Available Online at www.e-iph.co.uk
Indexed in Clarivate Analytics WoS, and ScienceOPEN

E-B Environment - Behaviour Proceedings Journal

ICIS2025PortDickson
https://www.icis.com.my/

e-IPH e-International Publishing House Ltd., United Kingdom

The 6th International Conference of Information Science
Avillion Port Dickson, Negeri Sembilan, Malaysia, 27-28 Jan 2025
Organiser: School of Information Science, College of Computing, Informatics and Mathematics, Universiti Teknologi MARA, Shah Alam, Malaysia

Waste Management Efficiency: Pilot study assessment

Mohamad Rahimi Mohamad Rosman*, Izzatil Husna Arshad, Faizal Haini Fadzil, Nurulannisa Abdullah, Mohamad Sayuti Md. Saleh, Mohd Zafian Mohd Zawawi
**Corresponding Author*

Information Science Studies,
Universiti Teknologi MARA Kelantan Branch, Malaysia

rahimimr@uitm.edu.my, husna672@uitm.edu.my, faizal958@uitm.edu.my, annisa@uitm.edu.my, sayuti16@uitm.edu.my, zaffian@uitm.edu.my
Tel: 60199891306

Abstract
Waste management is a crucial activity in individual or organisational contexts. In Malaysia, waste management is the responsibility of the local government councils. However, literature searches and practical observations show that there is a dearth of research on the issue of waste management efficiency, especially in the context of Kelantan. Therefore, this study aims to identify the relevant constructs, confirm the instrument's reliability, and assess the pilot assessment. A quantitative methodology was adopted; several activities were performed to validate the instrument's reliability. As a result, a 25-item instrument was developed consisting of several constructs.

Keywords: waste management, efficiency, pilot study, Kelantan, instrument development, and instrument validation.

DOI: https://doi.org/10.21834/e-bpj.v10iSI27.6834

1.0 Introduction

Waste management is defined as the act of composing, processing, managing, and disposing of waste (either household or industrial) throughout its lifecycle (Rosman et al., 2024). Over the years, waste management has been challenging for humans, the environment, and society. Many researchers have tried to investigate waste management issues from different countries, such as the work of Alzamora and Barros (2020). One of the issues involved in waste management is the cost involved in processing and disposing of different kinds of waste (Alzamora & Barros, 2020; Martinez-Sanchez, Kromann, & Astrup, 2015). However, due to the necessity of proper waste management, waste management is the responsibility of local government councils.

In the state of Kelantan, Malaysia, the responsibility of managing waste has been given to the local government councils that have been appointed, namely Majlis Perbandaran Kota Bharu Bandar Raya Islam, Majlis Daerah Tanah Merah, Majlis Daerah Tumpat, Majlis Daerah Ketereh, Majlis Daerah Kuala Krai, Majlis Daerah Bachok Bandar Pelancongan Islam, Majlis Daerah Gua Musang, Majlis Daerah Pasir Puteh, Majlis Daerah Jeli, Majlis Daerah Pasir Mas, Majlis Daerah Machang, and Majlis Daerah Dabong. Each local government council usually has its own rules and policies for managing different kinds of waste – however, several issues exist. First, there is a dearth of research on waste management efficiency among local councils, especially in Kelantan, Malaysia. Second, there is limited

DOI: https://doi.org/10.21834/e-bpj.v10iSI27.6834

knowledge of the level of user satisfaction towards waste management services in the context of local government councils in Kelantan. A lack of knowledge on this issue undermines the importance of waste management efficiency as an interesting research paradigm.

Thus, based on the framework and previous literature, this study developed an instrument for validating the research items. Several activities were performed to confirm the research instrument before data collection. The following subsection is arranged; first, we provide a brief literature review on waste and information system management. Then, the findings of the studies were discussed, along with future recommendations.

2.0 Literature Review

2.1 Waste Management in Malaysia

Researchers have consistently recommended developing information systems or data repositories for efficient waste management. These systems streamline waste management processes and serve as platforms for distributing information and coordinating the appropriate handling of materials and operations across various sectors, thereby minimising waste.

Mohd Dinie and Mashitah Mat Don (2013) emphasised prioritising and utilising sustainable municipal solid waste (MSW) management systems to ensure accessibility to critical information about the characteristics of waste generated. Likewise, M.F. Omar et al. (2016) proposed the implementation of Smart Waste Management (SWM) in Malaysia as a means to enhance city management and provide improved public services through innovative city applications that employ the Internet of Things (IoT) integrated with innovative wireless sensor technology.

Mahdi Mohammed Abdullah Abkar et al. (2024) highlighted several systems contributing to waste reduction in Malaysia's construction industry. For instance, the Industrialised Building System (IBS) has been recognised as a highly effective approach to improving construction performance by minimising waste, boosting productivity, and mitigating environmental damage through off-site prefabrication and modularisation. Building Information Modeling (BIM) also supports design processes with 3D modeling software, open-access information sharing, and multidisciplinary integration, all within sustainable waste management.

Furthermore, Yiing Chiee Moh and Latifah Abd Manaf (2014) highlighted the importance of using broadcast media, newspapers, billboards, and internet platforms as effective channels to disseminate information related to solid waste management and recycling initiatives. Similarly, Krishnaswamy Jayaraman et al. (2019) emphasised the role of social media networks in promoting green Malaysia initiatives and sharing best practices for e-waste disposal.

Fig. 1: Guidelines to send e-waste to the collection centre.
(Source: Department of Environment Malaysia, https://ewaste.doe.gov.my/index.php/what-is-e-waste/)

The rapid advancement of technology has driven increased production and use of electronic devices in Malaysia, including laptops, calculators, personal computers, and mobile phones. While information technology (IT) contributes to efficient waste management by developing information systems, improper use of IT products can also worsen the growing e-waste problem. E-waste is a broken, non-working, or old/obsolete electronic appliance such as a television, personal computer, air conditioner, washing machine, or refrigerator (Department of Environment, Malaysia).

In Malaysia, projections suggest that e-waste generation is expected to reach approximately 24.5 million units by 2025 (Hashim et al., 2024). The Global Transboundary E-waste Flow Monitor Report 2022 forecasts that electronic waste (e-waste) production will

increase by an average of 2 million metric tons per year until 2030, reaching 74.7 million metric tonnes (Dayang Masleha Mohd Rahman and Haidy Henry Dusim, 2023).

E-waste requires careful disposal, as informal practices such as open burning release harmful chemicals into the environment. Haikal Ismail and Marlia M. Hanafiah (2021) proposed the development of a data inventory that includes information on (1) environmental constraints affecting e-waste management and (2) economic and social factors influencing the process. Krishnaswamy Jayaraman et al. (2019) emphasised the importance of green design in reducing e-waste generation at both upstream and downstream stages. Additionally, consumer choices favouring environmentally friendly appliances play a crucial role in this effort. Disseminating guidelines on using and disposing of electronic products is essential to support green initiatives and raise consumer awareness.

Furthermore, green initiatives align closely with recycling efforts, making the effective distribution of recycling information vital for educating consumers about basic recycling practices (Yiing Chiee Moh and Latifah Abd Manaf, 2014). Likewise, Malaysia's Department of Environment (DOE) has prepared an infographic poster to guide the public in e-waste handling (Figure 1). The success of the e-waste recycling program largely centres on the active participation of all stakeholders. However, this participation faces several challenges, such as ambiguous regulations for private entities set by government agencies, insufficient infrastructure for residents, and inconsistencies in NGO initiatives (Mohammad Tahir et al., 2024).

2.2 Waste Management Policy

Malaysia's local authorities and government bodies have established many initiatives, including regulations, orders, guidelines, and efforts, such as campaigns. The discussions are simplified as in Table 1, derived from Mohamad Rosman et al. (2024).

Table 1. Initiatives by Local Authority and Government in Malaysia for Efficient Waste Management

Policy	Sources
● ***1974: Environmental Quality Act 1974 (ACT 127)***	Haikal Ismail and Marlia M. Hanafiah (2019)
Department of Environment (DOE), Malaysia, was established to manage, coordinate, and formulate environmental laws and regulations for environmental protection. The jurisdiction was on the scheduled/hazardous waste generated by the industrial sector.	
● ***1977: Environmental Quality (Licensing) Regulation 1977***	Haikal Ismail and Marlia M. Hanafiah (2019)
● **1987: Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987**	Haikal Ismail and Marlia M. Hanafiah (2019)
● ***1988 - Action Plan for a Beautiful and Clean (ABC) Malaysia***	Mohd Dinie Muhaimin Samsudin and Mashitah Mat Don (2013)
● ***1989: Environmental Quality (Scheduled Wastes) Regulation 2005 – Enacted 1989, Revised 2005***	Haikal Ismail and Marlia M. Hanafiah (2019)
● ***1989: Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment and Facilities) Regulation 2006 - Enacted 1989, Revised 2006***	
● ***1989: Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment and Disposal Facilities) Order 1989***	
The August 2005 revision extended the DOE's responsibility to monitor scheduled/hazardous waste generated by industrial and nonindustrial sectors, such as households. Seventy-seven scheduled/hazardous waste categories were recognised, including e-waste (coded as SW110, SW103, SW109). Disposing of scheduled/unsafe waste from the industrial sector requires appropriate treatment and disposal at licensed facilities. Any scheduled/hazardous waste activities from its generation, collection, and transportation until its treatment and disposal were to fall under regulations that the DOE enforced.	
● ***2005: Environmental Quality Prescribed Conveyance) (Scheduled Wastes) Order 2005***	Haikal Ismail and Marlia M. Hanafiah (2019)
This order concerns the collection and transportation activities of scheduled/ hazardous waste. DOE issued the Guidelines for Classification of Used Electrical and Electronic Equipment as a guideline to all stakeholders involved in the international trade of used electrical and electrical equipment.	
● ***2006: Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment and Disposal Facilities) Order 2006***	Haikal Ismail and Marlia M. Hanafiah (2019)
● ***2007: Malaysia Solid Waste and Public Cleansing Management Act 2007 (Act 672)***	Moh and Latifah Abd Manaf (2014)
Disposal of any solid waste could be done by destruction, incineration, deposit, or decomposition.	
● ***2008: Guidelines for Classification of Used Electrical and Electronic Equipment 2010 (First Edition 2006, Second Edition 2010)***	Haikal Ismail and Marlia M. Hanafiah (2019)
● ***2012: Customs (Prohibition of Exports) Order 2012***	Haikal Ismail and Marlia M. Hanafiah (2019)
● ***2014: The SWCorp Strategic Plan 2014–2020***	Zhechen, et. al (2024)

This plan aims to create a clean culture and reduce solid waste generation, yet the public also enhances their understanding of solid waste classification.

- ***2015: Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 2015*** — Haikal Ismail and Marlia M. Hanafiah (2019)

E-Waste Management Initiatives — Haikal Ismail and Marlia M. Hanafiah (2021): Haikal Ismail and Marlia M. Hanafiah (2019): DOE (2017): Fatihah Suja, et. al. (2014). Krishnaswamy Jayaraman et al. (2019): Yiing Chiee Moh and Latifah Abd Manaf (2014): Kang et al. (2020).

The government of Malaysia, through DOE, aims to safeguard the safe, effective, and economically beneficial management of e-waste in Malaysia by;
1) Enforcing Laws and Regulations,
2) Revision of Environmental Regulation,
3) Promotion of E-Waste Recovery Activities,
4) International Collaboration, such as with the Japan International Collaboration Agency (JICA)

Continuous collaboration between DOE and JICA (since 2011). Several projects were introduced;

- The Project for Model Development for E-Waste Collection, Segregation and Transportation from Household for Recycling" (2011)
- The Project for Development of Mechanism for Household E-waste Management (2015).

Furthermore, there is a proposal for a new regulation called the 'Household Scheduled Waste Regulation 201X'.

Moreover, e-waste of no commercial value must be disposed of at sites/premises licensed by DOE. DOE provides guidelines for industrial e-waste. DOE also manages the scheduling of hazardous and clinical waste under the Ministry of Health (MOH).

'Reduce, Reuse, Recycle' (3R) Initiatives — Mohd Dinie Muhaimin Samsudin and Mashitah Mat Don (2013): Yiing Chiee Moh and Latifah Abd Manaf (2014): Mahdi Mohammed Abdullah Abkar, et. al. (2024).

- 2001: Recycle Campaign held in Penang State - The campaign's motto: "Kembalikan Sinar kepada Pulau Mutiara" (Restore the Shine to the Pearl of the Orient).
- 2009: 15 recycling centers in Kuala Lumpur, 22 in Selangor, and 56 Pahang.

Plastics, paper, and glass are among the three types of waste that have the most significant potential for recycling. Malaysia's key institutional mechanism for waste recycling.

- National strategic plan for solid waste management (such as recycling non-organic waste in the ***10th Malaysian plan***)
- National recycling program
- The incentive for waste recycling activities

Municipal Solid Waste (MSW) Management Initiatives — Mohd Dinie Muhaimin Samsudin and Mashitah Mat Don (2013): Yiing Chiee Moh and Latifah Abd Manaf (2014)

- The cabinet committee (Government of Malaysia) recommended incineration as an alternative to landfilling for MSW treatment. Incineration has been recognised as an effective effort to decrease MSW volume and offer usable energy. MSW is managed by the Ministry of Housing and Local Government (MHLG).
- Malaysia's National Solid Waste Management Department (NSWMD) formulates and proposes policies, plans, and strategies concerning solid waste management and public cleansing, sets standards, specifications, and codes of practice exercising regulatory function, and grants licenses and approval under Act 672.
- Solid Waste Management and Public Cleansing Corporation (PPSPPA) runs the formulated policies, plans, and strategies proposed by NSWMD, monitors compliance with standards, specifications, and code of practices set by NSWMD, and enforces the solid waste management and public cleansing laws.

Water and Air Quality Monitoring Initiatives — Mohd Dinie Muhaimin Samsudin and Mashitah Mat Don (2013)

The Department of Environment (DOE) regularly monitors water and air quality from monitoring stations (river) and sampling stations in coastal and estuarine areas to assess marine quality.

Transboundary Movement of Hazardous Wastes Control — DOE (2013)a: DOE (2013)b

- Malaysia approved the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal 1989 in October 1993.
- Malaysia recognized the Ban Amendment in 2001 to prevent the transboundary movement of hazardous waste through 'legal loopholes,' such as reuse, which does not require any notification and approval from the Basel Convention before any shipment.

Construction and Building Management Initiatives — Shi and Xu (2021): S. Saad, et. al. (2022): A.M. Al-Awag, et. al. (2023).

Industrialized Building Systems (IBS) aims to replace conventional construction methods. IBS is recognized as a practical approach to improve construction performance, achieve safety and health standards, and reduce waste. Construction Industry Development Board Malaysia (CIDB) describes IBS as producing construction components within a controlled environment.

Renewable Energy (RE) / Energy Initiatives — Mohammed Hammam Mohammed Al-Madani, et. al. (2024): Jaya Prasanth Rajakal, et. al. (2024): The Star (2023): Tee, Gan and Junainah Sardi (2024).

- Since 2001, the Government of Malaysia has provided **feed-in tariffs,** investment tax allowances, or pioneer status to support Malaysia's energy efficiency and RE growth. The government also encouraged manufacturing firms to contribute to developing the renewable energy supply chain

(RESC), transforming raw energy into usable clean energy. Malaysian manufacturing sectors handle rice husks, organic waste, and agricultural residues that can be converted into biofuels and distributed within manufacturing facilities. In 2011, the **feed-in-tariffs** scheme supported the implementation of CHP systems in the palm oil industry.

- **The 12th Malaysia Plan** by the Economic Planning Unit of the Ministry of Economy targets achieving carbon neutrality by 2050.
- Malaysian Sustainable Palm Oil (MSPO) certification scheme.
- Bursa Malaysia's environmental, social, and governance framework regulates public-listed companies to meet emissions reduction obligations.
- National Biomass Action Plan (NBAP) 2023–2030 - empower and promote the biomass and renewable energy industry.
- Malaysia's Energy Transition Plan 2021–2040.
- National Energy Efficiency Action Plan of Malaysia.
- Malaysia Renewable Energy Roadmap (MyRER)

Tenaga Nasional Berhad (TNB) initiatives;

- 2014: Smart Metering System and Advanced Metering Infrastructure (AMI)
- 2018: Grid technologies to enhance the efficiency of the National Grid
- Environmental, Social and Governance & Economic (ESG) Agenda - Four sustainable development goals under the UN SDGs, which include UN SDG 7 (Affordable and Clean Energy), UN SDG 8 (Decent Work and Economic Growth), UN SDG 13 (Climate Action), and UN SDG 17 (Partnerships for Goals).
- System Average Interruption Duration Index (SAIDI) 50 initiative to keep the SAIDI under 50 min/consumer/year.
- Promotes sustainable business performance and creates employment opportunities, revenue growth, and *zakat* (alms) contributions.

3.0 Research Model and Methodology

3.1 Research Model

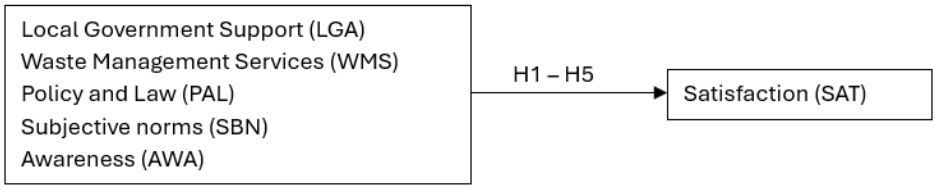

Fig. 2: Research Model

Figure 2 shows the foundation of the study's research model. The research model is developed based on the underpinning Theory of the Technology Acceptance Model (Davis, 1989), the Information System Success Model (DeLone & McLean, 2003), Theory of Planned Behavior (Ajzen, 1991), Theory of Reasoned Action (Ajzen & Fishbein, 1975), and Social Cognitive Theory (Bandura, 2001). A total of 6 first-order variables were chosen for the research model, namely Local Government Support (LGA), Waste Management Services (WMS), Policy and Law (PAL), Subjective norms (SBN), Awareness (AWA), and Satisfaction (SAT). Subsequently, five hypotheses were also formulated as follows:

H1: Local Government Support (LGA) has a significant and positive relationship to user satisfaction.
H2: Waste Management Services (WMS) has a significant and positive relationship to user satisfaction.
H3: Policy and Law (PAL) have a significant and positive relationship to user satisfaction.
H4: Subjective norm (SBN) has a significant and positive relationship to user satisfaction.
H5: Awareness (AWA) has a significant and positive relationship to user satisfaction.

3.2 Methodology

This study will adopt a quantitative research methodology to answer the research question. We follow a series of activities to prepare for the pilot study assessment. First, following the work of previous researchers, we performed a thorough literature review on the issues of waste management efficiency and website quality characteristics (Webster & Watson, 2002; Mohamad Rosman, Ismail, & Masrek, 2023). Second, we developed the theoretical framework, or the research model, based on relevant theories and models, as illustrated in Figure 1. Third, the instruments were developed, and several expert tests and corrections were performed before the pilot instrument

was distributed to potential pilot assessment respondents. The sample size is based on non-probability sampling using convenience sampling, due to the researcher's easy access to the sampling frame.

4.0 Findings

4.1 Expert Review

A pre-test form was developed and sent to the selected experts for instrument testing and validation. A total of five (5) experts were chosen for the study. Based on Table 2, 2 experts have an academic position as 'Associate Professors' while the other three were designated as 'Senior Lecturers.' All experts have a doctoral qualification and have more than 10 years of academic experience. Moreover, all experts have background knowledge of the research topic and have published papers and seminars/webinars on the relevant research topic. A short briefing session was held using Google Meet with all experts, and subsequently, each expert was given 3 weeks to complete the assessment. Polit and Beck's (2006) content validity index (CV-I) was used as the assessment tool.

Table 2. Expert Review

#	Academic Position	Qualification	Experience
1	Associate Professor	PhD	> 10 years
2	Associate Professor	PhD	> 10 years
3	Senior Lecturer	PhD	> 10 years
4	Senior Lecturer	PhD	> 10 years
5	Senior Lecturer	PhD	> 10 years

4.2 Content clarity and content relevance (CV-i)

Table 3 shows the summarized result of Content Clarity and Content Relevance (CV-i) rated by the selected experts. The CV-I of Polit and Beck (2006) is an instrument used to determine the degree to which the instrument has the appropriate number of items, and it is considered an essential procedure in instrument development. Based on the higher number of results, it can be confirmed that there is a strong and positive acceptance of the items and the instrument among all the selected experts. Subsequently, some minor modifications were made to the items as suggested and requested by the experts.

Table 3. Content Clarity and Content Relevance

		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5
Content Clarity	Proportion	0.9	0.96	0.9	0.94	0.97
Content Relevance	Relevant	0.9	0.94	0.9	0.9	0.9

4.3 Face Validity

The next step is to perform a face validity test with the potential respondents. A total of 10 potential respondents were randomly selected among the different Kelantan districts and will be excluded from the actual data collection process. The respondents were asked about their understanding of the items concerning sufficiency and comprehension. Upon completing the face validity process, no further comment was received. Subsequently, the face validity was also conducted with five senior officers from local councils to ensure that the items measured the real issues in Kelantan's districts. The items were modified to accommodate comments and suggestions from the local council's officers.

4.4 Pilot Study

After completing the face validity process, a pilot instrument was developed to test its reliability. A Google Form was used as the basis for the data collection process. One hundred respondents were selected for the pilot study assessment, and their records will not be included in the final model assessment. Each respondent was given a week to complete their evaluation, and 70 valid responses were received, indicating an acceptable response rate of 70%. Then, a reliability assessment was conducted, as shown in Table 4. The result suggests that the values of Cronbach's Alpha are between 0.890 and 0.960, surpassing the minimum value of 0.7 as suggested by Nunnally (1978) and Kaplan and Saccuzzo (2001).

Table 4. Reliability

Construct	Number of items	Cronbach's Alpha
Local Government Support (LGA)	3	0.919
Waste Management Services (WMS)	4	0.949
Policy and Law (PAL)	6	0.952
Subjective Norms (SBN)	4	0.890
Awareness (AWA)	3	0.949
Satisfaction (SAT)	5	0.960

5.0 Discussion

Table 5 shows the final instrument of the study. A total of 25 items were adopted and improved from the previous literature.

Table 5. List Item of Final Instrument

Construct	Item	
Local Government Support (LGA)	LGA1	My local authority has a good waste management campaign.
	LGA2	My local authority has an efficient waste management campaign.
	LGA3	A waste management campaign by my local authority encouraged me to manage my waste disposal properly.
Waste Management Services (WMS)	WMS1	My local authority provided adequate waste management services.
	WMS2	The waste management services provided by my local authority are affordable.
	WMS3	The waste management services provided by my local authority are available whenever I want.
	WMS4	I am satisfied with the garbage disposal schedule provided by my local authority.
Policy and Law (PAL)	PAL1	I am well informed of the waste management policy enforced by my local authority.
	PAL2	I am well informed of the law related to waste management enforced by my local authority.
	PAL3	My local authority has a clear policy on waste management.
	PAL4	My local authority has a clear law on waste management.
	PAL5	I always follow the waste management policy enforced by my local authority.
	PAL6	I always follow the law on waste management enforced by my local authorities.
Subjective norms (SBN)	SBN1	My family thinks that the waste management campaign provided by my local authority is effective.
	SBN2	My friends think that the waste management services provided by my local authority are sufficient.
	SBN3	I like to follow the waste management policy enforced by my local authority because my parents think I should.
	SBN4	I like to follow the waste management law enforced by my local authority because my friends think I should.
Awareness (AWA)	AWA1	A good waste management process contributes to a better environment.
	AWA2	A good waste management process contributes to a better society.
	AWA3	A good waste management process contributes to a better quality of life.
Satisfaction (SAT)	SAT1	I am satisfied with the waste management process currently enforced by the local authority.
	SAT2	I am satisfied with the local government approach currently enforced by the local authority.
	SAT3	I am satisfied with my perspective on the waste management process enforced by the local authority.
	SAT4	I think the local authority has done a good job in managing household waste.
	SAT5	I think the local authority has done a good job in managing industrial waste.

The resultant instrument was produced considering a few relevant theoretical models and frameworks; however, it is worth mentioning that there is a need to confirm the instrument further via the actual data collection process. Henceforth, we suggest that full-scale data collection on the relevant respondents is mandatory to enhance the instrument's reliability further.

6.0 Conclusion

The next step of this study is complete data collection. Data collection was expected to be completed within 4 weeks using Google Forms and distributed via social media and email. The research also capitalizes on the assistance of local government councils in distributing the instrument to the relevant parties. The study's results may benefit several stakeholders, such as researchers and government policymakers. Researchers may use the study's results to understand the underlying waste management efficiency problem within their local scope further. At the same time, government policymakers may utilize the factors identified within the study to improve service delivery further and subsequently improve the level of satisfaction among the local folks. This study, however, is not without limitations. First, the study utilizes a minimal number of constructs. We suggest that future studies include more diverse constructs to understand the research topic better. Second, this study only focuses on the generalization of Theory. Future studies should consider population generalization to get the ideal results for the mass population. Third, this study conceptualizes a single-order research model. Future studies should focus on more complex interactions of construct by adopting a second-order approach.

Acknowledgments

The authors would like to thank the financial support from Universiti Teknologi MARA Cawangan Kelantan, Malaysia, under Internal Grant 600-TNCPI 5/3/DDN (03) (005/2022).

Paper Contribution to Related Field of Study

The paper highlights the scarce literature on waste management efficiency, especially among local government councils. This paper developed and validated a 25-item instrument to assess waste management efficiency in the context of local government councils in Kelantan, Malaysia. The findings are important to both researchers and communities; researchers may use the research model to understand the context of the problem further, while communities might use the findings to improve the level of waste management services.

References

A.M. Al-Awag, W.S. Alaloul, M.S. Liew, A.O. Baarimah, M.A. Musarat (2023). The potential role of Industrialized Building Systems (IBS) in Malaysian sustainable construction: Awareness and barriers, AIP Conf. Proc. https://doi.org/10.1063/5.0128035.

Ajzen, I. (1991). The Theory of planned behavior. Organizational Behavior and Human Decision Processes, 50, 179-211.

Ajzen, I., & Fishbein, M. (1975). A Bayesian analysis of attribution processes. Psychological Bulletin, 82 (2), 261.

Alzamora, B. R., & Barros, R. T. D. V. (2020). Review of municipal waste management charging methods in different countries. Waste Management, 115, 47-55.

Bandura, A. (2001). Social cognitive Theory: An agentic perspective. Annual review of psychology, 52(1), 1-26.

Davis, F. D. (1989). Technology acceptance model: TAM. Al-Suqri, MN, Al-Aufi, AS: Information Seeking Behavior and Technology Adoption, 205, 219.

Dayang Masleha Mohd Rahman and Haidy Henry Dusim (2023). Menuju Pengurusan Kelestarian E-Sisa: Ulasan (Towards Sustainable E-Waste Management: A Review). Jurnal Kinabalu, 30. Retrieved from https://jurcon.ums.edu.my/ojums/index.php/ejk/article/view/5506.

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: a ten-year update. Journal of Management Information Systems, 19(4), 9-30.

Department of Environment (DOE) (2013)a. Overview of scheduled waste management in Malaysia and the way forward. Department of Environment, Malaysia.

Department of Environment (DOE), (2013)b. Environmental Quality Report - 2013. Department of Environment, Malaysia.

Department of Environment (DOE). (2017). New mechanism of household e-waste management in Malaysia. Department of Environment, Malaysia.

Department of Environment (DOE). What is e-waste? Department of Environment, Malaysia. Retrieved from: https://ewaste.doe.gov.my/index.php/what-is-e-waste/)

Fatihah Suja, Rakmi Abdul Rahman, Arij Yusof, and Mohd Shahbudin Masdar. (2014). e-Waste management scenarios in Malaysia. Journal of Waste Management. https://doi.org/10.1155/2014/609169.

Haikal Ismail, and Marlia M. Hanafiah. (2019). Discovering opportunities to meet the challenges of an effective waste electrical and electronic equipment recycling system in Malaysia. Journal of Cleaner Production, 238, 117927.

Haikal Ismail, and Marlia M. Hanafiah. (2021). Evaluation of e-waste management systems in Malaysia using life cycle assessment and material flow analysis. Journal of Cleaner Production, 308, 127358. https://doi.org/10.1016/j.jclepro.2021.127358.

Hashim, R., Salleh, N. A., Ibrahim, . J. A., Mohd Zahari, F., & Cooper, S. (2024). E-Waste Management Practices Through the Eyes of Responsible Departments at Malaysian Public Universities. Journal of Advanced Research in Applied Sciences and Engineering Technology, 52(1), 309–319. https://doi.org/10.37934/araset.52.1.309319

Jaya Prasanth Rajakal, Foo, Y. N, Anna Zulkifli, Bing, S. H., Jaka Sunarso, Ng, Denny K.S., and Viknesh Andiappan. (2024). Analysis of current state, gaps, and opportunities for technologies in the Malaysian oil palm estates and palm oil mills towards net-zero emissions. Heliyon, 10, e30768. https://doi.org/10.1016/j.heliyon.2024.e30768.

Kang, Kai Dean, Kang, Harnyi, Ilankoon, I.M.S.K., and Chong, Chun Yong. (2020). Electronic waste collection systems using Internet of Things (IoT): Household electronic waste management in Malaysia. Journal of Cleaner Production, 252, 119801. https://doi.org/10.1016/j.jclepro.2019.119801.

Kaplan, R. M., & Saccuzzo, D. P. (2001). Psychological testing: Principles, applications, and issues. Wadsworth/Thomson Learning.

Krishnaswamy Jayaraman, Seela Vejayon, Shruthi Raman, and Imtiaz Mostafiz. (2019). The proposed e-waste management model from the conviction of individual laptop disposal practices: An empirical study in Malaysia. Journal of Cleaner Production, 208, 688-696. https://doi.org/10.1016/j.jclepro.2018.10.125

M F Omar, et. al. (2016). Implementation of spatial smart waste management system in Malaysia. IOP Conf. Series: Earth and Environmental Science, 37, 012059. doi:10.1088/1755-1315/37/1/012059

Mahdi Mohammed Abdullah Abkar, Riduan Yunus, Yaser Gamil, and Mohammed Abdo Albaom. (2024). Enhancing construction site performance through technology and management practices as material waste mitigation in the Malaysian construction industry. Heliyon, 10, e28721. https://doi.org/10.1016/j.heliyon.2024.e28721

Martinez-Sanchez, V., Kromann, M. A., & Astrup, T. F. (2015). Life cycle costing of waste management systems: Overview, calculation principles and case studies. Waste management, 36, 343-355.

Mohamad Rosman, M. R., Fadzil, F. H., Abdullah, N., Arshad, I. H., Md. Saleh, M. S., and Mohd Zawawi, M. Z. (2024). Waste management satisfaction among local folks in Kelantan districts. Journal of Islamic, Social, Economics and Development (JISED), 9 (66), 668 – 681.

Mohamad Rosman, M. R., Ismail, M. N., & Masrek, M. N. (2023). Determinants and Impacts of Digital Library Engagement: Evidence from Research-Based Universities in Malaysia. International Journal of Information Science and Management (IJISM), 21(3), 49-65.

Mohammad Tahir, M., Fionna, G., Abdul Hair, B. A., Diana, P., and Sitty Syafa, B. (2024). Management of e-waste in Kota Kinabalu, Sabah: A Study on stakeholder engagement using an ecological approach. Geografi, 12(2), 66–78. Retrieved from: https://doi.org/10.37134/geografi.vol12.2.5.2024.

Mohammed Hammam Mohammed Al-Madani, Yudi Fernando, Mohammad Iranmanesh, Ming K. L., and Ming, L. T. (2024). Renewable energy supply chain in Malaysia: Fostering energy management practices and ecological performance. Renewable Energy, 120441. https://doi.org/10.1016/j.renene.2024.120441.

Mohd Dinie Muhaimin Samsudin, and Mashitah Mat Don. (2013). Municipal solid waste management in Malaysia: Current practices, challenges and prospects. Jurnal Teknologi (Sciences & Engineering), 62 (1), 95–101. DOI: 10.11113/jt.v62.1293.

Nunnally, J. C. (1978). An overview of psychological measurement. Clinical diagnosis of mental disorders: A handbook, 97-146.

Polit, D. F., & Beck, C. T. (2006). The content validity index: are you sure you know what's being reported? Critique and recommendations. Research in nursing & health, 29(5), 489-497.

S. Saad, W.S. Alaloul, S. Ammad, M. Altaf, A.H. Qureshi. (2022). Identification of critical success factors for the adoption of Industrialized Building System (IBS) in the Malaysian construction industry, Ain Shams Eng. J., 13 (2), 101547. https://doi.org/10.1016/j.asej.2021.06.031.

Shi, Y., and Xu, J. (2021). BIM-based information system for econo-enviro-friendly end-of-life disposal of construction and demolition waste, Autom. ConStruct.,125 103611, https://doi.org/10.1016/j.autcon.2021.103611.

Tee, W. H., Gan, C. K., and Junainah Sardi. (2024). Benefits of energy storage systems and its potential applications in Malaysia: A review. Renewable and Sustainable Energy Reviews, 192, 114216. https://doi.org/10.1016/j.rser.2023.114216

The Star. (2023). Biomass is the future. Retrieved from: https://www.thestar.com.my/news/nation/2023/12/08/biomass-is-the-future.

Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. MIS quarterly, xiii-xxiii.

Yiing Chiee Moh and Latifah Abd Manaf (2014). Overview of household solid waste recycling policy status and challenges in Malaysia. Resources, Conservation and Recycling, 82, 50– 61. http://dx.doi.org/10.1016/j.resconrec.2013.11.004

Zhechen, Zhang, et. al (2024). Municipal solid waste management challenges in developing regions: A comprehensive review and future perspectives for Asia and Africa. Science of the Total Environment, 930172794. https://doi.org/10.1016/j.scitotenv.2024.172794.