Community Awareness Model Based on Integrity, Attitude, Knowledge and Perception Towards Solid Waste Management and Environmental Care

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ARTICLE INFO	ABSTRACT
Article history: Received 22 June 2023 Received in revised form 6 September 2023 Accepted 30 October 2023 Available online 20 March 2024 *Keywords:* Solid Waste Management; Environmental Care; Sustainable; Correlation Analysis; Multiple Linear Regression	Globally, the solid waste management (SWM) and environmental care (EC) are critical issues that require significant attention. Increasing community Awareness is one solution to address these challenges. Community awareness on SWM and EC refers to a community's knowledge and understanding of the importance of proper waste management and environmental care. The objectives in this study are: i) to identify the strength of relationships between variables and ii) to develop a multiple linear regression model for community Awareness, Integrity, Attitude, Knowledge, and Perception. A total of 254 respondents from UiTM Perak Branch, Tapah Campus participated by completing an online questionnaire, with 70.87% female and 29.13% male respondents. The study used a simple random sampling technique and applied correlation analysis and multiple linear regression. The results showed moderate associations ($0.4 < r < 0.7$) between community Awareness and Integrity, Attitude, Knowledge, and Perception regarding SWM and EC. The multiple linear regression model was found to be significant with a p-value of less than 0.05 where all variables were significantly contributed on community Awareness.

1. Introduction

The surge in municipal solid waste production driven by population growth and urbanization, has prompted researchers to explore the use of advanced technology as a solution [1]. Most developing countries including Malaysia face serious environmental problems arising from the inappropriate management of solid waste [2]. Issues of global significance involve inadequate methods of waste disposal and inadequate rates of household waste diversion by means of recycling both organic and material waste. It is vital to gain insight into the attitudes of the community towards solid waste management services, outreach initiatives, regulations, and the barriers to implementing sustainable practices in order to formulate effective strategies for managing solid waste [3]. Environmental

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awareness does not only depend on the one's knowledge about the environment, but it comprises the determination, values, and necessary skills to effectively address environmental issues [4].

Solid waste management is a process that entails the safe and responsible collection, treatment, and disposal of waste. It includes waste reduction, segregation, transportation, treatment, and disposal. Environmental care involves actions that aim to protect the environment, including waste reduction, resource conservation, promotion of renewable energy, and adoption of sustainable living practices. It is crucial to properly manage solid waste to protect both the environment and human health as untreated waste can contaminate the soil, water, and air, posing a risk to public health. Waste can also cause unsanitary conditions, foul odours, and the proliferation of pests and disease-carrying insects. Therefore, proper solid waste management practices are necessary to ensure the protection of the environment and human health.

Active participation from individuals is essential in promoting and sustaining community awareness towards solid waste management (SWM) and environmental care (EC). Community awareness in this context refers to a community's knowledge and understanding of the importance of proper waste management and environmental care [5]. This encompasses activities such as waste reduction, proper disposal, recycling, and promoting environmentally friendly practices to support community awareness efforts. Raising individuals' awareness about SWM and the environment can assist in mitigating the adverse effects of waste on both the environment and human health. Indirectly, it promotes sustainable living and personal responsibility for environmental impact. It is the responsibility of each member of the community to contribute towards creating a sustainable environment for future generations.

The issue of SWM has become a worldwide concern due to population growth. Unsafe management practices are responsible for 33% of the world's 2.01 billion metric tons of municipal solid waste. In ASEAN, per capita municipal solid waste generation is 1.14 kg/capita/day, with an average waste per person per day of 0.74 kg and a range of 0.11 to 4.54 kg. Inadequate solid waste planning and insufficient financial investment in waste management have resulted in poorly operated facilities that pollute the environment and endanger public health [6,7]. Malaysia's population has grown significantly and reached 32.8 million in 2021, generating 38,427 metric tons of solid waste per day (1.17 kg/capita/day), with 82.5% landfilled. Municipal solid waste collection is expected to reach 14 million metric tons by 2022. Malaysia's rate has exceeded the 2020 rate of 30,000 metric tons per day reported in a study by the Japan International Cooperation Agency (JICA), indicating the need for new facilities to address these issues [8]. The Solid Waste Corporation (SWCorp) reported a recycling rate of 30.67% in 2020, lower than Singapore (59%), Korea (49%), and Taiwan (60%) [9].

Municipal waste management is impacted by human behaviour [10,11], and promoting favourable environmental attitudes is one way to address this issue [12]. Environmental education plays a key role in creating an ecologically conscious society, equipping individuals with the necessary information, skills, attitudes, motivations, and commitment to solve environmental problems and prevent new ones from arising [13]. Universities, with their strong culture of learning, are well-positioned to educate and shape future citizens and leaders [14]. In Malaysia, a survey revealed that a significant percentage of respondents had high awareness, knowledge, practice, attitude, and perception when it comes to SWM [15]. Additionally, Zulkipli *et al.,* [16] found that sustained public knowledge of SWM and EC is strongly influenced by age, practice, attitude, and perceptions. Another study by Zulkipli *et al.,* [17] demonstrated that gender, knowledge, perceptions, and attitude significantly affected student environmental awareness.

Moreover, Zulkifli *et al.,* [18] discovered that students' knowledge, practice, and attitude affect environmental sanitation. In a study conducted by Jamian *et al.,* [19], it was found that most students had good environmental knowledge, attitudes, and awareness, but their environmental care was

moderate. The study also revealed that female students exhibited higher environmental care practices, attitudes, and awareness compared to male students. In order to achieve effective environmental care and SWM, integrity is essential. Integrity involves inner sincerity and outside faith, necessitating honesty and keeping promises [20]. The study done by Liu *et al.,* [21] are hypothesized that Residents' willingness to classify domestic garbage depends on the penalty system's integrity and effectiveness. It builds models to study the mechanism behind home waste sorting. Domestic and international waste classification willingness and behaviour are also influenced by sociodemographic variables like gender, age, education, income, and family size.

An online database search reveals that there is a lack of research on the impact of individual integrity on environmental care and SWM. Previous studies on these topics have not fully explored the concept of integrity. Thus, this study seeks to bridge this research gap by incorporating the concept of integrity into the examination of the contribution of the level of Integrity, Attitude, Knowledge, and Perception towards community Awareness on SWM and EC among students from UiTM Perak Branch, Tapah Campus. In order to achieve this aim, the study has two objectives:

i. to identify the strength of relationships between variables
ii. to develop a multiple linear regression model for community Awareness, Integrity, Attitude, Knowledge, and Perception.

2. Methodology

This section outlines the methodology used in this study, with the flow of each procedure depicted in Figure 1. The first step is the research design, which includes specifying the population, sample size, sampling technique, questionnaires, and hypotheses. The second procedure explains the correlation analysis method, while the final procedure describes the multiple linear regression method.
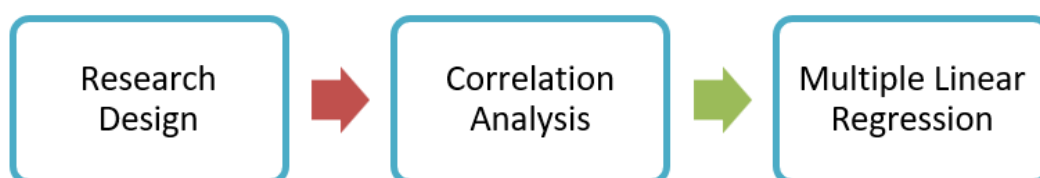

Fig. 1. Flow of Methodology Procedures

2.1 Research Design

The target population for this study includes all students from UiTM Perak Branch, Tapah Campus, with a sample size of 254 respondents selected randomly using a simple random sampling technique due to its ease of use, simplicity, and cost-effectiveness. The questionnaire for this study was developed using Google Form adopted from Zulkipli *et al.,* [16] and the link to the form was disseminated through various platforms including WhatsApp, Facebook, Telegram, and email. The questionnaire consisted of two sections: Section A covered demographic information, including gender, age group, semester, and place of residence, while Section B focused on SWM and EC factors, such as community Awareness, Integrity, Attitude, Knowledge, and Perception as shown in Figure 2.
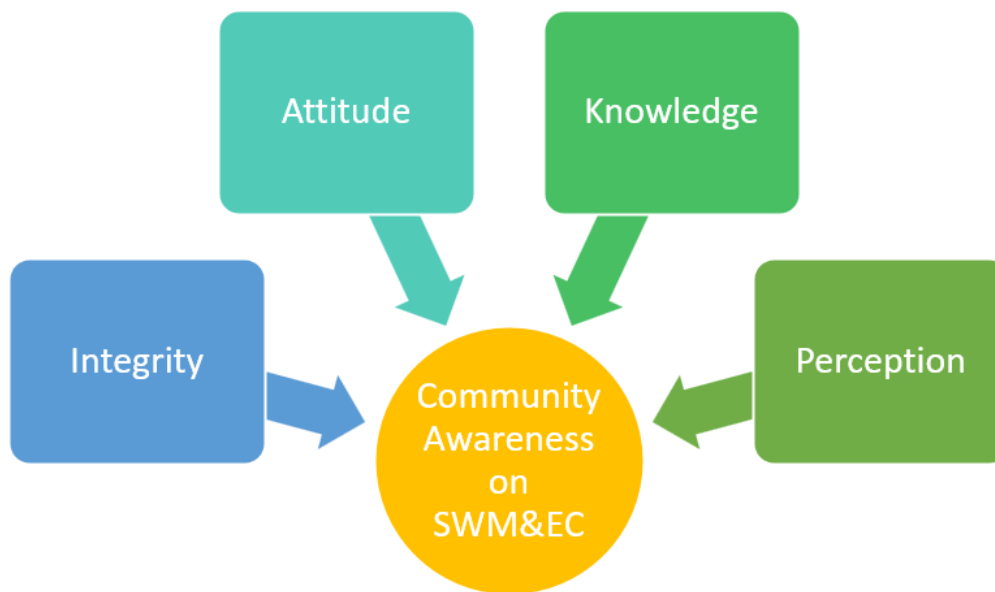
Fig. 2. Research Design on Community Awareness on SWM and EC

The data collection process involved using a 7-point Likert scale, with responses ranging from 1 (strongly disagree) to 7 (strongly agree), as outlined in Table 1. The data collected were recorded and analysed using the IBM SPSS 26 software. The hypotheses of study were as follows H_0 = Integrity, Knowledge, Attitude, and Perception do not contribute to community Awareness of SWM and EC. and H_1 = Integrity, Knowledge, Attitude, and Perception contribute to community Awareness of SWM and EC.

Table 1
Descriptive of variables, level of variables and scale of measurement
for community Awareness on SWM and EC

Variables	Descriptions	Scale of measurement
Dependent		
Community Awareness on SWM and EC	1 = strongly disagree	
	2 = moderate disagree	
Independent	3 = disagree	Interval
Integrity	4 = neutral	
Attitude	5 = agree	
Knowledge	6 = moderate agree	
Perception	7 = strongly agree	

2.2 Correlation Analysis

The study examines community Awareness, Integrity, Attitude, Knowledge, and Perception as factors of interest. The first objective is to explore the relationships between these variables, which is achieved through correlation analysis. The Pearson correlation coefficient (r) is a statistical technique used to assess the presence of a relationship between two variables. The coefficient ranges between -1 to +1, with values near +1 indicating a strong positive linear relationship, values near -1 indicating a strong negative linear relationship, and a coefficient value of 0 indicating no relationship between the two variables. The equation of Pearson coefficient of correlation is shown in Eq. (1) [25].

$$r = \frac{\sum xy - \frac{\sum x \sum y}{n}}{\sqrt{\left(\sum x^2 - \frac{(\sum x)^2}{n}\right)\left(\sum y^2 - \frac{(\sum y)^2}{n}\right)}} \tag{1}$$

where;
    r = correlation coefficient
    n = number of observations
    ∑x = sum of the product x
    ∑y = sum of product y
    ∑xy = sum of the product x and y
    $\sum x^2$ = sum of square of values of variable x
    $\sum y^2$ = sum of square of values of variable y
    $(\sum x)^2$ = square of the sum of all values of variable x
    $(\sum y)^2$ = square of the sum of all values of variable y

2.3 Multiple Linear Regression

The multiple linear regression approach is utilized to develop the community Awareness model for SWM and EC. Several assumptions need to be met to ensure the reliability of the equation. Firstly, a sample size of at least 15 respondents per predictor is required for a reliable equation [22]. Tabachnick and Fidell [23] provide a formula for determining the sample size requirements, taking into account the number of independent variables to be used: N > 50 + 8m, where m is the number of independent variables. In this study, there are four independent variables such Integrity, Attitude, Knowledge, and Perception, which means that the required sample size is more than 50 + 8(4) = 82. Secondly, the existence of multicollinearity must be diagnosed based on the Tolerance and VIF values. VIF values below ten indicate no multicollinearity issue between the independent variables, and the Tolerance value should be more than 0.1 [24]. Thirdly, outliers can be identified on the scatter plot of standardized residuals. According to Tabachnick and Fidell [23], outlier cases of standardized residuals that exceed +3.3 or are less than -3.3 are considered. The general equation model of multiple linear regression is expressed in Eq. (2).

$$Yi = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \varepsilon \tag{2}$$

where;
    Y_i = predicted value of the dependent variable
    β_0 = constant term
    β_k = regression coefficient of independent variables
    X_k = independent variables
    ε_i = random error terms

3. Result and Discussion

The results of this study are presented in three sections. Firstly, the background of the respondents is discussed in section 3.1, using descriptive statistics analysis. Secondly, the strength of the relationship between variables is illustrated in section 3.2, using a correlation analysis approach. Finally, the development of community Awareness, Integrity, Attitude, Knowledge, and Perception are presented using a multiple linear regression methodology.

3.1 Descriptive Statistics

The demographic description of the respondents is presented in Table 2. Out of 254 respondents, 70.87% were female and 29.13% were male. The majority of respondents were from KPPIM (42.13%), followed by FP (30.31%) and FSG (27.56%). The age distribution of the respondents shows that 54.72% of them were between 20 to 21 years old, while 31.50% were aged between 18 to 19 years old and 13.39% were aged between 22 to 23 years old. Furthermore, the results revealed that 62.60% of respondents were staying in college residences, while 37.4% were non-residents. In terms of their semester of study, the majority of respondents were in Part 4 (54.33%), followed by Part 2 (29.92%), Part 5 (12.99%), and Part 3 (2.36%).

Table 2
Demography Descriptive Statistics of Respondents

Demography Variables	Descriptions	Frequency	Percentage (%)
Gender	Male	74	29.13
	Female	180	70.87
Faculty	FSG	70	27.56
	KPPIM	107	42.13
	FP	77	30.31
Age Group	18-19	80	31.50
	20-21	139	54.72
	22-23	34	13.39
	Above 24	1	0.39
Place of residence	College residence	159	62.60
	Non- residence	95	37.40
Semester	Part 2	76	29.92
	Part 3	6	2.36
	Part 4	138	54.33
	Part 5	33	12.99

3.2 The Correlation Analysis

The results of correlation analysis are presented in Table 3. The results indicate that all variables are significantly correlated with each other, with a p-value less than 0.05, demonstrating the presence of relationships. There are moderate relationships between the community's Awareness towards Integrity, Attitude, Knowledge, and Perception regarding SWM and EC, with the Pearson correlation coefficient (r) ranging from +0.4 to +0.7.

Table 3
Correlation Analysis Between Variables

Variables	Awareness	Attitude	Perception	Integrity	Knowledge
Awareness	1.0	0.689	0.685	0.617	0.746
(p-value)		(0.001)	(0.001)	(0.001)	(0.001)
Attitude	0.689	1.0	0.608	0.534	0.624
(p-value)	(0.001)		(0.001)	(0.001)	(0.001)
Perception	0.685	0.608	1.0	0.463	0.734
(p-value)	(0.001)	(0.001)		(0.001)	(0.001)
Integrity	0.617	0.534	0.463	1.0	0.491
(p-value)	(0.001)	(0.001)	(0.001)		(0.001)
Knowledge	0.746	0.624	0.734	0.491	1.0
(p-value)	(0.001)	(0.001)	(0.001)	(0.001)	

3.3 The Multiple Linear Regression

Multicollinearity occurs when the correlation coefficient value is higher than 0.9 (r > 0.9) [25]. However, since all the correlation coefficients in Table 3 are less than 0.9, it can be concluded that there is no multicollinearity present in the data. As shown in Table 4, the Cook's Distance values were all below 1, indicating that individual cases did not have an improper influence on the model. Therefore, no significant outliers were detected that could potentially influence the model.

Table 4
Residuals Statistics

Cook's Distance	Statistics
Minimum	0.000
Maximum	0.463
Mean	0.008
Standard deviation	0.036

Figure 3 displays the P-P plot, which shows that the data follows a straight line from the lower left to the upper right. In other words, the dots lie closer to the diagonal line, indicating that the normality assumptions for the residuals are not violated.
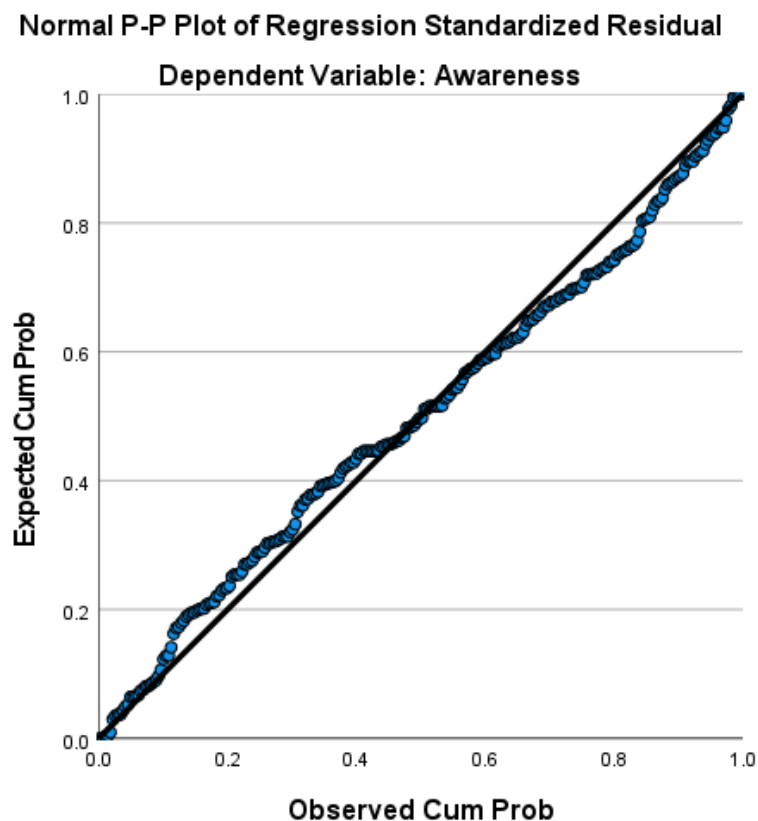

Fig. 3. Normal P-P Plot of Regression Standardized Residual

Furthermore, Figure 4 presents the scatter plot of standardized residual distribution within the range of +3 to -3, indicating that it is randomly distributed.
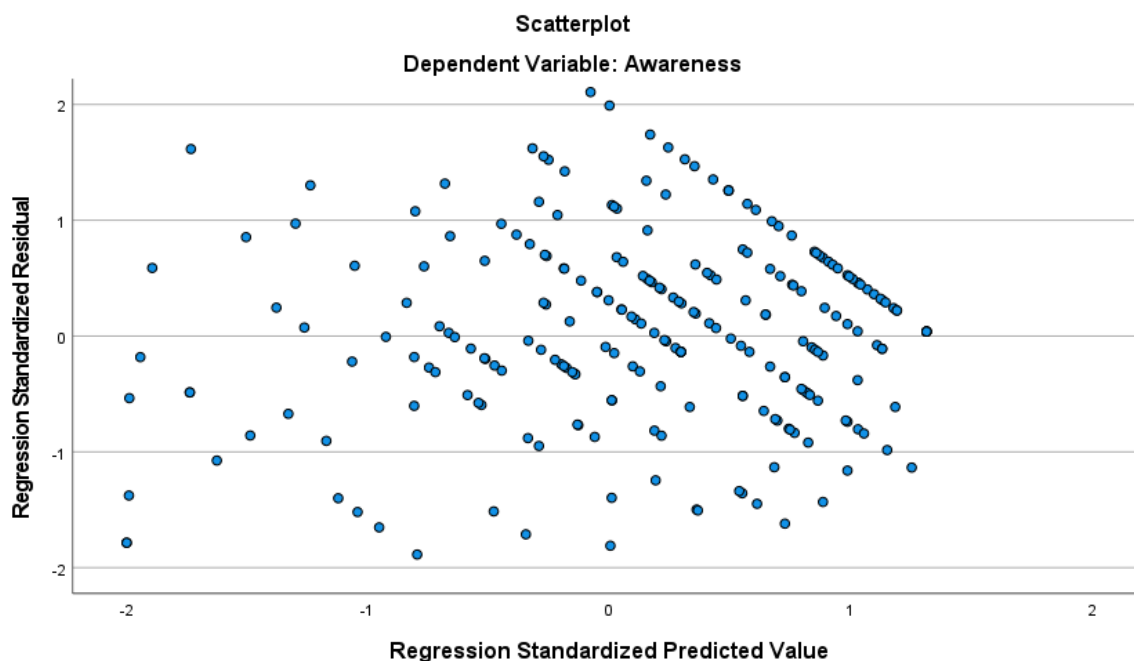
Fig. 4. Scatter Plot of Regression Standardized Residual

The variation in community Awareness towards SWM and EC indicate 69.2% is explained by Integrity, Attitude, Knowledge and Perception among the respondents as presented in Table 5.

Table 5
Model Summary

Model	R	R Square	Adjusted R Square	Std Error of Estimate
1	0.832	0.692	0.687	2.37101

The F-statistic obtained was 139.766 with a p-value was 0.001 less than 0.05. This indicates that the estimated multiple linear regression model developed in this study is valid and statistically significant as shown in Table 6.

Table 6
Model of Fitness ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig
Regression	3142.902	4	785.726	139.766	0.001
Residual	1399.806	249	5.622		
Total	4542.709	253			

The collinearity statistics output highlighted the value for Tolerance and VIF, with Tolerance value greater than 0.1 and the VIF values less than 10. It indicates that both values lie within the acceptable range as tabulated in Table 7. This confirms that there is no issue of collinearity among the variables. In the regression model, all independent variables such as Integrity, Attitude, Knowledge, and Perception involved in this study significantly contributed to community Awareness on SWM and EC.

Table 7
Coefficients Output

	Unstandardized Coefficients		Collinearity Statistics	
	B	Sig	Tolerance	VIF
Constant	2.813	0.002		
Attitude	0.216	0.001	0.511	1.958
Perception	0.166	0.002	0.421	2.376
Integrity	0.241	0.001	0.669	1.495
Knowledge	0.333	0.001	0.401	2.493

The multiple regression model was written as in Eq. (3).

$$Y_i = 2.813 + 0.216 Attitude + 0.166 Perception + 0.241 Integrity + 0.333 Knowledge \qquad (3)$$

Where, *i* is community Awareness on SWM and EC.

Attitude, Perception, Integrity, and Knowledge are positively contributed to community Awareness on SWM and EC with the estimated coefficients are 0.216, 0.166, 0.241, and 0.333 respectively. This summarizes for every additional in level of Attitude, Perception, Integrity, and Knowledge, the community level of Awareness will increase 0.216, 0.166, 0.241, and 0.333 respectively, if the other independent variables are held constant.

4. Conclusions

Solid waste management and environmental care are global issues that demand global attention. The complexity and impact of this problem on both the environment and human have spurred researchers to investigate it. It is essential to have a sustainable ecosystem available for current and future generations, making research in this area crucial for maintaining natural balance. This study aimed to examine the community Awareness of SWM and EC among Diploma students at UiTM Perak Branch, Tapah Campus, based on their Attitude, Perception, Integrity, and Knowledge. Out of the 254 respondents, 70.87% were female, and 29.13% were male, the majority of respondents being from KPPIM (42.13%), aged between 20 to 21 years old (54.72%), staying in college residences (62.60%), and from Part 4 (54.33%). The study concluded that all variables, including Integrity, Attitude, Knowledge, and Perception had a moderate association, with a coefficient of correlation value that ranging from 0.4 to 0.7. According to the regression analysis results, every variable included in the study significantly contributed to community Awareness of environmental care and solid waste management, indirectly helping to raise awareness. In the future, a multiple linear regression model will be developed to estimate community Awareness of SWM and EC. As a recommended course of action, the authors intend to include a practice factor and expand this study to gain further insights.

References

[1] Xia, Wanjun, Yanping Jiang, Xiaohong Chen, and Rui Zhao. "Application of machine learning algorithms in municipal solid waste management: A mini review." *Waste Management & Research* 40, no. 6 (2022): 609-624. https://doi.org/10.1177/0734242X211033716

[2] Popli, Kanchan, Chunkyoo Park, Sang-Min Han, and Seungdo Kim. "Prediction of solid waste generation rates in urban region of Laos using socio-demographic and economic parameters with a multi linear regression approach." *Sustainability* 13, no. 6 (2021): 3038. https://doi.org/10.3390/su13063038

[3] Owojori, Oluwatobi Mary, Ratshalingwa Mulaudzi, and Joshua N. Edokpayi. "Student's knowledge, attitude, and perception (KAP) to solid waste management: A survey towards a more circular economy from a rural-based tertiary institution in South Africa." *Sustainability* 14, no. 3 (2022): 1310. https://doi.org/10.3390/su14031310

[4] Abidin, Rahimi, Fadhilah Mohd Zahari, Nor Hasni Osman, Azhar Ahmad, Aviasti Anwar, Eri Achiraewati, and A. Harith Nu'man. "Issues and Challenges in Cultivating Environmentally Preferred Purchasing Among Young Generation." *Journal of Advanced Research in Applied Sciences and Engineering Technology* 28, no. 3 (2022): 57-67. https://doi.org/10.37934/araset.28.3.5767

[5] Brotosusilo, A., S. H. Nabila, H. A. Negoro, and D. Utari. "The level of individual participation of community in implementing effective solid waste management policies." *Global Journal of Environmental Science and Management* 6, no. 3 (2020): 341-354.

[6] Zulkipli, Faridah, Zulkifli Mohd Nopiah, Nurul Husna Jamian, Noor Ezlin Ahmad Basr, and Cheng Jack Kie. "Sustainable Public Awareness on Solid Waste Management and Environmental Care using Logistics Regression". *Jurnal Kejuruteraan* SI 5, no.2 (2022): 139-148.

[7] United Nations Environment Programme and International Solid Waste Association, "Global Waste Management Outlook," 2015. https://www.unenvironment.org/resources/report/global-waste-management-outlook.

[8] Malaysian Investment Development Authority (MIDA), "Waste to Energy for a Sustainable Future," 2021. https://www.mida.gov.my/waste-to-energy-for-a-sustainablefuture

[9] Japan International Cooperation Agency (JICA), "The Study on National Waste Minimisation in Malaysia," 2016. http://goo.gl/jbCJsn

[10] Gardner, Gerald T., and Paul C. Stern. *Environmental problems and human behavior*. Boston: Allyn and Bacon, 1996.

[11] Koger, Susan M. *The psychology of environmental problems: Psychology for sustainability*. Psychology press, 2011. https://doi.org/10.4324/9780203847978

[12] Michelsen, Gerd, and Daniel Fischer. "Sustainability and education 1." *Sustainable Development Policy: A European Perspective; Taylor and Francis: London, UK* (2017): 135-158. https://doi.org/10.4324/9781315269177-7

[13] Eulefeld, Günter. "The UNESCO-UNEP programme in environmental education." *European Journal of Science Education* 1, no. 1 (1979): 113-118. https://doi.org/10.1080/0140528790010114

[14] Bursztyn, Marcel, and José Drummond. "Sustainability science and the university: pitfalls and bridges to interdisciplinarity." *Environmental Education Research* 20, no. 3 (2014): 313-332. https://doi.org/10.1080/13504622.2013.780587

[15] Zulkipli, Faridah, Zulkifli Mohd Nopiah, Nurul Husna Jamian, Noor Ezlin, Ahmad Basri, and Cheng Jack Kie. "Mean Score Analysis on Awareness of Solid Waste Management in Malaysia." (2022). https://doi.org/10.6007/IJARBSS/v12-i6/14020

[16] Zulkipli, Faridah, Zulkifli Mohd Nopiah, Nurul Husna Jamian, Noor Ezlin Ahmad Basri, and Cheng Jack Kie. "Sustainable Public Awareness on Solid Waste Management and Environmental Care using Logistics Regression". *Jurnal Kejuruteraan* SI 5, no. 2 (2022): 139-148

[17] Zulkipli, Faridah, Nurul Husna Jamian, and Ilya Zulaikha Zulkifli. "Logistic regression analysis for awareness among students towards environmental care in UiTM, Tapah Campus." *Multidisciplinary Informatics Journal (MIJ)* 2, no. 1 (2019): 74-81.

[18] Zulkifli, Ilya Zulaikha, Nurul Hunsa Jamian, & Faridah Zulkipli, (2019). "Factors Influencing Environmental Sanitation among Undergraduates at UiTM, Tapah Campus". *International Journal of Recent Technology and Engineering* 8, no. 2S11 (2019): 598-601. https://doi.org/10.35940/ijrte.B1092.0982S1119

[19] Jamian, Nurul Husna, Faridah Zulkipli, Ilya Zulaikha Zulkifli, and Zulkifli Mohd Nopiah. "Survey on environmental care among UiTM Campus Tapah student on solid waste management using mean score and t-test analysis." *International Journal of Engineering and Technology (UAE)* 7, no. 4 (2018): 114-118. https://doi.org/10.14419/ijet.v7i4.33.23512

[20] Wang, R. "An Exploration of Private Morality in Socialist Core Values". Shangqiu Normal University. 34, 62–65 (in Chinese), 2018.

[21] Liu, Chengqing, Qianqian Jing, Jianhui Cong, and Weiqiang Zhang. "How do integrity level and economic punishment affect residents' willingness and behavior to separate household waste? New evidence from 1293 questionnaires in Jinan." *Journal of Cleaner Production* 365 (2022): 132713. https://doi.org/10.1016/j.jclepro.2022.132713

[22] Stevens, James P. *Applied multivariate statistics for the social sciences*. Routledge, 2012. https://doi.org/10.4324/9780203843130

[23] Tabachnick, Barbara G., Linda S. Fidell, and Jodie B. Ullman. *Using multivariate statistics*. Vol. 6. Boston, MA: pearson, 2013.

[24] Ul-Saufie, A. Z., A. S. Yahya, and N. A. Ramli. "Improving multiple linear regression model using principal component analysis for predicting PM10 concentration in Seberang Prai, Pulau Pinang." *International Journal of Environmental Sciences* 2, no. 2 (2011): 403-410.

[25] Chua, Yan Piaw. *Ujian regresi, analisis faktor dan analisis SEM*. McGraw-Hill Education (Malaysia), 2014.