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Journal of Sustainable Development of Energy, Water and Environment Systems

http://www.sdewes.org/jsdewes

Year 2023, Volume 11, Issue 2, 1110443

Original Research Article

Acceptance of Waste to Energy Technology by Local Residents of Jakarta City, Indonesia to Achieve Sustainable Clean and Environmentally Friendly Energy

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Cite as: Suryawan, I. W. K., Septiariva, I. Y., Sari, M. M., Ramadan, B. S., Suhardono, S., Sianipar, I. M. J., Tehupeiory, A., Prayogo, W., Lim, J. W., Acceptance of Waste to Energy Technology by Local Residents of Jakarta City, Indonesia to Achieve Sustainable Clean and Environmentally Friendly Energy, J.sustain. dev. energy water environ. syst., 11(2), 1110443, 2023
DOI: https://doi.org/10.13044/j.sdewes.d11.0443

ABSTRACT

Economic and urban developments have contributed more plastic waste and are also dominated by organic waste. The organic content and high caloric content of the waste characteristics in Indonesia support the selection of an appropriate waste to energy technology. At this time the concept of waste to energy is being developed in a number of developed countries as a method for managing waste and strategy to improve waste management and reduce environmental impacts. This study aims to determine the level of public acceptance towards waste to energy technology enabling waste to energy to be adequately managed by increasing public awareness. A random sampling was carried out on residents in Jakarta using a hybrid method. The results showed the percentage of total variance of the three factors, namely socio-economic, environmental impact and development was 72.11%. Socio-economic refers to the ability of the community to see opportunities, environmental impact refers to community awareness, and development refers to the technical aspects of waste to energy development. Of the three factors, socio-economic factor became the most determining factor to the waste to energy public preference and acceptance. The education level and potential income from the project can be determined as the most determining factors for developing and implementing waste to energy in

Jakarta. The binary probit regression analysis model approach is used for the willingness to accept waste to energy by grouping models from communities with different classes formed from cluster analysis, namely overall respondents (model I), low participation (model II), pro-sustainable environment (model III), and pro economy and society (model IV). In addition, the most significant feature for each model was the increase in public knowledge about waste to energy technology to be applied in the future. This is also a lesson for other regions and countries that will apply waste to energy technology to consider non-technical aspects to increase public acceptance, particularly in terms of the strategic issue claiming the harm of the waste to energy.

KEYWORDS

Waste to energy technology, Local residents, Jakarta city, Indonesia, Sustainable clean energy, Environmentally friendly energy, Factor analysis, Cluster analysis.

INTRODUCTION

Developing countries, after achieving independence from colonialism, generally adopt conventional waste management system [1] viewing the waste management as a government affair [2]. Conventional waste management, such as open dumping, is generally seen ineffective and unsustainable [3]. Also, in developing countries, most conventional methods are financially constrained [4]. This condition then bring some impacts on the low waste collection process and causes illegal disposal, especially in urban areas [5]. Managing waste to energy (WtE) in turn is seen as a solution for waste management with the co-benefit of electricity generation [6]. WtE has been applied in developed countries such as the United States, China, Japan [7], and Taiwan [8]. Solid waste management is something that almost every city government offers to its citizens [9]. While service levels, environmental impacts [10], and costs vary greatly, solid waste management is arguably the most important municipal service and is required for all other municipal actions [11]. Incineration is uncommon and, in general, ineffective due to high capital, technical, and operating costs, high moisture content in waste, and a high percentage of inerts. Some incinerators are in use, but they are facing financial and operational challenges [11]. Prevalent in areas with high land costs and limited land availability.

However, WtE can be adequately managed by increasing public awareness of the environment and cooperation from various stakeholders to take advantage of opportunities for renewable energy sources [15] through the development of technology [16]. An optimal local government-NGO collaborative governance approach in terms of the waste management process can enhance public participation and respond to state decentralization and rising environmental issues in urban areas [17].

Overall, the application of sustainable development can be made by prompting more environmentally sustainable and socially responsible by creating norms, rules, and standardized procedures [18]. The problem of waste is very complex [19], from finding a location for landfilling that always causes rejection from the community to the technology that will be used to process the waste [20]. In practice, waste management raises several problems such as the rapidly increasing need for landfill land due to not carrying out an effective waste volume reduction process [21].

The circular economy is an alternative to the current linear waste management scheme, production process, use, economic model, which preserves the resources used as long as possible [30]. It also extracts the maximum value in the use mechanism, product recovery, and regeneration of products and/or materials at remaining used. The concept of a circular economy is a response to the aspiration to realize sustainable development in the context of the enormous pressures of production and consumption on natural resources and the environment. The circular economy system plays a role in a linear waste management model where every waste material is optimally managed. This view of the circular economy concept can be more easily seen in the natural aspect, where all living systems work optimally because they influence each other [30]. For this reason, this study divided three grade levels in WtE acceptance. The three nested sustainability systems include the economy wholly contained by society, and entirely managed by the environment (Figure 1). With this concept, the improvement of society with low participation must be increased. Therefore, the sustainability of the WtE program needs to concern with this for enabling this program to run smoothly.

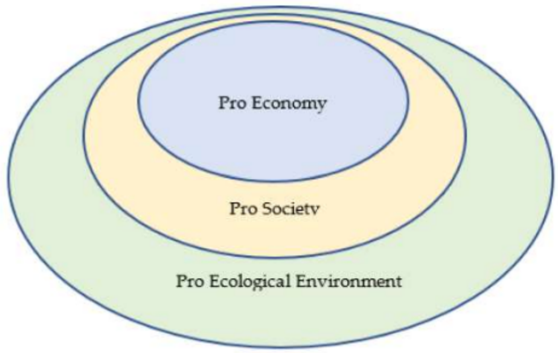

Figure 1. The concept of sustainable environment, society, and economic development

In turn, the results of this study can be used as a reference in efforts to increase revenue for sustainable development, significantly reducing waste generation and achieving clean energy at the city level. The burden of pollution from poor waste management can be reduced and can be used for the construction of WtE facilities in Jakarta, even in several cities in Indonesia and other developing countries. Because WtE is an effective solution to both issues, it requires intense scientific attention. WtE management is distinguished by various technologies, refers to a variety of waste types, and necessitates multidisciplinary decision support [31]. WtE has the potential to be applied without regard to the waste hierarchy principle and resource conservation if the energy value is sufficiently high [32]. To make sure that the waste sector provides secondary raw materials to the economy as predicted by circular economy, rather than serving as a secondary source of energy, we need a more in-depth consideration of the role of WtE in this system.

The objective of this study to establish the level of public acceptance for WtE, allowing WtE to be adequately managed by raising public knowledge. Most studies have merely mentioned the potential for WtE applications and do not recognize the urgency in terms of the public's acceptance of WtE. A new perspective will be acquired by clarifying the WtE program using the hypothesis of the sustainability environment, society, and economic development framework of community groups.

METHOD

This study used quantitative data with simple random sampling techniques to estimate citizen willingness' to acceptance of WtE program. First, a literature study was carried out so that the right questionnaire structure was obtained. Then a pretest test was carried out on the questionnaire that was made and then survey execution was carried out on the number of respondents according to a significance of 5% of the total population.

Questionnaire structure

The questionnaire structure was prepared based on a preliminary study describing variables affecting willingness to acceptance of WtE in the questionnaire. The design of the questionnaire consisted of three parts in which the first part contained questions related to the respondent's attributes and the second one contained the level of acceptance of the waste into energy management (Table 1). Meanwhile, the third part was the respondent's response to the acceptance of waste into energy processing.

Table 1. Questionnaire attributes used in WtE admission in Jakarta

Attribute	Factors	Justification	Literature
To improve the aesthetics	Technical Development	Focuses on curvilinear surfaces and ecological architecture to aesthetically transform an outcast infrastructure into an integral urban component	[34]
To increase economic value	Socio-Economic	WtE enable businesses to make significant economic gains and become more competitive, the obstacles listed above must be overcome.	[35]
To open business opportunities	Socio-Economic	The WtE sector will be able to expand rapidly in the future, opening up appealing avenues for investment in new businesses.	[36]
To open job	Socio-Economic	Other advantages of this type of project include the creation of job opportunities in the local communities.	[37]
To reduce the GHG impact	Environmental Impact	GHG reduction, demonstrating that replacing the current landfill-based system with a WtE scheme will benefit the climate impact.	[38]
To reduce land use in Landfill	Technical Development	WtE decreases the amount of garbage sent to landfills, hence lengthening the useful life of landfills.	[39]
To reduce water pollution impact	Environmental Impact	Due to the potential for groundwater and surface water pollution, which could have an adverse impact on public health, agricultural production, and other factors, current landfill runoff of leachate represents a significant environmental burden tied mostly to landfill sites operating.	[40]
To support environmental health	Technical Development	The output of waste generation has increased dramatically, posing a constant threat to the health of residents' living environments.	[41]

The scale used in this questionnaire was the Likert scale, also called as the summated rating scale. This scale is widely used for allowing the respondents to express their feelings in the statement approval. The statements are given in stages, started from the lowest to the highest level. The more choices, the more representative the respondent's answers are. However, the more the answer choices, the harder the words to be understood in general terms. The answers used in the questionnaire included strongly agreed (5), agree (4), neutral (3), disagree (2), and strongly disagree (1) [42].

The WtE offers a significant opportunity to manage waste reduction while also improving energy security [43]. This path appears to have the potential to reshape the future of energy and environmental management. However, technical and socioeconomic are stumbling blocks that must be overcome before such WtE can be successfully implemented [44]**.** Waste management practice has largely focused on technical development issues, with little or no consideration given to the social and economic aspects of households. The new demands for equitable delivery of community services necessitate a paradigm shift in the service providers' approach [45]. Planning for waste infrastructure is critical for providing effective and acceptable service delivery [45]. In addition, public awareness of environmental impacts is also something that must be considered in the sustainability of WtE applications.

Waste generation will also increase, resulting in additional sources of pollution. Waste management is critical for avoiding environmental pollution; otherwise, contamination of the air, water, and land will occur [46]. The term for water contamination is eutrophication, and the term for atmospheric pollution is ozone layer depletion or global warming potential. Waste treatment from both plants and raw material processing units is thought to protect the environment from water pollution, and GHG emissions have become a major environmental issue [47]. So that the attributes used for the environmental impact factor strengthen this, only two attributes that are commonly known by the public, besides the use of the term air pollution is one of the triggers for one of the impacts of GHG.

Statistical factor and cluster analysis

Principally, the factor analysis process attempts to find a relationship among several independent variables so that one or several sets of variables can be made fewer than the initial variable [48]. This factor analysis assesses which variables are considered appropriate to be included. This testing is done by entering all the existing variables to be, then subjected into several tests. The primary purpose of factor analysis is to define the structure of a data matrix and to analyze a relationship among a large number of variables by defining a set of similarity variables or dimensions, also called as factors. Researchers identified each structure dimension with factor analysis and determined to what extent each dimension was able to explain each variable. Once the measurements and explanations of each variable have been identified, the main objectives of factor analysis can be carried out, those are data summarization and data reduction. Thus, factor analysis aims to find a way to summarize the information contained in the original (initial) variable into a new set of dimensions or factors [49].

The object under study was divided into different groups (clusters) and compared based on specific characteristics. The purpose of the analysis was to create homogeneous groups of single heterogeneous objects. The purpose of cluster analysis in this study was to classify the acceptance value criteria of respondents based on the proximity of the acceptance value to WtE technology. Based on the results of grouping respondents through cluster analysis, a discriminant analysis was carried out to determine the differences between the groups formed. The discriminant analysis results then obtained a model or function equation from wailingness to acceptance WtE. The minimal sum of persons is willing to accept in order to pay or participate in WtE good or waste management service is referred to as the willingness to accept (WTA). The equation of this function refers to a function of the relationship between the independent variable wailing to acceptance WtE. A mathematical model can describe this relationship according to eq. (1):

$$\text{Willingness to Accept (WTA) WtE} = a + b_1X_1 + b_2X_2 + b_3X_3 + \ldots\ldots + b_nX_n, \quad (1)$$

where: a, b_1, b_2, b_3, b_n - constant; X_1, X_2, X_3, X_n - independent variable.

In this study, a model was created which resulted in overall of all respondents in the study (n=532) which is presented in model I. This model I shows the socio-economic significance of the people of Jakarta as a whole from this study. While Model II, III, and IV are models formed from grouping respondents' classes based on cluster analysis. Where the cluster formed is a class of respondents who come from groups that have low participation (model II), pro sustainable environment (model III), and pro economy and society (model IV).

RESULTS AND DISCUSSION

This research was conducted in Jakarta (Figure 2) from August to November 2021. A random sampling was carried out on residents using a hybrid method, namely using Google forms and direct interviews. The purpose of simple random sampling was to reduce the potential for human bias in selecting cases to be included in the sample. Furthermore, the sample is part of the population taken to represent the entire population to be used as the respondents in a study. In this study, the samples were taken using Slovin's equation where the use of a total population of 10,562,088 people [33] showed that the minimum number of samples was 400 people.

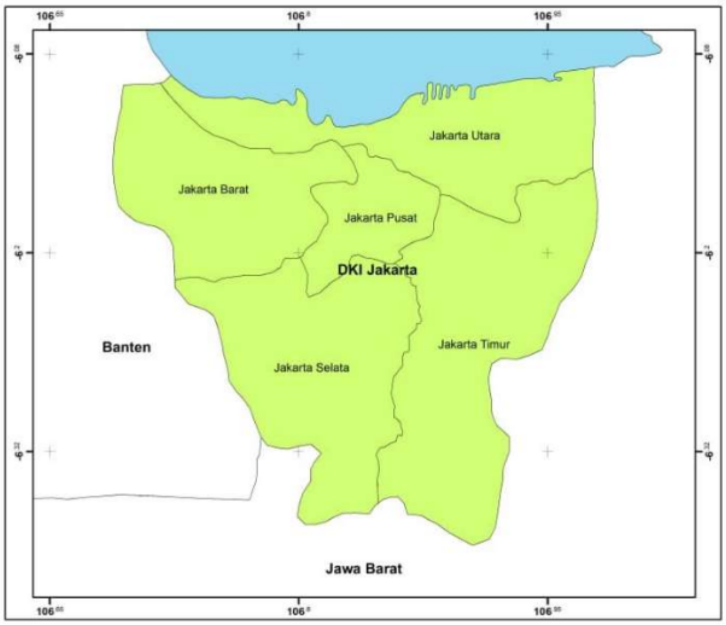

Figure 2. Study location in DKI Jakarta

DKI Jakarta Province has implemented WtE at Bantargebang Landfill using applied landfill gas recovery method [5]. In May 2018, the Government of Special Capital Region of Jakarta began to build WtE as a processing in the primary process by creating an Intermediate Treatment Facility (ITF) [12]. The central government has also carried out several acceleration efforts by issuing Presidential Regulation Number 18 of 2016 concerning the acceleration of Waste-Based Power Plants (PLTSa) [13]. However, this presidential regulation was challenged by environmentalists claiming that the presidential regulation, referring to the use of incinerator technology, was not environmentally friendly and contradicted several previous laws. Therefore, the government again issued a presidential regulation to accelerate WtE development in several cities in Indonesia. Presidential Regulation Number 35 of 2018 concerning Acceleration of Construction of Waste Processing Installations into Electrical Energy Based on Environmentally Friendly Technology has forced the government to accelerate the development of WtE technology [14].

A number of social factors can affect community participation [22] in waste management including age, education, income level, occupation, and family members [23]. In addition, education level, family income level, and behavior towards environmental cleanliness, knowledge of waste regulations, willingness to participate, and waste retribution positively correlate with household waste management [24]. This study aimed to determine the level of public acceptance of WtE technology in Jakarta city. In Indonesia, the calorific value of waste is typically lower than the minimum standard for waste processing with an incinerator [25] or drying [26] with RDF recovery [27]. As a result, in order to meet the required heating value for WtE, must employ pre-treatment facilities [28]. In principle, the plan developed is a thermal process technology with the name intermediate treatment facility (ITF) [29]. This ITF aims to reduce waste as much as 80-90% of the total capacity of the amount of waste in each ITF facility [12].

First, Total Variance Explained value is used to determine the number of factors formed by choosing the main factor or component with the smallest characteristic root parameter (total eigenvalue) > 1. These steps determine the factors affecting the acceptance of WtE technology in Jakarta. **Table 2** shows the determining factors of the acceptance performance of WtE technology in Jakarta. Based on the factor analysis results, the factors had a total eigenvalue > 1.

Table 2. Results of factor analysis of WtE acceptance in Jakarta

Waste To Energy Acceptance Factor	Factor loading	Eigenvalue	Variance explained (%)	Reliability coefficient
F1: Socio-Economic		2.897	36.21	0.884
To increase economic value	0.815			
To open business opportunities	0.813			
To open job	0.707			
F2: Environmental Impact		1.748	21.89	0.754
To reduce water pollution impact	0.788			
To reduce the GHG impact	0.787			
F3: Development		1.124	14.05	0.693
To support environmental health	0.586			
To improve the aesthetics	0.512			
To reduce land use in Landfill	0.503			
Total variance explained			72.11	
The Kaiser–Meyer–Olkin	0.604			
Barlet Test	*df*=28; *p*-value = 0.000			

As seen in **Table 3**, three factors had a total eigenvalue > 1. The factors formed consisted of factors 1 with a total eigenvalue of 2.897 with a variance value of 36.21%, factor 2 with a total eigenvalue of 1.748 with a variance value of 21.89%, and factor 3 with a total eigenvalue of 1.124 with a variance value of 14.05%. The total percentage of the variance of the three factors was 73.94%. Thus, 73.94% of all existing variables can be explained by the three formed factors. These two factors can explain their influence of 72.11% on factors that influence public acceptance of WtE technology. The Kaiser–Meyer–Olkin (0.604) and Barlet (*p*-value = 0.000) test also showed that variables have been feasible to be applied in factor analysis.

The scree plot diagram shows the factors formed based on the eigenvalues (**Figure 3**). Determining the name of the factor included in factor analysis can be done by giving the name of the factor representing the names of the variables making up the factor and giving the name of the factor based on the variable that has the highest value factor loading. Say, based on the first method, factor 1 is formed from an increase in economic value, open business opportunities, and open jobs, called socio-economic. Factor 2 includes reducing water pollution and GHG impact, so factor 2 is called as the environmental impact factor. Factor 3 includes reducing land use, supporting environmental health, and improving aesthetics, called as development.

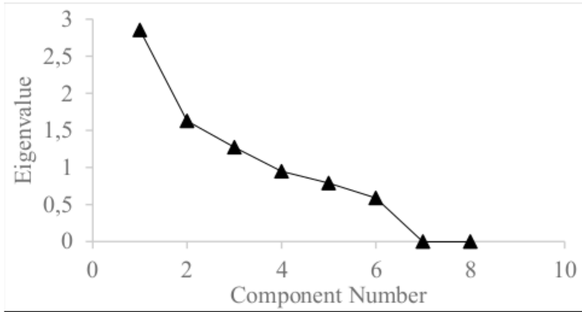

Figure 3. Results of eigenvalue and component number factor analysis of WtE acceptance in Jakarta

Clustering is an activity that aims to group data with similarities between one data and other data into clusters or groups so that data in one cluster has a maximum level of similarity and data between clusters has a minimum similarity. Clustering can also be interpreted as data segmentation method implemented in several fields, including patterns, regional zoning, object identification, and image processing. In addition, cluster analysis aims to find the groups of objects in such a way that objects in a group will be the same (or related) to each other and different from objects in other groups. In this study, the cluster analysis of the acceptance value of WtE in Jakarta used the *K*-means algorithm, with the number of clusters being three. The formation results of cluster groups were based on the score factor value for each observation or respondent. Cluster 1 is comprised of individuals or communities that have a high awareness for the environmental effect values but a low support for socio-economic and political growth, also known as low participation. Cluster 2 encompasses all of the contributing variables, and as such, it is considered a positive factor for the sustainable environment. The third and final cluster has a high socio-economic and development level, but a poor awareness for the influence that human activity has on the environment; for this reason, it is considered to be pro-economic and pro-social.

Analysis of variance (ANOVA) determined the WtE acceptance factor that significantly affected each resulting cluster. After the ANOVA test, the ANOVA results were obtained, as illustrated in **Table 3**. Based on these results, high significance value was found in the interaction groups cluster 1-3 and 2-3. While the interaction cluster 1-2 did not show a significance in Environmental Impact factor. For this cluster it needed an improvement in terms of the knowledge of environmental problem in Jakarta to become pro sustainable in environment.

Table 3. Results of cluster analysis for WtE acceptance in Jakarta

Factor	Cluster 1 (n=79)	Cluster 2 (n-328)	Cluster 3 (n-125)	F-value	Scheffe multiple range tests		
					1-2	1-3	2-3
F1: Socio-Economic	3.966	4.231	4.512	65.164***	***	***	***
F2: Environmental Impact	4.095	4.780	3.372	414.079***	n/a	***	***
F3: Development	3.743	4.356	4.469	118.149***	***	***	***
Cluster name	Low Participation	Pro Sustainable Environment	Pro Economy and Society				

*p<0:05; **p<0:01; ***p<0:001:
[a]Mean values were computed based on 5 Likert scale; [b]n/a indicates ‘not significant

Table 4. Characteristics of local segmented clusters

Characteristics		Cluster 1	Cluster 2	Cluster 3
Gender	Male	40 50.60%	193 58.80%	69 55.20%
	Female	39 49.40%	135 41.20%	56 44.80%
	$\chi^2 = 1.911$ $df=1$; $p = 0.385$			
Marital Status	Single	53 67.10%	218 66.50%	89 71.20%
	Married	26 32.90%	110 33.50%	36 28.80%
	$\chi^2 = 0.942$; $df=1$; $p = 0.624$			
Age	20-29	55 69.60%	157 47.90%	83 66.40%
	30-39	19 24.10%	132 40.20%	32 25.60%
	40-59	5 6.40%	39 11.90%	10 8.00%
	$\chi^2 = 20.180$; $df=3$; $p = 0.000$			
Higher Education Level	High School	38 48.10%	140 42.70%	42 33.60%
	University/Postgraduate or above	41 51.90%	188 57.30%	83 66.40%
	$\chi^2 = 4.821$; $df=1$; $p = 0.09$			
Job	Formal	49 62.00%	273 83.20%	78 62.40%
	Non-Formal	30 38.00%	55 16.80%	47 37.60%
	$\chi^2 = 29.670$; $df=1$; $p = 0.00$			
Income	< IDR 5.000.001	29 36.70%	30 9.10%	48 38.40%
	IDR 5.000.001 - 10.000.001	3 3.80%	41 12.50%	14 11.20%
	IDR 10.000.001 - 15.000.001	16 20.30%	126 38.40%	25 20.00%
	> IDR 15.000.001	31 39.20%	131 39.90%	38 30.40%
	$\chi^2 = 71.352$; $df=3$; $p = 0.00$			
Resident knowledge for public participation in WtE management	Knowing	61 77.20%	303 92.40%	85 68.00%
	Do not know	18 22.80%	25 7.60%	40 32.00%
	$\chi^2 = 44.485$; $df=1$ $p = 0.00$			
Willingness' to Acceptance	Accept	60 0.759	313 0.954	75 0.6
	Not Accept	19 0.241	15 0.046	50 0.4
	$\chi^2 = 90.193$; $df=1$; $p = 0.00$			

Chi-square analysis was carried out for each quantitative data, namely the social demographic and awareness characteristics of the respondents in this study. Table 4 shows that job, income, knowledge, and acceptance had a significance value of 5%.

Multinomial Logit analysis is used if the response variable (dependent) is categorized into three or more categories in the research variable. In this study, the dependent variable (*Y*) referred to the acceptance of WtE technology. Meanwhile, quantitative data in gender, marital status, age, higher education level, job, and income were used as the *X*-axis. The multinomial logit test in this study was carried out in four models. Overall, each model showed a higher education level and income indicating the acceptance of WtE technology, except for Model II. In addition, in model I (Over all) and the model IV (Pro economy and society), gender also influenced acceptance, in this case female that were more accepting of WtE technology. The most significant variable in all models was knowledge already known by the community. People who have read the issue and the urgency of this technology gave a positive response to the acceptance of WtE.

Meanwhile, income had the highest significance in the models I and model III. The accuracy of each model had a value of more than 50%, especially in model III, which had a value of 97%, showing that the former model was quite good to describe the local acceptance of the acceptance of WtE technology (Table 5). Meanwhile, 2 Log likelihood also had a value above the Chi-square value so that this equation can be used.

Table 5. Estimation results of local people's perception for Waste to Energy in Indonesia

Variables in the Equation	Model I (All *n*=532)		Model II Cluster 1 (*n*=79)	
	Coeff.	Std. Error	Coeff.	Std. Error
Constant	0.435	0.726	-1.913	1.301
Gender (1=male; otherwise, 0)	-0.831*	0.432	1.073	0.904
Marital Status (1=single; otherwise, 0)	0.632	0.531	19.693	6765.595
Age (1=20-29; otherwise, 0)	-0.692	0.647	18.895	6847.694
Higher Education Level (1=Universities level; otherwise, 0)	1.264***	0.486	-0.349	0.972
Job (1=Formal; otherwise, 0)	0.132	0.46	0.746	0.886
Income (1=<IDR 5.000.000; otherwise, 0)	-2.242***	0.632	-38.4	9626.224
Knowledge (1= Knowing the issues; otherwise, 0)	3.113***	0.413	2.423***	0.875
Prediction accuracy (%)	93.4		88.6	
−2Log likelihood	270.092		40.959	
Chi-square value	$\chi 2$ (7; 0.01 = 18.48)			
Variables in the Equation	**Model III Cluster 2 (*n*-328)**		**Model IV Cluster 3 (*n*-125)**	
	Coeff.	Std. Error	Coeff.	Std. Error
Constant	3.719	1.556	0.591	1.157
Gender (1=male; otherwise, 0)	-1.118	1.001	-1.764**	0.855
Marital Status (1=single; otherwise, 0)	0.474	1.181	-0.326	0.873
Age (1=20-29; otherwise, 0)	-0.365	1.44	-1.468	1.042
Higher Education Level (1=Universities level; otherwise, 0)	2.247**	1.098	1.195*	0.763
Job (1=Formal; otherwise, 0)	-1.524	1.089	0.487	0.736
Income (1=<IDR 5.000.000; otherwise, 0)	-4.802***	1.576	-1.076	1.054
Knowledge (1= Knowing the issues; otherwise, 0)	2.58***	0.924	3.246***	0.716
Prediction accuracy (%)	97		89.6	
−2Log likelihood	57.226		74.872	
Chi-square value	$\chi 2$ (7; 0.01 = 18.48)			

***, **, * are significance at $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively

Population growth cannot be separated from economic development, production and fulfilment of life needs, improvement of life quality, and welfare [50]. However, to meet the needs and improve the life quality, economic growth must continue to be encouraged [51]. The target of economic growth, one of the efforts made by a country, is to distribute development evenly, either in the form of infrastructure or in the form of human resource development. In all these efforts, whether in terms of economic growth, equitable development, or regarding simply fulfilling the necessities of life, sufficient energy sources are needed to drive the activities and productivity of society and industry [52]. Therefore, along with population growth, the fulfilment of community needs, economic growth targets, and the need for energy also escalates.

The socio-economic factors formed in this study showed the community's desire to get the circular economy obtained from the WtE project. Waste management plants/facilities are built with public money to provide public service [53]. In economic calculations annual cash flow of the system is equalized with zero, taking into account all incomes from products like energy vectors, secondary materials, compost and investment and operating costs [53]. The Jakarta Government is the initiator of infrastructure development, one of the supporters of economic growth [54]. Therefore, development related to WtE infrastructure is deemed critical for having a large and sustainable multiplier effect on the progress of the national economy. In addition, infrastructure development is expected to be a trigger for accelerating an equitable development throughout Indonesia. This impacts several sectors, including increasing employment opportunities [55] in various regions, which reduces poverty levels and economic disparities between areas.

Environmental factor is one of the most important factors in the urgency of implementing WtE in Jakarta [56]. The existing waste management will cause some ecological problems like other waste disposal sites [57]. Classic problems commonly exist unpleasant odours, contamination of groundwater by residual leachate that is not channelled to leachate treatment [58]. In addition, the unutilized methane gas released into the air can cause a greenhouse gas effect in the earth's atmosphere, which is more dangerous [56]. Public awareness of environmental conditions is now also a driving factor for sustainable development, especially for waste management encouraging the creation of clean energy.

Then, the last factor formed is the development of WtE. The formation of development factors is also driven by regulations and the existing conditions [59], including Jakarta. Therefore, as one of the steps or efforts to overcome the increasing volume of waste, government encourages the waste processing by changing it into electrical energy based on environmentally friendly technology [60]. The Perpers 35/2018 states that waste management aims to improve public health and the life quality of the local environment, and to significantly reduce the waste volume for the cleanliness and beauty of the city and to use waste as a resource to gain the added value. However, inviting the involvement of business entities in processing waste into electrical energy is not simple. More uncertainties for business entities in the waste processing project into electrical energy [59] have created, doubts for business entities to invest in this sector. The government also needs to encourage local to recycle and reuse the waste archive circular economy [56].

The public acceptance of WtE thermal-based is affected by such demographic variables as age, or education level. [61]. In this research, this study's demographics showed a significantly higher education and income level than the others. The logit equation test showed that the higher the level of education and income, the higher the acceptance of WtE. This also showed the need to promote social economic development conforming to the unique ecological environment and capacity to achieve coordinated development [62].

Improving the quality of human resources can be done through education [63]. The primary role of education is to alert citizens who are able to develop an integrated democratic behaviour to increase the living standard based on productive social democracy. Education is a solution to economic, social, and environmental problems. [64] Through education, people are able to improve their personal qualities and abilities to improve the living standard for themselves and their families. The public becomes more educated and is not easily provoked by the propaganda of certain parties who want to disrupt political stability and social life in the community. Education can encourage welfare and people's behaviour to be more modern and accept any differences in the environment surrounding.

Creating an integrated waste management system requires a large budget as well as cooperation between the government and the community. The community's willingness to help the government in providing several facilities and infrastructure for waste management is by contributing the rest of the community's income every month. The factors that greatly affect the willingness to pay of each individual are the individual's income level and education level, where the results of his research showed a positive and significant effect on the individual's willingness to pay value [65]. While the variables of age, number of family members, employment status and gender had no significant effect on people's willingness to pay. Finally, increasing WtE acceptance based on factor and cluster analysis for WtE acceptance can be done by paying attention to the scheme in Figure 4.

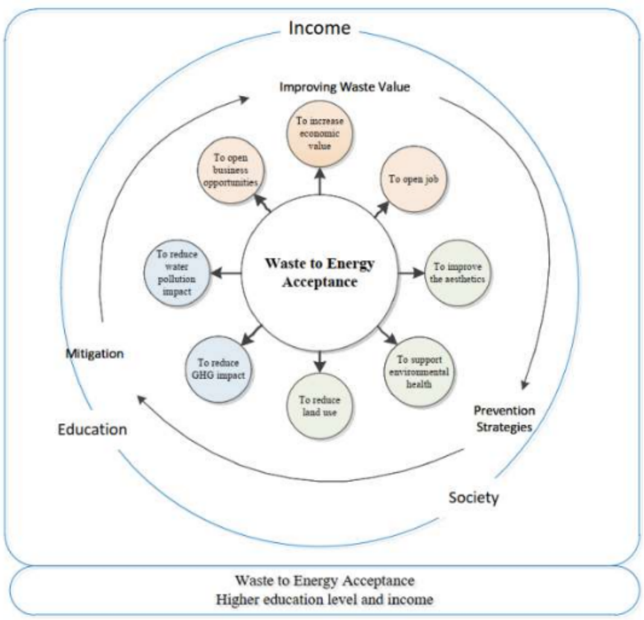

Figure 4. The evaluation framework of factor and cluster analysis for WtE acceptance

CONCLUSIONS

As the development of WtE in Jakarta City become an upcoming issue, knowing public preference and acceptance is necessary to achieve a sustainability in the project implementation. This study has resulted in a number of findings including eight main attributes and three factors to define the public preferences of the WtE development and implementation in Jakarta City. Of these factors, socio-economic factor was found as the most influential factor to the WtE public preference and acceptance, followed by environmental impact and development factors. It indicated that the community will strongly involve to the WtE project if they can obtain an economic value from the project. Employment opportunities may be endorsed for achieving public acceptance in Jakarta City. Besides, it was found that there are three clusters of respondents which can be defined as pro economy, pro society, and pro ecological environment. The pro economy and pro society cluster should also be concerned and managed by the project developer as if they want the program can be run better. A higher level of education is found to be the highest discriminant variables that can encourage the community to develop a better perception of the WtE project development. Therefore, the education level and potential income generation from the project can be determined as the most influencing factors for developing and implementing WtE in Jakarta City. The acceptance of the public to the WtE project later on can lead to the achievement of the sustainability of clean and environmentally friendly energy from waste.

ACKNOWLEDGEMENT

The researcher would like to thank all those who have supported the survey and data collection in this research. In addition, the researchers also thank the reviewers who have supported optimizing the results of the study. The authors declare no conflict of interest.

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Paper submitted: 23.04.2022
Paper revised: 04.01.2023
Paper accepted: 12.01.2023

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