

## Sustainable Public Awareness on Solid Waste Management and Environmental Care using Logistics Regression

(Kesedaran Awam Mampan terhadap Pengurusan Sisa Pepejal dan Penjagaan Alam Sekitar  
menggunakan Regresi Logistik)

Faridah Zulkipli<sup>a</sup>, Zulkifli Mohd Nopiah<sup>b\*</sup>, Nurul Husna Jamian<sup>a</sup>, Noor Ezlin Ahmad Basri<sup>c</sup> & Cheng Jack Kie<sup>d</sup>

<sup>a</sup>Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, 35400 Tapah Road, Perak, Malaysia

<sup>b</sup>Department of Engineering Education, Faculty of Engineering & Built Environment, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

<sup>c</sup>Department of Civil Engineering, Faculty of Engineering & Built Environment, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

<sup>d</sup>Faculty of Industrial Management, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 23600 Gambang, Kuantan, Pahang, Malaysia

\*Corresponding author: zmn@ukm.edu.my

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### ABSTRACT

*Solid waste management and environmental care are essential in all countries to ensure sustainability at all times. But awareness on the importance of both is not yet satisfactory. This is evidenced by the increasing amounts of solid waste generated and the lack of oversight due to public community involvement. The purpose of this study is to investigate the sustainability of public awareness on solid waste management and environmental care among the population of Malaysia. This study uses an online questionnaire for the data collection process. The logistic regression method is used to analyze the data. A total of 422 respondents represented by 20.9% were male while 79.1% were female. The results showed that only 37.91% of respondents were aware of solid waste management and concern for the environment. In fact, more than 50% of respondents are still less aware of solid waste management and environmental concerns. This shows that most of the communities in Malaysia had a lack awareness on the importance of waste management and environmental care. The culture and values of individual responsibility play an important role in ensuring that environmental sustainability is maintained. Solid waste management and environmental care coalitions need to have broad coverage across the country so that all communities are aware and understand the shared responsibility for waste management and environmental care. This awareness will help achieve the national agenda through Joint Prosperity as well as the Sustainable Development Goals by 2030.*

*Keywords: Sustainable public awareness; solid waste management; environmental care; logistic regression*

### ABSTRAK

*Pengurusan sisa pepejal dan penjagaan alam sekitar adalah penting di semua negara untuk memastikan kelestarian pada setiap masa. Tetapi kesedaran tentang kepentingan kedua-duanya belum memuaskan. Ini dibuktikan dengan peningkatan jumlah sisa pepejal yang dihasilkan dan kekurangan pengawasan kerana penglibatan masyarakat awam. Tujuan kajian ini adalah untuk menyiasat kelestarian kesedaran awam terhadap pengurusan sisa pepejal dan penjagaan alam sekitar di kalangan penduduk Malaysia. Kajian ini menggunakan soal selidik dalam talian untuk proses pengumpulan data. Kaedah regresi logistik digunakan untuk menganalisis data. Seramai 422 responden yang diwakili oleh 20.9% adalah lelaki manakala 79.1% adalah perempuan. Keputusan menunjukkan bahawa hanya 37.91% responden menyedari pengurusan sisa pepejal dan kebimbangan terhadap alam sekitar. Malah, lebih daripada 50% responden masih kurang menyedari pengurusan sisa pepejal dan kebimbangan alam sekitar. Ini menunjukkan bahawa kebanyakan masyarakat di Malaysia kurang kesedaran tentang kepentingan pengurusan sisa dan penjagaan alam sekitar. Budaya dan nilai tanggungjawab*

*individu memainkan peranan penting dalam memastikan kelestarian alam sekitar dikekalkan. Gabungan pengurusan sisa pepejal dan penjagaan alam sekitar perlu mempunyai liputan yang luas di seluruh negara supaya semua masyarakat sedar dan memahami tanggungjawab bersama untuk pengurusan sisa dan penjagaan alam sekitar. Kesedaran ini akan membantu mencapai agenda nasional melalui Wawasan Kemakmuran Bersama serta Matlamat Pembangunan Mampan menjelang 2030.*

*Kata kunci: Kesedaran awam lestari; pengurusan sisa pepejal; penjagaan alam sekitar; regresi logistik*

## INTRODUCTION

Waste is defined as the disposing of unwanted or worthless goods, as well as material that has been discarded by people and might be solid, liquid, or gaseous. Sludge, trash, garbage, and other solid waste are examples of solid waste. It also includes solid trash from mining, agriculture, electronic, industrial, and municipal waste, as well as residential and commercial waste (Debrah et al. 2021). Solid waste refers to any non-liquid waste generated by individuals, households, small businesses, or institutions (Baawain et al. 2017). Solid waste management is a complex issue with political, economic, institutional, and environmental dimensions. It has become one of the most critical concerns confronting urban spaces in emerging countries as a result of exponential urban growth (Debrah et al. 2021).

An increased quantities of solid waste generation continue persistent due mainly to rapid population increase, urban migration, economic enhancements, and modern lifestyles (Zulkipli et al. 2021). Due to these, every country face obstacle in establishing long-term waste management policy. As a result, annual solid waste generation of 3.40 billion tons is expected to result in a 739 quadrillion British thermal units (Btu) energy requirement, with a projected increase of over 28% by 2040. (Kaza et al. 2018).

Solid waste management is a notable environmental issue with immediate consequences for both the environment and public health. The tremendous growth in waste generation around the world makes proper waste management more difficult (Baawain et al. 2017; Poldnrk 2015; Taherzadeh & Rajendran 2015). Furthermore, the rapid growth of urban populations, economies, and power consumption in developing countries has resulted in an increase in solid waste production. (Oliveira et al. 2020; Saxena et al. 2020; Habib et al. 2019). According to Ikhlal (2018), waste management is a complex sustainability issue that necessitates a clear vision and integrated approach in dealing with its inherent interaction with environmental and economic factors.

Malaysia is ranked third in ASEAN in 2016 in terms of waste generation per individual, with 1.17 kg/capita/day,

while Singapore (3.763 kg/capita/day) and Brunei (1.4 kg/capita/day) (UNEP, 2017). From 2015 to 2020, Malaysia's average waste production increased by 5.19%, from 38,563 tons/waste/day to 49,670 tons/waste/day. Malaysia's waste recycling rate is expected to increase to 40% by 2025 compared to current rate in 2020 was 30.67% as reported by Solid Waste Corporation (SWCorp 2020). Despite the continued generation of waste in every municipality in Malaysia as a result of the Covid-19 condition, the 2021 Budget allocation of RM322.5 billion reflected the rapid socioeconomic growth, despite the fact that Malaysia's Gross Domestic Product growth averages dropped between 6.5% and 7.5% (Bank Negara Malaysia 2021). It happened due to the lack of awareness on the importance of properly managed the waste and concerns on environment, as well as public concern about the consequences of not separating the solid waste.

Figure 1 illustrates the waste management conceptual framework (Latifah 2021). It passes through three phases namely waste generation (Phase 1), waste transportation (Phase 2), and waste treatment (Phase 3) encompassing of 10 different subsystems. The functional units used to categories household and commercial waste, green waste, wet waste from wet markets, non-hazardous industries, building waste debris, and other related wastes is tons of Municipal Solid Waste materials per year. The organic waste, paper, plastic, metal, glass and other wastes grouped as six main categories of waste. Wastes collected from three sub-processes that track organic waste, namely waste generation, waste collection and transfer, and recovery materials, are included in the "other waste" category (composting, energy recovery from waste and waste disposal).

Figure 2 represented the summary of solid waste composition in 2020, it consists of states supervised by SWCorp under Act 672. Based on the results, food waste was the highest solid waste contributor, followed by plastics and diapers (SWCorp 2020). During this year, Malaysia also hit by Covid-19 outbreak and under several Movement Control Orders (MCO). As a result, the quantity of the most produced solid waste is indicated by these three solid waste categories.

Interdisciplinary approaches to solid waste management had included the socioeconomic, environment, stakeholders, motivation, attitude, behavior, theory, power and knowledge, techniques, and technical issues (Xu et al. 2016). Moreover, in order to sustain the solid waste management or environmental issues in developing countries, formal or non-formal education in solid waste management for sustainable development at all levels of society is essential. It has the ability to spark societal change. Authorities with the right knowledge, attitude, skills, and innovation are required to educate society and disseminate solid waste management and environmental care information for environmental sustainability or better way to handle the solid waste management.

According to Barudin et al. (2021), the Pondok community has excellence knowledge and awareness of sustainable SWM practices. However, the community's involvement in sustainable SWM such as recycling, composting, and others is still satisfactory. A study by Choon et al. (2017) concluded that almost half of those polled stated that they lacked the knowledge to practice waste sorting. Further, age and education were found to be positively associated with reuse and recycling practices.

Overall, a comprehensive waste management education is critical for Malaysia to establish an effective waste management system. This finding is also supported by a study by Afroz et al. (2017) whereby people who are more informed and more convinced of their knowledge intend to practice recycling than those who not in order to contribute towards environmental sustainability. Moreover, a study conducted by Zulkipli et al. (2019) discovered that gender, knowledge, perceptions, and attitude were influence the level of awareness among undergraduates on environmental care.

Later, Zulkipli et al. (2022) examined the level of awareness on solid waste management among youth in Malaysia using mean score analysis. Overall, knowledge, practice, attitude, perception and awareness are indicated positively among the respondents. However, based on their demography aspects, females are more aware than male. While, respondents age more than 30 years old had relatively moderate level of awareness. In addition, some of states had moderate score of practice, attitude and perception.

However, previous study by Desa et al. (2010) obtained that student had moderate level of knowledge, attitude,

awareness and behavior concerning on SWM. As a result, this study recommends that students be educated in creating awareness about SWM on campus to promote change in attitudes and sustainable environmental practices be implemented.

A study by Rahman (2016) reported that knowledge, attitude, personal responsibility, beliefs, social influences, information resources, and environmental management facilities contributed 44% on environmental care behavior. Whereby, social influences and beliefs contributed most on environmental behavior followed by environmental management facilities, attitude, and personal responsibility. However, environmental knowledge did not influence behavior, but it did influence attitude, which in turn affected behavior. Therefore, the primarily aim of this study is to assess the public awareness on solid waste management and environmental care in Malaysia.

## METHODOLOGY

### RESEARCH DESIGNS

The population of this study is all Malaysians who aged 18 years old and above as majority of Malaysians, more than 70 percent are from this age category. This study applied convenience sampling technique by adopting the questionnaire from Jamian et al. (2018) and sharing the Google form link designed through WhatsApp, Facebook, Telegram and email, which is divided into two sections. Section A is consisting of demography and Section B is consisting of solid waste management and environmental care factors. Gender, age group, education level grouped and income grouped are variables under demography. Meanwhile for sustainable public awareness on solid waste management and environmental care consists of knowledge, perception, attitude and practice as presented in Table 1 and Figure 2. The hypotheses of study are  $H_0$  = Gender, Age, Education, Income, Knowledge, Practice, Attitudes and Perceptions are not contributing factors that influence the level of public awareness on solid waste management and environmental care and  $H_1$  = Gender, Age, Education, Income, Knowledge, Practice, Attitudes and Perceptions are contributing factors that influence the level of public awareness on solid waste management and environmental care.

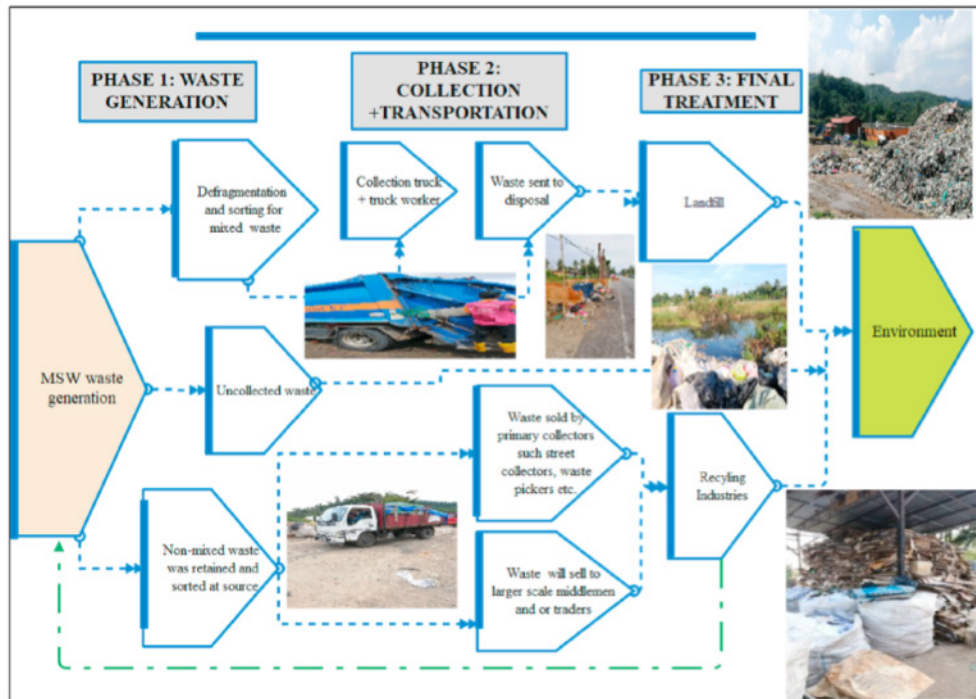


FIGURE 1. The general scheme for waste-flow tracking of solid waste management. Phase 1 for waste generation, Phase 2 for waste collection and transportation and Phase 3 for final treatment  
 Source: Latifah (2021)

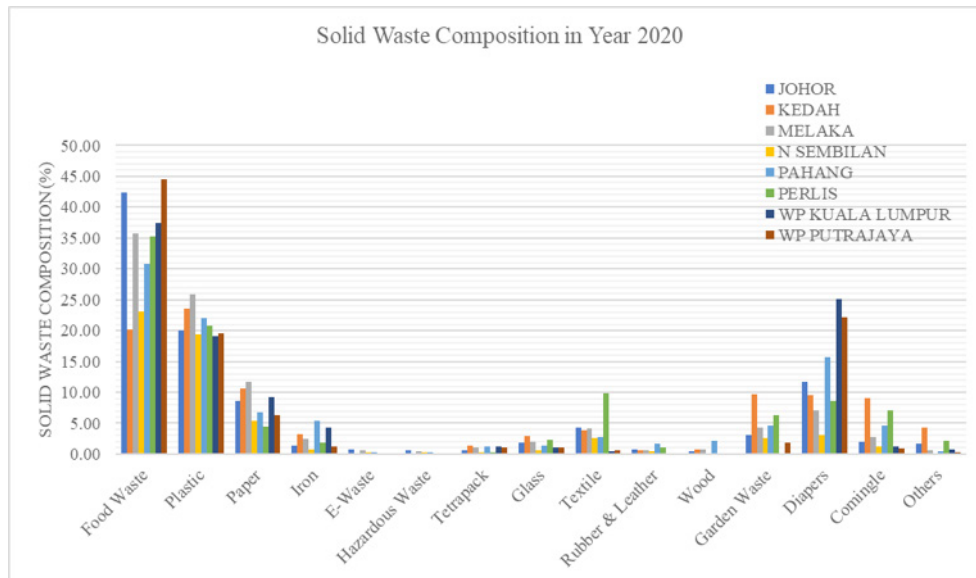


FIGURE 2. Summary of solid waste composition in percentage for Johor, Kedah, Melaka, Negeri Sembilan, Pahang, Perlis, Wilayah Persekutuan Kuala Lumpur and Wilayah Persekutuan Putrajaya in 2020. All states are supervised by SWCorp under Act 672. Solid waste types consist of food waste, plastic, paper, iron, e-waste, hazardous waste, tetra pack, glass, textile, rubber and leather, wood, garden waste, diapers, comingle and others.



Questionnaires' findings were recorded and analyzed using the IBM SPSS 26 software. This study collected 422 survey responses to assess the public awareness on solid waste management and environmental care in Malaysia. Table 1 provides an overview of the explanatory variables used in the logistic regression model of the study. Most of the variables are derived from the survey as in Figure 3, which it is considered relevant from theoretical point of view and included as explanatory variables (Zulkipli & Jamian 2021; Jamian et al. 2018)

Some applications on logistic regression for solid waste management Begun et al. (2006) conducted research in Malaysia on contractor's awareness towards solid waste management using logistic regression analysis. The result showed that waste management plan, source reduction, recycle activity, waste sorting, harmfulness on human health and willing to pay for waste collection contributes significantly toward contractor's awareness.

Seng et al. (2018) use logistic regression analysis to examine the contributing factors on solid waste management in Cambodia among households. Education level and incomes have positive influences on knowledge and attitude towards waste management. Nevertheless, practice of waste management received less influence from public. As a conclusion, practice need to burst more among public to increase household's awareness.

#### LOGISTIC REGRESSION MODEL

This study has been designed with logistic regression analysis model. The likelihood ratio index has been measured as an indicator of goodness of fit for the model in order to determine the factors that contribute to the awareness of environmental care. The developed model assesses the relationship between variables; which are gender, education, income, knowledge, practice, attitude and perception. The dependent variable is designed as a dichotomous dummy based on the hypothesis of public awareness on solid waste management and environmental care in Malaysia.

The logistic regression model is as,

$$\text{Log} \frac{P_i}{1-P_i} = Z_i = \beta_0 + \beta_i X_i + \varepsilon \quad (1)$$

Where,

$P_i = 1$  if public awareness on solid waste management and environmental care is adequately aware

$P_i = 0$  for otherwise

$X_i$  = independent variables

$\beta_0$  = constant term

$\beta_i$  = coefficient of independent variables

$\varepsilon$  = the error term

$i = 1, 2, 3, \dots, n$

Since the logistic regression test is a non-parametric test involving non-parametric data, then the study data is not normally distributed, for example the researcher does not have to check whether the study data is normally distributed before making the analysis. Therefore, here are some of the requirements of logistic regression: (a) dependent variable is dichotomous data, which the measurement scales for dependent variables should be dichotomous such as data has only two categories; (b) sample size of study - the minimum number of respondents for each study variable is 10 (Hosmer et al. 2013).

## RESULTS AND DISCUSSION

### DESCRIPTIVE STATISTICS ON DEMOGRAPHY

The survey was conducted among Malaysian citizen age of 18 years old and above. The survey was distributed through an online platform such as WhatsApp, Telegram and Email. 422 respondents participated in this survey. The summary of demography descriptions is illustrated in Table 2. Based on 422 participated respondents, consisting of 20.9% of Male and 79.1% of Female, more than half of the respondents are age below than 19 years old, while almost 42% are age above than 20 years old. The respondents had an education qualification of three categories, which are for Foundation/Matriculation 12.3%, Undergraduate Studies with 87.2% and for Postgraduate Studies with only 0.5%. The respondents were asked whether they had an income or not having an income. Based on the survey results, the respondents had an income are more than half which is 81.3% compared to those who are not having an income.

TABLE 1. Description of the variables, level of variables and scale of measurements for developing the sustainable public awareness on solid waste management and environmental care using logistic regression model.

Variables	Descriptions	Scale of measurements
Dependent variable:		
Sustainable public awareness on solid waste management and environmental care	1 = Yes 0 = No	Nominal
Independent variables:		
Gender	1 = Male 2 = Female	Nominal
Age	1 = <= 19 years old 2 = >= 20 years old	Nominal
Education	1 = Foundation/Matriculation 2 = Undergraduate Studies 3 = Postgraduate Studies	Ordinal
Income	1 = No 2 = Yes	Nominal
Knowledge	1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree	Interval
Practice		
Attitude		
Perception		

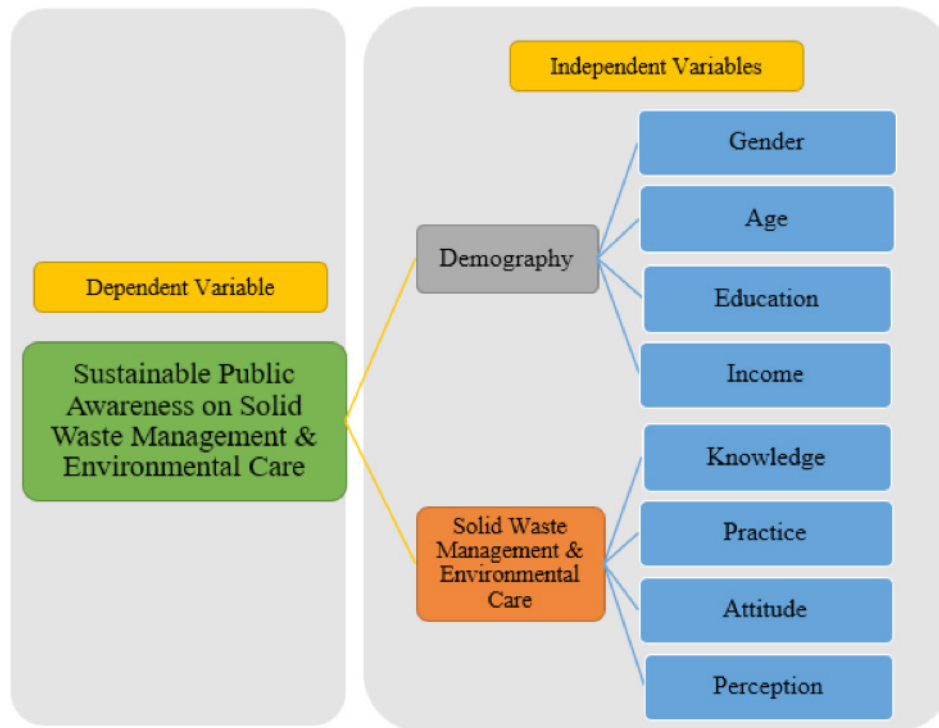


FIGURE 3. Framework design for sustainable public awareness on solid waste management and environmental care. Dependent variable is sustainable public awareness. Independent variables are gender, age, education, income, knowledge, practice, attitude and perceptions.

## CROSSTABULATION TABLE

Table 3 highlighting the crosstabulation summary between gender and sustainable public awareness on solid waste management and environmental care. The result shows that with regard to their gender, only 37.91% are aware of sustainable solid waste management and environmental care. However, more than 60% are still not really aware of this matter. Both Male and Female are still lack of awareness on the sustainable solid waste and environmental care as a role of community responsible. Solid waste management is inextricably linked to the circular economy, two fundamental concepts that play a key role in the 2030 Agenda, particularly in the SDGs for sustainable cities and communities (SDG 11), responsible consumption and production (SDG 12), and life beneath the sea (SDG 13). (SDG 14) as reported by United Nation in 2015 (UN. 2015). Thus, these results supported by the increasing trend of solid waste generation yearly. The public awareness is expected to increase at least more than 50% in order to ensure national agenda can be achieved by 2025 as well as the fulfilment of Sustainable Development Goals by 2030 as a sustainable green environment and an efficiency of solid waste management.

## CLASSIFICATION TABLE

It is concern to look at the proportion of cases that have been correctly classified. The classification table indicates how many cases where the observed values of the dependent variable with 1 or 0 were correctly predicted. In an ideal model, all cases will be on the diagonal, and the overall percent correct will be 100% (Hosmer et al. 2013). Table 4 showed that 20% of those in the Awareness group were correctly classified, while 89.7% of those in the no awareness to Awareness group were incorrectly classified. Overall, 63.3% of the questions were correctly classified.

## MODEL CHI-SQUARE TEST

The overall significance is tested using the Model Chi square, which is derived from the likelihood of observing the actual data under the assumption that the fitted model is accurate. The  $p$ -value is compared to a significance level, 0.05 to determine whether the overall model is statistically significant (Hosmer et al. 2013). The model was statistically significant, according to Table 5, because the  $p$ -value was 0.000, which was less than 0.05. It was discovered that the predictors have a significant on sustainable public awareness on solid waste management and environmental care.

As a result, the logistic regression model for the combination of demography and sustainable public awareness on solid waste management and environmental care factors was significant and meaningful (good fitting model).

## LIKELIHOOD RATIO

Based on Table 6, it found that there are no multicollinearity problems as the standard error obtained for each variable lies between -2 and +2. The regression results found that predictors that had significance influences on sustainable public awareness on solid waste management and environmental care in Malaysia were Age, Practice, Perception and Attitude. For Age, respondents of age below and equal to 19 years old were 0.647 times more aware in solid waste management and environmental care compared to those who were age above and equal to 20 years old. With regard to Practice, it is found that respondents who practice on solid waste management and environmental care were 7.322 times more than respondents who do not practice. Moreover, for Attitude and Perception, the odd ratios, Exp (B), were 1.419 and 0.625, respectively. These findings revealed that Perception and Attitude increased the sustainable public awareness on solid waste management and environmental care by 1.419 times and 0.625 times, respectively.

Results on correlation matrix is presented in Table 7. The correlation coefficient value of each significant variable indicates that the whole thing has a weak relationship either positive or negative by obtaining a correlation coefficient value of less than +0.3 to -0.3. Table 8 shows the predictor variables maintained in the logistics regression model because the variables are a significant predictor variable against the dependent variable.

In addition, Table 9 shows independent variables that are not included in the logistical regression model because they are found to be insignificant. Hence, the logistic regression model is as in Equation (2).

## CONCLUSION

Solid waste management and environmental care play an importance element for sustainable development goals. However, the complexity process involved in solid waste management leads to inefficiency and lack of responsibility especially on public concerns on its process and environmental care. The solid waste generation rise significantly over time due to rapid population, urbanization and economic development. Furthermore, life style changes due to income and lack of public awareness contributed to solid waste generation trend. Therefore, this study is aims to determine the sustainable public awareness on solid waste management and environmental care in Malaysia.

A logistic regression model is applied for in the study. Sustainable public awareness on solid waste management and environmental care is assigned as dependent variable. While for predictor variables are consist of Gender, Age, Education, Income, Knowledge, Practice, Attitude and Perception. As a result, only Age, Practice, Attitude and Perceptions are significant towards sustainable public

awareness on solid waste management and environmental care with *p*-value is less than 0.05. As a conclusion, all stakeholders, including the government, policymakers, and solid waste management authorities, should pay close attention to sustainable public awareness, with the most important factor being public or community acceptance and engagement.

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$$\text{Log} \frac{P_i}{1-P_i} = -0.732 - 0.436\text{Age} + 1.991\text{Practice} + 0.350\text{Attitude} - 0.470\text{Perception} \tag{2}$$

TABLE 2. Summary results of descriptive on demography

Variables	Descriptions	Frequency	Percentage (%)
Gender	Male	88	20.9
	Female	334	79.1
Age	<= 19 years old	245	58.1
	>= 20 years old	177	41.9
Education	Foundation/Matriculation	52	12.3
	Undergraduate Studies	368	87.2
	Postgraduate Studies	2	0.5
Income	No	79	18.7
	Yes	343	81.3

TABLE 3. Crosstabulation results of gender and sustainable public awareness on solid waste management and environmental care

Gender	Awareness = Yes	Percentage (%)	Awareness = No	Percentage (%)	Total
Male	36	40.91 %	52	59.09 %	88
Female	124	37.13 %	210	62.87 %	334
Total	160	37.91%	262	62.09 %	422

TABLE 4. Classification table

Observed	Predicted		Percentage Correct
	Awareness = Yes	Awareness = No	
Awareness = Yes	32	128	20.0
Awareness = No	27	235	89.7
Overall Percentage			63.3

TABLE 5. Omnibus tests of model logistic regression coefficients

Model	Statistic
Chi-square	22.948
Degree of freedom	4
p-value	<0.001*

Note: \*p-value<0.05

TABLE 6. Variable in the equation

Variables	Coefficient (β)	Standard Error	p-value	Exp (B)
Constant	-0.732	0.669	0.274	0.481
Age	-0.436	0.208	0.036	0.647
Practice	1.991	0.684	0.004	7.322
Attitude	0.350	0.151	0.021	1.419
Perception	-0.470	0.228	0.039	0.625



TABLE 7. Correlation matrix

Variables	Constant	Age	Practice	Attitude	Perception
Constant	1.000	-0.071	-0.299	-0.973	-0.257
Age	-0.071	1.000	0.024	-0.066	-0.039
Practice	-0.299	0.024	1.000	0.294	-0.116
Attitude	-0.973	-0.066	0.294	1.000	0.165
Perception	-0.257	-0.039	-0.116	0.165	1.000

TABLE 8. Model if term removed

Variables	Model Log Likelihood	Change in -2 Log Likelihood	df	Sig. of the Change
Age	-270.782	4.396	1	0.036
Practice	-274.493	11.817	1	<0.001
Attitude	-271.284	5.401	1	0.020
Perception	-270.709	4.250	1	0.039

TABLE 9. Variables not in the equation

Variables	Score	df	Sig.
Gender	0.362	1	0.548
Income	0.755	1	0.385
Education	0.116	2	0.944
Knowledge	2.693	1	0.101
Overall statistics	3.658	5	0.600

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