



## Strategic Domestic Solid Waste Management in Urban Areas

Abdul Aziz Zakaria<sup>1</sup>, Nur Hidayah Yaacob<sup>1</sup>, Nurul Anis Abdan<sup>1</sup>, Ailin Nabila Jamal Sharif<sup>1</sup>, Farah Ayuni Shafie\*<sup>1</sup>, Siti Rohayu Mohd Isa<sup>2</sup>, Mohd Idris Mohamed Yusof<sup>3</sup>, Nur Azyan Fathiah Azman<sup>4</sup>, Mohd Razif Sarkam<sup>4</sup>, Ahmad Razali Ishak<sup>1</sup>, Shantakumari Rajan<sup>1</sup> and Rudzaimair Malek<sup>5</sup>

<sup>1</sup>Centre for Environmental Health and Safety Studies, Faculty of Health Sciences, Universiti Teknologi MARA, Kampus Puncak Alam, Selangor, Malaysia

<sup>2</sup>Solid Waste Management and Public Cleansing Corporation, Melaka

<sup>3</sup>KDEB Waste Management Sdn Bhd

<sup>4</sup>Department of Health and Environment, Kuala Lumpur City Hall

<sup>5</sup>Kuching Utara City Hall

\*Corresponding author: [admin@maeh4u.org.my](mailto:admin@maeh4u.org.my)

### Abstract

Effective domestic solid waste management in urban areas has become a key element in the pursuit of sustainability, as it encompasses a range of strategic approaches to reduce waste generation and promote recycling and recovery while minimizing environmental impact. Recognizing the importance, this discussion aims to (1) assess the current state and innovation of domestic waste management practices, (2) identify the key challenges and barriers faced in implementing strategic waste management practices, and (3) develop effective strategies and policy recommendations for improving domestic waste management in urban areas. The discussion was structured into five sections: policy, operational management, initiative and technology, public behaviour and collaboration. By adopting a holistic approach from each section to strategic domestic waste management, urban areas can reduce the amount of waste they generate, divert more waste from landfills, and create a cleaner and healthier environment for everyone.

**Keywords:** Household waste, circular economy, sustainable development, municipality

© 2024 MAEH Research Centre.  
All rights reserved

## INTRODUCTION

Effective domestic solid waste management has become a crucial component in the pursuit of sustainable development, as it encompasses a wide range of strategic approaches aimed at minimising waste generation, promoting recycling and resource recovery, and mitigating environmental impacts (Awogbemi et al., 2022; Kurniawan et al., 2022). The world generates an estimated 2.01 billion metric tons of municipal solid waste (MSW) annually, of which 33% is not adequately managed in an environmentally safe manner. The average amount of waste generated per person daily is 0.74 kg, but this ranges widely from 0.11 to 4.54 kg. The per capita MSW generation in Southeast Asia is 1.14 kg per day, and 1.17 kg per day for Malaysia (Kaza et al., 2018). SWCorp also reported in 2020 that the Malaysian recycling rate stood at 30.67%,

which is better than the average recycling rate of developing countries at 15-20% but significantly lower than that of other developed nations such as Taiwan (60%), Singapore (59%), and Korea (49%) (Rajesh, 2019; MIDA, 2021).

In Malaysia, the responsibility for solid waste management (SWM) lies with multiple entities, including the Ministry of Urban Wellbeing, Housing, and Local Government (KPKT), National Solid Waste Management Department (JPSPN), Solid Waste Management and Public Cleansing Corporation (SWCorp), local governments, and concessionaires (Razali & Wai, 2019). This collective approach demonstrates Malaysia's strong responsibility and commitment to effective SWM. The 12th Malaysia Plan 2021–2025 (RMK-12) recently focused on

several themes, including improving sustainability (Economic Planning Unit, Prime Minister’s Department Malaysia, 2021). The plan introduces Game Changer VIII, embracing a circular economy emphasising the enhanced utilisation of recycled materials and effective management of production waste (Cheng et al., 2022). In addition, SWM is highly integrated into sustainable development goals (SDGs), mentioned explicitly or implicitly in 10 of the 17 SDGs set forward by the United Nations, emphasising the significance of a strategic SWM system (Hannan et al., 2020).

Residential areas are the primary generators of solid waste as this is where people reside. Food waste, plastic, paper, fabric and household items such as used oil, e-waste, and tyres are typically disposed of from residential areas. The increasing rate of household waste has become a serious concern. Malaysian landfills account for 95% of the total waste gathered, including recyclable and compostable waste, and landfills in Malaysia have surpassed capacity and may close within a few years (Kuan et al., 2022; Chen et al., 2021). The mismanagement of MSW is a pressing environmental concern exacerbated by population growth, rapid industrialisation, urbanisation, and limited public awareness of waste generation, resulting in adverse health impacts (Mohamad et al., 2022). Acknowledging the importance of strategic domestic waste management, this discussion aims to assess the current state and innovation of domestic waste management practices, identify the key challenges and barriers faced in implementing strategic waste management practices, and develop effective strategies and policy recommendations for improving domestic waste management in urban areas.

**POLICY IN WASTE MANAGEMENT**

Waste management should align with sustainable development principles to prevent harm to present and future generations (Khan et al., 2020). Thus, the JPSPN was established under the Solid Waste and Public Cleansing Management Act of 2007 (Act 672) and the Solid Waste and Public Cleansing Management Corporation Act of 2007 (Act 673). Both acts were gazetted in August 2007 and came into force by 2009. The JPSPN, as provided under Act 673, has the function of coordinating various agencies, including federal and state government, local authorities, private agencies, and the public, while SWCorp role is to assist in the implementation of the policy (Bukhari et al., 2020). This department is coordinated under the KPKT. The respective states are Perlis, Kedah, Pahang, Negeri Sembilan, Malacca, Johor, and the Federal Territories of Kuala Lumpur and Putrajaya.

According to Section 74, Act 672, the public must segregate solid waste and failure to do so, if convicted, can be fined a maximum of RM1000.00. Section 108 (2) (g) states that it is the individual’s responsibility to separate solid waste that can be recycled while also avoiding dumping waste at disposal centres. The state government of Selangor, Perak, Penang, Kelantan, and Terengganu remained under the jurisdiction of previous acts, including the Local Government Act 1976, Town and Country Planning Act 1976, and Site, Drainage and Building Act 1974 (Khan et al., 2020).

**OPERATIONAL WASTE MANAGEMENT**

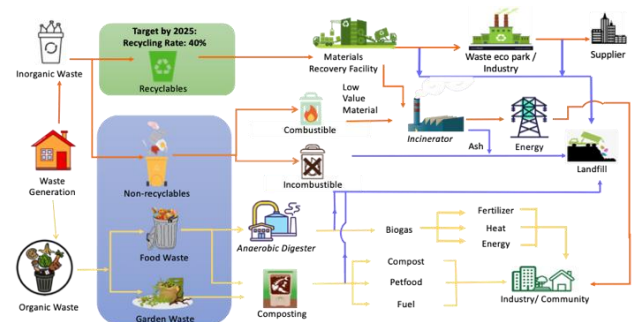
The main areas that require improvement in waste management operations include waste collection, transportation, and disposal. Insufficient waste containers and stations impede waste management efficiency in some places. Improving infrastructure and collection systems is essential for proper household waste collection. Problems in waste collection

arise in urban areas, such as Kuala Lumpur, where the development is not planned adequately and poses issues such as the placement of waste containers and bins. In addition, domestic waste collection in traditional village settlements in urban areas can be challenging because of the limited access to narrow roads. It is necessary to prepare central collection points in these settlements, which require proper planning by local authorities.

The frequency of domestic waste collection was also highlighted in the discussion as one of the provisions of Act 672 is the standardisation of a 2 + 1 collection system involving two days of domestic waste collection and one day of recyclable or bulk waste collection. The 2 + 1 collection system is adequate for rural and suburban areas. However, it may not be feasible in urban areas with high populations and traffic, especially tourism areas, which have high levels of waste generation and require more frequent waste collection. Another example of a collection system can be seen in Selangor, which does not enforce Act 672 and enacts its own state government SWM law (mention the state law) that implemented the 3 + 1 collection system, where the concessionaire collects domestic waste three times a week. This collection frequency was deemed more suitable because Selangor has the highest population density of all Malaysian states (Baig et al., 2022).

Transportation is crucial to waste management because inefficient transportation systems can result in delays, increased costs, and negative environmental impacts. Improving waste transportation logistics by optimising routes, deploying suitable vehicles, and establishing tracking systems can increase the efficacy of waste management. SWCorp—implemented Automated Vehicle Locating System (AVLS), which uses Global Positioning System (GPS) to track the location of vehicles, that can be utilised to monitor the activities of waste collection trucks. The acquired data can be used to track the progress of the waste collection, identify issue areas, and optimise truck routes. In addition, KDEB Waste Management (KDEBWM) has taken the initiative to monitor waste collection operations by installing cameras on waste collection vehicles.

Effective waste management involves proper recycling and segregation of different types of waste. Many waste disposal systems lack efficient recycling facilities and fail to promote segregation at the source. Significant improvements in waste management are possible through the implementation of awareness programmes, the enhancement of recycling infrastructure and the provision of recycling incentives. In addition, proper treatment and disposal facilities are required to effectively manage the various types of waste including incinerators and landfills. These aspects are analysed in Environmental Impact Assessment (EIA) studies prior to any implementation of SWM. Figure 1 shows the current flow and fate of domestic solid waste.



**Figure 1.** Current Domestic Solid Waste Flow in Malaysia

Many locations lack proper waste processing, treatment, and disposal capabilities, thereby increasing waste dumping into landfills. Investing in advanced treatment technologies and waste-to-energy facilities can improve waste disposal systems including waste mining. A few projects, such as the Selangor Green Energy Eco Park by KDEBWM, which is expected to process 2,400 tons of waste daily to produce approximately 50 megawatts of energy, have been introduced as initiatives to improve the efficiency of waste management and lessen the dependency on landfills.

## INITIATIVE AND TECHNOLOGY IN WASTE MANAGEMENT

As Malaysia adapts to urbanisation, the application of technologies has aided in many fields, including waste management. The technology used in waste management has increased the efficiency of this field through monitoring, waste collection, and recycling processes. The energy, time and human resources can be reduced by utilising technology as it can handle the growing amount of waste more effectively.

Monitoring system applications have made a significant impact on waste management. The increasing development of the Internet of Things (IoT) and upgraded surveillance system helps the authorities manage their operation well and make amendments to the area that needs improvement. Agencies involved in waste management in Malaysia, such as SWCorp, KDEBWM, and the local authorities, including Kuala Lumpur City Hall (DBKL), have implemented their way of tech into their daily operation. For example, SWCorp has enforced a system to comprehensively monitor their waste operation called the C4i system (Command, Control, Communication, Computer, and Intelligence). Implementing advanced technology to the system enables them to perform on-site monitoring of concessionaires efficiently. Besides that, KDEBWM and DBKL have sensor-based waste bins, which can send real-time data on the level of waste filled into those bins. It helps them optimise the waste collection routes, reduce unnecessary pickups and ensure timely collection, saving fuel and decreasing traffic congestion.

Malaysia still has a long way to go regarding the circular economy. The concept of circular economy is based on which the design of the products has been versatilely manufactured with different uses and is guaranteed to be reused multiple times (Arruda et al., 2021). The authorities have studied and tried various efforts to extend the life cycle of waste generated in the country, such as recycling, composting, and waste-to-energy facilities. SWCorp has deployed the Waste Executive Geographic Information System (WEGIS) internet application in an effort to assist the circular economy. This application was created in 2019 to boost the agency's efficiency by managing and monitoring concession activities in seven states using high-level data access. Here, the public can access nearby recycling and recovery facilities to send their household waste without sending it straight to the bins. Furthermore, KDEBWM plan to build a Waste-to-Energy (WTE) power plant technology to move towards a resource-efficient, low-carbon, and circular economy without adverse environmental impacts and does not require a big land. It reduces the volume of waste going into landfills while generating renewable energy.

Another option to promote a circular economy is by composting organic waste. There are a lot of composting methods that can be used. One reliable approach is using Black Soldier Fly (BSF) larvae composting. This method utilises the larvae of BSF to break down organic waste, including food waste, into nutrient-rich compost. Since food waste is the highest waste generated in Malaysia, it is crucial to use these composting approaches to minimise the transport of organic waste to landfills as it can generate hazardous gasses if

released into the open air. DBKL has successfully implemented BSF farming through the project of bioconversion of organic waste generated by KL Wholesale Market, and they managed to reduce about 10 tonnes of waste per month, according to DBKL.

UiTM also made the same approach to counter the food waste problem at the university. They extensively researched BSF farming and invented a new BSF Intellicycle Composting Rack (BSF-ICCR). This innovative system allows communities, local authorities, and industries to manage food waste sustainably and effectively. The BSF-ICCR adapted IoT by introducing an automated temperature and humidity control system that can easily be managed using a smartphone. This innovation makes BSF farming accessible in many areas with minimal care. Embracing IoT in BSF composting moves waste management towards a more data-driven, intelligent and eco-friendly future (Mohd Rasdi et al, 2022).

All of these innovative technologies can be leveraged more to enhance the waste management system in Malaysia. The authorities have made many efforts to counter the waste problem by promoting and adopting these technologies and ensuring equitable access to the public. By providing continuous awareness campaigns, workshops, and programs, the public can make full use of these technologies to manage domestic waste, thus reducing the amount of waste sent to landfills.

## PUBLIC BEHAVIOUR REGARDING WASTE MANAGEMENT

Law and regulations play a pivotal role in ensuring sustainable development. Each country has their regulations, which state that it is necessary to follow the rules and acts created and endorsed. According to Khan et al. (2019), in their research article entitled "A Survey on Perceptions of Legal and Non-Legal Factors Affecting Sustainable Solid Waste Management in Malaysia", the majority of the respondent do agree that legal factor is crucial in waste management. Also, in the same article, most respondents agree that a satisfactory policy facilitates sustainable SWM. That means the public does realise the importance of act and policy on this aspect. However, on the contrary, during the discussion with the focus group discussion panelists, stated that based on their work experience, that there is still a lack of enforcement by the authorities. This caused the public not to follow the act or rules imposed. Moreover, this public behaviour is driven by the lack of enforcement towards waste management.

Secondly, it involves facilities factors that are present to promote and make recycling accessible to the public. Discussions with the local authorities agreed that recycling facilities also play an important role in why domestic waste management in Malaysia is one of the current national issues. There is a lack of recycling centres and limitedly in Malaysia. If it is present, the location is quite further apart. Therefore, the public has problems accessing and using it easily. This makes the recycling process troublesome for the public and indirectly causes a lack of participation among the public to engage actively and involve in the recycling process.

According to SWCorp, regular monitoring is required by the right authorities. This means inconsistent participation of the public has become one of the challenges of waste management in Malaysia. It was also added that a lack of staff to monitor regularly towards the community contributes to inconsistent participation among the public in waste management. The public has to be regularly reminded of the importance of waste management, which makes the authorities' job a huge challenge. It can be assumed that people do have knowledge of

waste management, but the issue is from the public whether they always stick to what they have been taught or not.

Another issue discussed during the forum was the lack of awareness and implementation of waste management in the household. Waste management education was taught in childhood, but the behaviour was not carried out when the student was at home. This is because the children will follow their parent's footsteps whether to practice the correct waste management at home itself. This behaviour requires constant reminders so that the next generation will have a high awareness to practice good waste management, even at home. Education in school only is not enough to instil a correct mindset on waste management in the young generation, as environmental or social factors also play a huge role in breeding a correct and good mindset everywhere that particular person is.

Public participation is very important in the execution of waste management initiatives. For instance, waste segregation is a fundamental and critical aspect of any effective waste management system, including the integration of advanced technologies. Without waste segregation, the potential benefit of the technologies would be limited and lower the quality of recycled materials. Thus, public participation is instrumental in ensuring the public segregates waste effectively.

Thus, these are the few challenges that are faced by the authorities in implementing good practices on the public aspect of strategic domestic waste management. It can be concluded that the roles and the factors of effectiveness of waste management do not just fall on the authority but also on the public. Incineration with air pollution issues and the lack of landfills are serious challenges. This multifactorial aspect needs to be focused more, and strategies to reduce or minimise the challenges faced can be well-executed.

## COLLABORATIVE EFFORT FOR A STRATEGIC WASTE MANAGEMENT

The fundamental goal of current waste management practices is to reduce waste production and extend the lifespan of landfill sites. Therefore, the goal must be the main focus of cooperation between the government, private organisations, research institutions, and the public. Collaboration allows for sharing resources, knowledge, and expertise from different stakeholders. Government agencies, private sector entities, research institutions, and the public each bring unique perspectives, experiences, and capabilities that can be leveraged to address complex waste management challenges effectively.

The government should support the circular economy goals by providing the facilities such as innovation centres, or research and development hubs that collaborate with industries to foster the creation of new, innovative products with circular design principles. The government can incentivize companies to invest in developing eco-friendly products through grants, funding, or tax reduction. Embracing circular economy principles can reduce carbon emissions by promoting the use of recycled materials and decreasing the use of raw materials in manufacturing. This would benefit the government in line with their National Low Carbon Cities Masterplan directions, highlighting the need to provide funding and financing to facilitate low-carbon development and increase community participation in low-carbon development (Rahman, 2020).

Government agencies provide policies such as implementing a circular economy and various programs such as recycling, waste to energy, and waste to wealth. The government is only able to implement some programs that have been designed; this opportunity needs to be taken by the

private sector because managing waste provides a good return. Research institutions can contribute valuable insights into and advancements in waste management technologies, processes, and best practices. Government agencies should encourage private parties and research institutions to implement policies and programs produced through incentives, such as tax exemptions or research grants.

## CONCLUSION

Strategic domestic waste management in urban areas is complex and multifaceted. It requires a holistic approach that includes policy, operational management, initiative and technology, public behaviour, and agency collaboration. As policymakers, the government must regulate the waste management industry to ensure that waste is managed environmentally sound and sustainably. Next, issues in the operational management of waste management, such as infrastructure, waste collection frequency, and transportation and disposal systems, should be addressed to develop innovative solutions. In addition, initiatives, and technologies such as advanced monitoring systems, promoting the circular economy through website applications, recycling, composting, and waste-to-energy facilities play a crucial role in improving waste management to reduce the amount of waste that goes to landfills. It is also vital for the public to be aware of the importance of strategic domestic waste management and to be willing to participate in waste management programs and initiatives.

Collaboration among government agencies, private sector entities, and research institutions facilitates the development and implementation of well-informed waste management policies. The government should provide incentives and facilities for companies adopting the circular economy principles. Research institutions can provide evidence-based insights, while private sector entities can offer practical perspectives and market expertise. Together, they can develop practical and feasible policies. By adopting a holistic approach to strategic domestic waste management, urban areas can reduce the amount of waste they generate, divert more waste from landfills, and create a cleaner and healthier environment for everyone.

## CONTRIBUTION STATEMENT

The MAEH Urban Health Forum was held at the National Institute of Health (NIH), Setia Alam, from 19-20 June 2023. AAZ, NHY, NAA, ANJS and FAS conceived the forum, applied for and obtained funding from the Malaysian Association of Environmental Health and Universiti Teknologi MARA, and also drafted the first version of the manuscript. SRMI, MIMY, NAFA, MRS, ARI, SR and RM analysed the issue. All participants at the forum contributed to the focus group discussion that produced the article and approved the final version.

## REFERENCES

- Arruda, E. H., Melatto, R. A. P. B., Levy, W., & Conti, D. de M. (2021). Circular economy: A brief literature review (2015–2020). *Sustainable Operations and Computers*, 2, 79–86.
- Awogbemi, O., Kallon, D. V. V., & Bello, K. A. (2022). Resource recycling with the aim of achieving zero-waste manufacturing. *Sustainability*, 14(8), 4503.
- Baig, M. F., Mustafa, M. R. U., Baig, I., Takajudin, H. B., & Zeshan, M. T. (2022). Assessment of land use land cover

- changes and future predictions using CA-ANN simulation for selangor, Malaysia. *Water*, 14(3), 402.
- Bukhari, N. A., Zulkleple, M. M., Fauzi, M. F., Muin, N. A., Noordin, R. M., Saati, S. A., ... & Munawwirah, A. R. (2020). Towards Zero Waste: Technologies and Minimisation Strategies: The Langkawi Charter on Urban Health. *MAEH Journal of Environmental Health*, 2(1), 4-7.
- Chen, H. L., Nath, T. K., Chong, S., Foo, V., Gibbins, C., & Lechner, A. M. (2021). The plastic waste problem in Malaysia: management, recycling and disposal of local and global plastic waste. *SN Applied Sciences*, 3, 1-15.
- Cheng, K. M., Tan, J. Y., Wong, S. Y., Koo, A. C., & Amir Sharji, E. (2022). A review of future household waste management for a sustainable environment in Malaysian cities. *Sustainability*, 14(11), 6517.
- Economic Planning Unit, Prime Minister's Department Malaysia, 2021. Twelfth Malaysia Plan 2021-2025 A Prosperous, Inclusive, Sustainable Malaysia. Prime Minister's Department Malaysia, Putrajaya, pp. 1-532.
- Khan, I. N. G., Dahalan, W. S. A. W., Khalid, R. M., Nopiah, Z. M., & Hassan, K. H. (2020). Legislations on Solid Waste Minimization: A Comparison Between Malaysia and Australia. *Syariah and Law Discourse*, 1(1), 12-24.
- Hannan, M. A., Begum, R. A., Al-Shetwi, A. Q., Ker, P. J., Al Mamun, M. A., Hussain, A., ... & Mahlia, T. M. I. (2020). Waste collection route optimisation model for linking cost saving and emission reduction to achieve sustainable development goals. *Sustainable Cities and Society*, 62, 102393.
- Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). What a waste 2.0: a global snapshot of solid waste management to 2050. World Bank Publications.
- Khan, I. N. G., Dahalan, W. S. A. W., & Nopiah, Z. M. (2019). A survey on perceptions of legal and non-legal factors affecting sustainable solid waste management in Malaysia. *Akademika*.
- Kuan, S. H., Low, F. S., & Chieng, S. (2022). Towards regional cooperation on sustainable plastic recycling: comparative analysis of plastic waste recycling policies and legislations in Japan and Malaysia. *Clean Technologies and Environmental Policy*, 24(3), 761-777.
- Kurniawan, T. A., Othman, M. H. D., Hwang, G. H., & Gikas, P. (2022). Unlocking digital technologies for waste recycling in Industry 4.0 era: A transformation towards a digitalisation-based circular economy in Indonesia. *Journal of Cleaner Production*, 357, 131911.
- MIDA e-newsletter. (2021, December). MIDA. Retrieved from <https://www.mida.gov.my/waste-to-energy-for-a-sustainable-future/>.
- Mohamad, N. A. J., Yatim, S. R. M., Abdullah, S., Azmin, M. T., & Alwi, N. (2022). Forecasting Municipal Solid Waste (MSW) generation in Klang, Selangor using Artificial Neural Network (ANN).
- Mohd Rasdi, F. L., Ishak, A. R., Hua, P. W., Mohd Shaifuddin, S. N., Che Dom, N., Shafie, F. A., Abdullah, A. M., Abdul Kari, Z., & Atan, E. H. (2022). Growth and Development of Black Soldier Fly (*Hermetia illucens* (L.), Diptera: Stratiomyidae) Larvae Grown on Carbohydrate, Protein, and Fruit-Based Waste Substrates. *Malaysian Applied Biology*, 51(6), 57-64.
- Rahman, H. A. (2020). Malaysia Commitment towards Low Carbon Cities. *Int. J. Acad. Res. Bus. Soc. Sci.*, 10(15), 253-266.
- Rajesh, P. (2019). Solid waste management-sustainability towards a better future, role of CSR—a review. *Social Responsibility Journal*.
- Razali, F., & Wai, C. W. (2019). A review of Malaysia solid waste management policies to improve recycling practice and waste separation among households. *International Journal of Built Environment and Sustainability*, 6(1-2), 39-45
- Zabidi, F. S. M., Kasim, N. A. M., Ahmad, S., & Miskan, N. H. (2022). Factors Influencing Waste Management In Malaysia. *Journal of Business Innovation*, 7(1), 100.