus, the data used in this research meets validity.

R Square Test

From the results of the R Square test, it was found that the value was 0.211, meaning that simultaneously the consumption behavior and waste management variables had a positive and significant effect with a significance value of 0.225 or 22.5%.

Table 3. R Square Test

	R Square	R Square Adjusted
Y. Awareness	0,225	0,211

Source: Data from researchers

Hypothesis Testing

In hypothesis testing using SEM-PLS, the value used is P Value, the significance of P Value < 0.05. The following is a table of results from the P Value;

Table 4. P Value Test

Variabel	Original Sample (O)	P Values
X1. Consumption Behaviour -> Y. Awareness	0,218	0,017
X2. Waste Management -> Y. Awareness	0,361	0,000

Source: Data from researchers

From the test results, it can be seen that the Consumption Behavior variable has a P Value of 0.017 < 0.05 and the Waste Management variable has a P Value of 0.00 < 0.05, meaning that both variables have a positive and significant effect on awareness of managing waste. . Apart from the relationship between variables X1 and X2 towards Y, the significance of the indicators in each variable

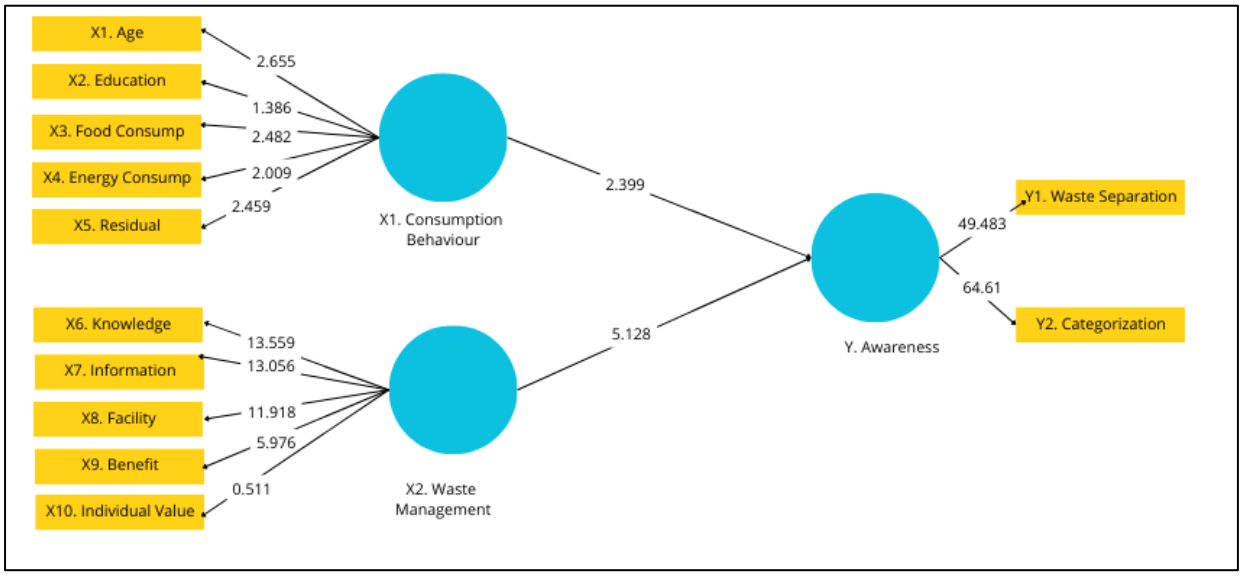
Table 5. P Value Indicator Test

	Original Sample	P Values
1.Knowledge <- X2. Waste Management	0,815	0,000
2.Education <- X2. Waste Management	0,849	0,000
3.Facility <- X2. Waste Management	0,826	0,000
4.Benefit <- X2. Waste Management	0,720	0,000
5.IndividualValue <- X2. Waste Management	-0,083	0,610
X1.Age <- X1. Consumption Behaviour	0,628	0,008
X2.Education <- X1. Consumption Behaviour	0,356	0,172
X3.Food Consumption <- X1. Consumption Behaviour	0,641	0,013
X4.Energy Consumption <- X1. Consumption Behaviour	0,581	0,039
X5.Residual <- X1. Consumption Behaviour	0,585	0,014
Y.1.Waste Separation <- Y. Awareness	0,970	0,000
Y2.Categorization <- Y. Awareness	0,784	0,000

Source: Data from researchers

From the results of the outer test above, it can be seen that the P Value of the individual value indicator and the education value indicator each have a P Value > 0.05, which means that these two indicators do not have a significant influence on the constructs of Variables X1 and X2.

Figure 2. Intra Variable Relational



Source: Data from researchers

The image above is an illustration of the relationship between variables and indicators in this research. From the results of SEM PLS analysis, the following regression model can be produced;

$$Y = 0.218X1 + 0.361X2 + e$$

3.2. Taxonomic Model Development: Individual Behavior and Waste Management

From table 4 above we can understand that the Waste Management variable has a greater influence in forming awareness to manage waste in the form of sorting activities with a coefficient value of 0.361. In the Waste Management variable in table 5 it can also be seen that the indicators of knowledge, education, and the availability of facilities plays a more dominant role compared to the Benefits and Individual Value indicators, this can be seen in the original sample column. Meanwhile, the Consumption Behavior variable shows that Food Consumption, Energy Material Consumption and Residues from consumption activities play an important role in encouraging the formation of consumption behavior.

From the results of this analysis, we can understand that the variables that are more dominant in driving awareness of waste management are the availability of facilities, education, knowledge and consumption behavior. Due to these findings, the household waste management paradigm in this research relies on relevant information regarding the impacts/risks of consumption behavior and ineffective waste management. The data tabulation below also shows that environmental impacts are in the first place that influence individual behavior in managing waste.

Table 6. Individual Waste Management Motivation

Motivation	Total	Percentage
Waste Processing Cost	9	8%
Enviromental Effect	53	48%
Reward & Punishment	3	3%
Others	3	3%
Economic Beneficiary	27	24%
Facility	16	14%
Grand Total	**111**	**100%**

Source: Data from researchers

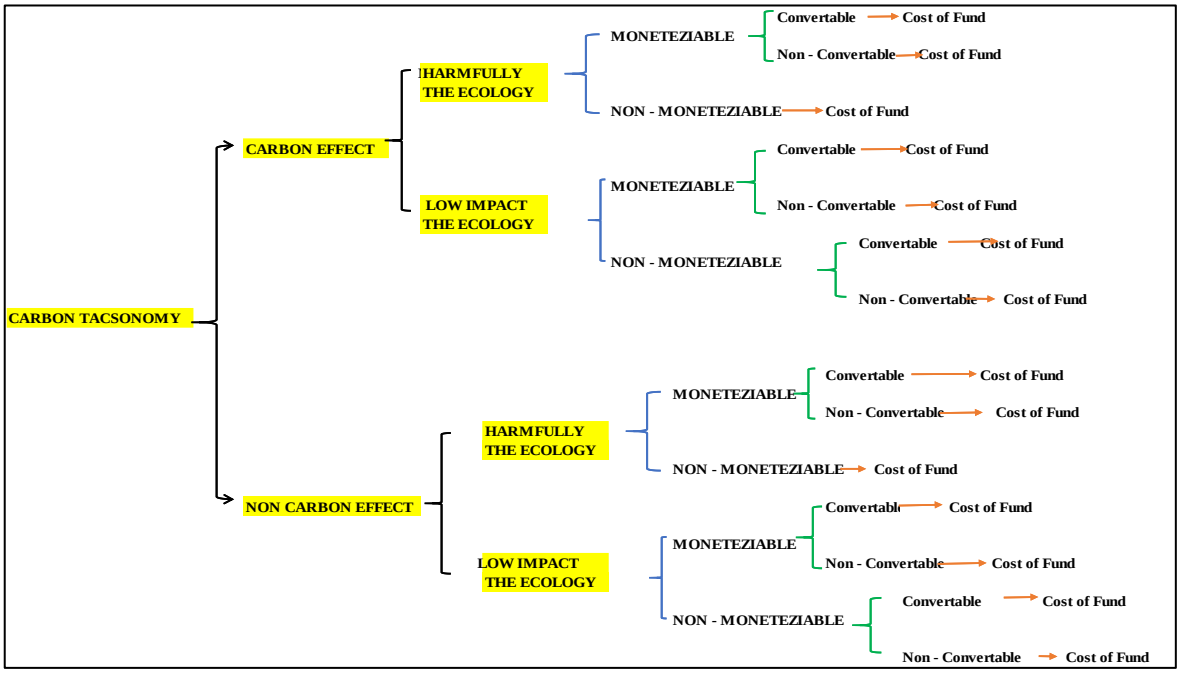
Next, in the process of identifying and classifying waste is the aspect of its impact on the environment which is expressed in total exhaust gas (Purwanta, 2010, Song et al, 2023), in the context of carbon emissions, waste arising from human activities is divided into two; Carbon Effected (has an impact on the concentration of carbon emissions in the atmosphere) and Non-Carbon Effected (has no impact on the concentration of carbon emissions in the atmosphere), this is because there are residues from human activities that do not evaporate (become gas), such as metals (Oneil, 1943, Tholen, 1979) so that it is not released as carbon in the atmosphere, however, whether the residue has an impact on carbon concentrations or not, both will have an impact on the environment in other forms (Amasuom and Baird, 2016), hence the sub-classification of Carbon Effect & Non Carbon Effect is Harmfully The Ecology. The development of this model is important, because individual perspectives on activities that impact the environment and efforts to reduce them are influenced by education, knowledge and relevant information regarding environmental impacts.

To be able to calculate the magnitude of the environmental impact and its economic value, all individual activity data tabulations in this research will be converted into carbon units and then the carbon value will be converted again into monetary units. So that the economic value of the results of carbon conversion can be calculated, the waste classification in the data in this research is categorized into its impact on the environment, based on several categories which will be arranged as a carbon classification (taxonomy) model, the model is as follows;

1. Potential carbon emissions resulting from household waste (Impact on the environment)
2. Potential economic benefits
3. Life Cycle, or its potential to be changed into another form
4. Carbon units in rupiah value.

Based on the categories that have been determined, the division of these categories is visualized in the following illustration.

Figure 3. Carbon Tacsonomy Model



Source: Data from researchers

3.3. Taxonomic Model Development: Carbon Conversion and Cost Analysis

From the data tabulation survey, several household rubbish/wastes were obtained;

Table 7. Household Waste

Item	Quantity on Kilo	Metric
Cooking Oil Consumption	308	Litre
Cooking Oil Residual	190	Litre
Electrical Power	2.400	Watt
Vegetables Consumption	571	Kilogram
Rice Consumption	853	Kilogram
Meat Consumption	597	Kilogram
Organic Waste	425	Kilogram
Plastic Waste	468	Kilogram
Glass Waste	213	Kilogram
Iron Waste	206	Kilogram
Wood Waste	214	Kilogram
Leather Waste	220	Kilogram
Paper Waste	384	Kilogram
TOTAL	**4.649**	

Source: Data from researchers

The data is then classified into a tabulation/taxonomy that has been created through several categories as follows;

1. Does this waste have a carbon emission impact?

2. Does this waste have an impact on the environment?
3. Does the waste have economic potential?
4. Can the waste be converted into other forms?

From this series of questions, the following classification was obtained;

Table 8. Waste Classification

Item	Quantity on Kilo	Metric	Classification
Cooking Oil Consumption	308	Litre	Carbon Effect - Harmfully - Convertible
Cooking Oil Residual	190	Litre	Carbon Effect - Harmfully - Convertible
Electrical Power	2.400	Watt	Carbon Effect - Harmfully - Convertible
Vegetables Consumption	571	Kilogram	Carbon Effect - Harmfully - Convertible
Rice Consumption	853	Kilogram	Carbon Effect - Harmfully - Convertible
Meat Consumption	597	Kilogram	Carbon Effect - Harmfully - Convertible
Organic Waste	425	Kilogram	Carbon Effect - Harmfully - Convertible
Plastic Waste	468	Kilogram	Carbon Effect - Harmfully - Convertible
Glass Waste	213	Kilogram	Non Carbon Effect - Low Impact - Convertible
Iron Waste	206	Kilogram	Non Carbon Effect - Low Impact - Convertible
Wood Waste	214	Kilogram	Carbon Effect - Harmfully - Convertible
Leather Waste	220	Kilogram	Carbon Effect - Harmfully - Convertible
Paper Waste	384	Kilogram	Carbon Effect - Harmfully - Convertible
TOTAL	**4.649**		

Source: Data from researchers

The waste classification is then converted into moneter (Rp) units to be able to calculate the impact in monetary units, so that relevant comparative information will be obtained for cost and investment analysis. The carbon multiplier factor is obtained from the greenhouse gas conversion coefficient published by the UNFCCC (2021) for each waste caused by human activities. The conversion method from research data in benthic kilograms into carbon units calculated per cubic ton is calculated in the following formula;

$$CO2= \left\{ \left\{ \frac{1}{1.000} \right\} \text{ X Waste Quantity} \right\} \text{ X Carbon Coefecient}$$

From this calculation, the value of carbon emissions released into the atmosphere will then be obtained, then the emission value will be converted into monetary units. Referring to Suryani (2023) the price of carbon per kilogram is IDR. 77. The calculation method is as follows; Carbon Value = Carbon emissions X Carbon price.

From the data obtained, it was found that 4,649 kilograms of household waste collected was equivalent to 944 kilograms of carbon emissions, with a carbon price of Rp. 77/kg, then the economic value of these emissions is IDR. Rp. 72,714. The following is an illustration

Table 9. Waste Conversion

Item	Quantity on Kilo	Factor	Carbon Conversion	Price	Total Cost
Cooking Oil Consumption	308	0,16751	52	77	3.973
Cooking Oil Residual	190	0,16751	32	77	2.451
Electrical Power	2.400	0,6745	15	77	1.155
Vegetables Consumption	571	4,7	2,68	77	207
Rice Consumption	853	4,7	4,01	77	309
Meat Consumption	597	4,7	2,81	77	216
Organic Waste	425	587,34	249,62	77	19.221
Plastic Waste	468	8,9	4,17	77	321
Glass Waste	213	8,9	1,90	77	146
Iron Waste	206	8,9	1,83	77	141
Wood Waste	214	828,03	177,20	77	13.644
Leather Waste	220	8,9	1,96	77	151
Paper Waste	384	1041	399,74	77	30.780
TOTAL	**4.649**	**107**	**944**	**1.001**	**72.714**

Source: Data from researchers

By knowing the monetary value, knowing the mapping of waste classification and conversion, in the future this information will be able to be used as comparative data to make relevant investment considerations related to waste management, determine the function of the waste whether it can be converted into another form or not, as well as comparative information to increase awareness in waste management.

4. CONCLUSION

From this research it can be found that the Waste Management variable has a more dominant effect in forming awareness for managing waste, while the Waste Management variable can be seen that the indicators of knowledge, education and availability of facilities play a more dominant role compared to the indicators of Individual Benefits and Values. Meanwhile, the Consumption Behavior variable shows that Food Consumption, Energy Consumption and Residues from consumption activities play an important role in encouraging the formation of consumption behavior. Based on these findings, the orientation of forming a carbon taxonomy model is oriented towards knowledge about waste and potential economic benefits which leads to economic value/conversion of carbon matrices into monetary units. Carbon emission conversion model;

$$CO2= \left\{ \left\{ \frac{1}{1.000} \right\} \text{ X Waste Quantity} \right\} \text{ X Carbon Coefecient}$$

Carbon Value = Carbon emissions X Carbon price.

Suggestions for Further Research

This research has limitations in several ways which it is hoped can be fulfilled in future research. These limitations include; The assumption of carbon units in the conversion factors used is not yet final; on a macro scale, research regarding this is also ongoing. The Harmfully and Low Impact on Ecology indicators cannot yet be defined accurately.

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