

Sustainable Solid Waste Management towards Urban and Community Sustainability: The Case of E-Idaman

Norhani Aripin^{*}, Noor Afza Amran, Rokiah Ishak

^aTunku Puteri Intan Safinaz School of Accountancy (TISSA-UUM), Universiti Utara Malaysia, 06010 UUM Sintok, Kedah, MALAYSIA

Abstract

This study aims to explore the sustainable solid waste management initiatives implemented in Kedah and Perlis, Malaysia. Sustainable solid waste management study may assist the government specifically the local authorities of Local Government to find alternative treatment method of municipal solid waste management and also monitoring the cleanliness of the Malaysian environment. This study specifically explores how the Environment Idaman Sdn. Bhd. (E-Idaman) managed the solid waste, with aims to minimize their cost on waste management and also increase its additional income through implementation various initiatives including 4R's (reduction, reuse, recycling and recovery) strategies. It is hoped that the findings from this study will provide insights to government local authorities in dealing with waste management. It also may guide waste management disposal company to practice a holistic waste management with cost effective, using efficient technology and contribute to environmentally friendly.

Keywords: Solid waste management, sustainability, municipal solid waste

1. INTRODUCTION

Cities are hubs for ideas, commerce, culture, science, productivity, social, human and economic development. Urban planning, transport systems, water, sanitation, waste management, disaster risk reduction, access to information, education and capacity-building are all relevant issues to sustainable urban development. Further, sustainable community development calls for a significant improvement in the lives by providing adequate shelter for all; improving community management; and promoting sustainable land-use planning and management. It also aims for promoting the integrated provision of environmental infrastructure: water, sanitation, drainage and solid waste management; sustainable energy and transport systems in community; community planning and management in disaster-prone areas; sustainable construction industry activities; and human resource development and capacity-building for community development.

One of the focus areas in making cities and community sustainable is promoting an integrated provision of environmental infrastructure including clean water, sanitation, drainage and solid waste management. Government related agency need to recognize the need to be responsive to the demands of the members of the public who will be affected by the organization's actions. One of the main concerns by stakeholders is the effective management of solid waste due to the increase of environmental problems. Thus, the sustainable solid waste management practices deal with waste reduction and waste separation practices are important in achieving harmonization of cities and community sustainability.

In 2015, Malaysia has become a signatory of the United Nations 2030 Agenda for Sustainable Development that covers three key areas of economy, social and environment with 17 Sustainable Development Goals (SDGs). In 2017, the Green Technology Master Plan Malaysia (GTMP) 2017-2030 was released to further guide the push.

^{*}Corresponding author.
E-mail: norhani@uum.edu.my

This GTMP focuses on 6 initial key sectors which consider having high potential to facilitate green growth in the country which also include the waste management as one of the elements. One of the main concerns of GTMP 2017- 2030 related to waste sectors is how to treat and dispose waste and how to recover the resource which is dealing sustainable waste management Ministry of Energy, Green Technology and Water Malaysia (2017).

The definition of Municipal Solid Waste (MSW) is open to administrative interpretation which may vary widely between countries, agencies and even local jurisdictions. The MSW is refer to the solid waste generated at residences and commercial establishments (i.e., offices, retail shops, restaurants), and institutions (i.e., hospitals and schools) but does not include construction/demolition debris, automobile scrap or medical/ pathological waste (Chandler et al., 1997). Meanwhile, the sustainable solid waste management (SWM) practices can be described as managing waste today without compromising the prospects of future generations by maximizing the recovery of resources from the waste stream. Sustainability should be the fundamental component in contemporary MSWM decision making (Hacer & Braida, 2015).

Based on the press statement made in The Star dated 9 September 2018 by the Housing and Local Government Minister Zuraida Kamaruddin, one of the biggest challenges in major cities of developing countries is waste management. With a population of over 32 million, Malaysia generates about 38,000 metric tonnes of waste on a daily basis. Out of the huge amount, waste separation and recycle rate is only at 24%, while the remaining 76% goes to the landfill. Further, as reported by The Star dated 13 February 2019, Malaysia has become the "world's rubbish bin" and this was a powerful statement made by Greenpeace Malaysia in 2018, when it was reported that the country had taken in 754,000 tonnes of plastic waste from over 19 countries that year which equivalent to the weight of 100,000 large elephants. This reeked of bad news, especially for Jenjarom, a town located in the Kuala Langat District, that is now smothered in 17,000 tonnes (17mil kg) of waste, according to the BBC.

In addition, Kawai and Tasaki (2016) reveal that MSW generation per capita among Malaysian citizen is on average of 0.9 kilogram per day. This statistic shows that Malaysia is the among top three countries in term of waste generation in East Asia after Singapore (0.94kg) and Brunei Darussalam (1.40 kg). In terms of MSW generation per capita of 20 major municipalities in Asia and South Africa, Kuala Lumpur (1.62) is ranked at the first place, followed by Bangkok (1.50). The authors also find that each municipal value exceeds the corresponding national value for MSW generation per capita and comments that urbanization has a positive effect on increasing MSW generation per capita, especially in developing countries, where disparities in economic activities and living standards between rural and urban areas are large. MSW per capita in urban municipalities has been reported to be more than that in rural municipalities in developing countries.

Thus, based on the alarming issue on solid waste management, it is timely for researchers to conduct this study with aim to explore the waste management prtices of E-Idaman. E-Idaman Sdn. Bhd. (EISB), which is jointly owned by Metacorp Berhad and Cenviro Sdn. Bhd. to undertake the waste management business in the Northern region of Peninsular Malaysia namely Perlis, Kedah, Penang, and Perak. It is hoped the findings from this study will benchmark the effectiveness of the SWPCMC Act 2007 in dealing with waste management focusing in Kedah environment. Furthermore, this study may provide an insight to evaluate the successful of SDG 11 implementation by Malaysian government in making cities and communities development sustainable.

2. LITERATURE REVIEWS

A considerable number of research have been conducted to investigate the solid waste management from various perspectives globally. For example, Baaki, Baharum and Ali (2019) explored how a performance assessment framework for safe and sustainable health-care waste management (SSHCWM) can be used to evaluate the implementation of sustainable waste management activities in health-care facilities. They identified some factors such as regulation, policies and technical guidance; behaviour change; perceptions, roles and interactions of stakeholder networks; training and education; budget; implementing EMSs; implementing lifecycle waste management; implementing waste management hierarchy as a potential of critical success factors. C, Patil, K.T., and Prakash (2018) formulated frameworks for the drivers and barriers of integrated sustainable solid waste management (ISSWM) in India. They found institutional effectiveness and the robust policy and frameworks are the most driving power. In contrast, poor social values and ethics, huge population and illiteracy are the three most critical barriers faced by developing nations in achieving the sustainability practices in the solid waste management. Further, Mwanza, Mbohwa and Telukdarie (2018) reviewed the municipal solid wastes (MSWs) management system, from an engineering management (EM) perspective, for the City of Kitwe, Zambia. The research findings indicated that the existing MSW system for the city is highly unsustainable and lacks EM methodologies. There are still several challenges in the management of MSWs which include: lack of proper

collection and storage of MSWs; lack of an engineered landfill; lack of waste recovery and treatment systems; and lack of public education aimed at reducing and separating MSWs.

In a different setting, Ofori and Mensah (2021) analysed the factors that promote pro-environmental intentions and sustainable electronic waste management among households in Ghana. They found that environmental values were the major influencer of pro-environmental intentions. Further results showed that sustainable e-waste management is mainly influenced by perceived behavioural control followed by pro-environmental intentions. Singh and Sushil (2021) identified the linkages of sustainability, which helps to capture the existing waste management practice in sustainable organizations. They found that the social image of an organization as a sustainable organization is the effect of its governmental directives, followed by the organization. The governmental directives are the most influencing dimension, and waste management efficiency and energy consumption are the most related dimension of sustainability in the organization. To increase its customer satisfaction, profit share and market value, these factors must be considered as vital factors of organization's sustainable performance.

In 2007, Malaysian Government has gazetted the Solid Waste and Public Cleansing Management Corporation Act 2007 (SWPCMC Act 2007). This Act regulates the management of controlled solid waste and public cleansing for the purpose of maintaining proper sanitation. Furthermore, the Government also introduced Sustainability Development Goals (SDGs) 11 with a goal to make cities and human settlements inclusive, safe, resilient and sustainable. One of the ways of making cities and human settlement sustainable is by having an effective SWM practice. For the states that adopted the SWPCMC Act 2007 (Act 672), a total of 3,108.9 thousand tonnes of solid wastes was produced in 2019 as compared to 3,098.7 thousand tonnes in 2018. In line with the National Solid Waste Management Policy 2016 that has targeted national recycling rate of 22.0 per cent in 2020, Malaysia's recycling rate in 2019 has exceeded the set target that is 28.1 per cent. In Asia region, South Korea and Singapore recorded recycling rate of 53.7 per cent and 34.0 per cent respectively (Department of Statistics Malaysia, 2020).

As a result of increasing rate of waste generation and population growth, land area has become more demanding causing the increment of the cost in solid waste management. Due to that, solid waste management will become more expensive in the future as it is reported that local government has provided a large amount of financial provision for solid waste management which more than 50% of their annual budget. The increase of cost in managing solid waste is due to inefficient and ineffective solid waste management in Malaysia specifically the urban area.

In 2020, the Covid-19 pandemic hits the world and have major impact to various countries and organisations. Living in a new normal could be challenging and changing the business model and processes. Marques, Serrasqueiro and Nogueira (2021) analyse the literature on the topics of Covid-19 and the sustainability. The results indicate a high number of publications in the social dimension, with a relevant proportion of studies in the health sector. In national health systems, monitoring, innovating in human resource management and investing in information technology can ensure organizations' reliability and sustainability. Valizadeh, Mozafari and Hafezalkotob (2021) suggest the Covid-19 crisis has added a large amount of waste to urban waste, including infectious waste such as personal protective equipment and used equipment for patients. The results show that contractors were able to reduce total costs by establishing a coalition and sharing their capacities. In fact, the synergy of cooperation between them creates incentives for contractors to organize large coalitions.

Brohan et al. (2021) investigated the environmental consequences of the COVID-19 pandemic in Malaysia, focusing on the effect of COVID-19 on municipal solid waste (MSW). The data on domestic waste collection were collected from the Solid Waste Management and Public Cleaning Corporation (SWCorp) from 1 January 2020 to 31 December 2020. The results indicated that the enforcement of the early MCO showed a positive effect by decreasing the volume of MSW. However, the amount of MSW began to increase again when the MCO reached the conditional and recovery stages. While the pandemic was still spreading, the local governments and waste management companies had to quickly alter their waste management systems and procedures. Similarly, Ismail et al. (2020) also found the similar decreasing trend of food waste generation during MCO in Selangor. The findings give contribution of knowledge in the quantification and analysis of food waste drivers in Malaysia. Additional considerations should be rendered in the field, for example, industrial activities, weather conditions, biomass burning, and traffic density.

2.1 Solid waste management

Malaysia has experienced rapid industrialization and urbanization over the last few decades. This situation has increased the generation and changes the characteristics of MSW. The fundamental aspect that needs to be considered in designing a sustainable MSW management system is the availability of information on the characteristics of waste generate. Solid wastes management in Malaysia are categorized into three categories namely municipal solid waste management, scheduled waste management and clinical waste management. Each category is under different government agencies. For example, Ministry of Housing and Local Government takes the responsibility to supervise municipal solid waste management; Department of Environment manages the scheduled waste generation and disposal matters; and Ministry of Health control clinical waste management.

The elements of solid waste management can be classified into waste generation, dumping waste, collection and transportation, reduction, reuse, recycling, recovery / composting, landfill site selection and landfill. Sustainable municipal solid waste management practices deal with waste reduction and waste separation practices as the most preferred elements in the waste hierarchy (EPA South Australia, 2014; Sustainable Facility Tools, 2014;) Sustainable municipal solid waste management practices involve decisions at strategic, tactical, and operational levels. Considerations include selection of waste treatment sites and landfills capacity expansion strategies for allocating trans-formation facilities and landfills service zoning, and the need for collection days in each zone and for each type of waste.

Sustainability of the municipal solid waste management practices can be achieved if it is appropriate to the local conditions and can continue in the long term by using the human, financial and material resources available in the area. It should also be environmentally sustainable in that it minimizes the use of non-renewable natural resources (such as oil) and does not lead to long-term environmental problems that will be left for later generations to address. Effective management of municipal solid waste has become environmentally and economically mandatory due to the increase of environmental problems. In this context, the evaluation of economic aspects is imperative since the implementation of a municipal solid waste management system relates to considerable investment and operating costs.

In Malaysia, municipal solid waste management used to be under the responsibility of different local authorities (Local Governments) which clearly stated in Section 72 of the Local Government Act 1976 (Abd Manaf et al., 2009). Under provision of LGA 1976, local authority was responsible to provide services including directly or through contract public cleansing to all urban and semi urban communities under its jurisdiction, municipal solid waste should be disposed in sanitary manner. However, revenue of local authorities was facing deficit due to high operation cost associated with waste collection and transportation. Abas and Wee (2014) reported that local government has provided a large amount of financial provision for municipal solid waste management which more than 50% of their annual budget Although 50% of the operating cost was spent for the solid waste management, only 76% of the generated wastes were collected. This phenomenon exists due to inefficient and ineffective municipal solid waste management in Malaysia specifically the urban area.

Zainua & Songip (2017) reported that according to previous Malaysia's Director General of National Solid Waste Management Department, 40% - 80% of local authority's expenditures are on managing municipal waste and public cleansing. The cost of Municipal Solid Waste Management (MSWM) services per premise is around RM15.00 and the privatisation of the MWM had cost the Malaysian Government more than RM300 million. In order to reduce the burden of local authorities, solid waste services were privatized in year 1996. There are three solid waste concessionaires which have their own operating zone namely Idaman Bersih Pte. Ltd. for northern regions, Alam Flora Pte.Ltd. for central regions and Southern Waste Management for southern regions. However, local authorities are still having their responsibility in monitoring the cleanliness for amend under their jurisdiction.

Further, as an action to minimize high cost of MSWM, the Malaysian government has launched several recycling campaigns in the year 2000s to involve the participation of non-governmental organizations (NGO) and community groups as well as the launch of an extensive public education and publicity campaign. The government had been implementing various strategies in solid waste management system to encourage public to participate in 4R (reduce, reuse, recovery and recycle) programs but the results have been disappointing. The government had targeted to increase the rate of recycling over the year to 22% by the year 2020, to achieve higher recycling percentage and lesser waste to be sent to landfills for disposal. Unfortunately, the campaign received only a warm response from the public. The overall failure of the campaign has been succinctly noted by the Minister of Housing and Local Government, in which he mentioned that after more than two years of recycling campaigns, only 2%

of waste is recycled while it will take only nine and a half days to fill the Petronas Twin Towers with garbage (Omran et al., 2009).

Permana, Towolioe, Abd. Aziz & Siong Ho (2015) revealed that the presence of community practices on waste reduction and waste separation was strongly correlated to a sense of cleanliness in the community. This result implicitly indicates that by using positive environmental image and performance within a locality, the community can become enthusiastically involved and push for sustainable SWM practices. They suggested that waste reduction and waste separation are two preferred practices in sustainable solid waste management (SSWM). These two methods are seemingly impossible to implement without high awareness within the communities as well as a strong commitment and support from the city authorities (Permana, et al., 2015). Thus, public awareness is a vital in promoting the successful of sustainable solid waste management.

2.2 Advantages of sustainable solid waste management practices

To extend, annual waste generation in Malaysia has reached 33,000 tonnes/day or about 12 million tonnes per year with more complicated compositions principally with organic waste (55%), paper (13%) and plastic (19%). So far, about 95% of the waste collected (which is 75% of waste generated) was landfilled (Agamuthu and Fauziah, 2011). Current disposal method of landfilling needs improvements to prolong the landfill life and to minimize the problem of land scarcity. Approximately 76% of the total MSW generated in the country is collected, where 2.0% is recycled while the remaining MSW are sent to the 144 disposal sites throughout the country.

Even with the difficulty in searching for suitable sites for landfills, they still remain as the main waste disposal option due to the lower cost of operation at only RM35/tonnes, as compared to RM500/tonnes for incineration and RM216/tonnes for composting. The annual increase of MSW was that a fast and a long-term solution must be implemented immediately to prevent more detrimental effects to the environment.

Malaysian Federal Government had established two new agencies under Solid Waste and Public Cleansing Management Act 2007. National Solid Waste Management Department was set up as a policy making and regulatory body to supervise solid waste services based on local administration boundary. Solid Waste and Public Cleansing Management Corporation was established to complement and ensure the successful implementation of the national solid waste management policy. In general, the policy aims to provide a comprehensive, integrated, cost-effective, and sustainable solid waste management system in line with society's demand for environmental conservation and public well-being (Abd Manaf et al., 2009).

Although new municipal solid waste management structure was in place, illegal solid waste disposal and environmental pollution could not be addressed effectively (Moh & Abd Manaf., 2014). There is a lack of enforcement capacity by National Solid Waste Management Department. Moreover, coverage of the municipal solid waste services in Malaysia is still not sufficient especially in rural area which cause illegal disposal activities such as open-air burning, open dumping and disposal by dumping into river (Moh & Abd Manaf, 2014). To overcome this issue, a better MSW management system which takes into consideration waste compositions, separation, recycling, and public awareness are essentially required.

In order to achieve an efficient and sustainable municipal solid waste management practices in a developing country like Malaysia, alternative options including material recovery, composting and thermal treatment could be implemented. Besides the improvement in the environmental quality, the implementation of an integrated waste management would also contribute to economic perspective. However, a specific improvement tool involving public participation is necessary in order to ensure that an appropriate MSW management system can be implemented.

3. METHODOLOGY

Several methods were utilised for data collection, including interview. An interview was conducted with representatives from E-Idaman on 24 January 2022 at Wisma Idaman, Alor Setar, Kedah. The interviewees were Mr. Munir Amani Dasheer (Head of Division for Operation) and Mr. Ahmad Sharafi Mohd Saad (Head of Green Resource Recovery Sdn Bhd- GRRSB). The aims of the interview were to get input from the respondents about the solid waste management practices of E-Idaman. In addition, a site visit was conducted to Rimba Mas Sanitary Landfill located in Perlis on 14 February 2022. This landfill is one of the landfills monitored by SWCorp. Starting from November 2021, Umpan Jaya Sdn Bhd secured the concession to manage the Rimba Mas Sanitary Landfill.

During the site visit, Mr Muhammad Shukor Abdul Halim, the Director of Umpan Jaya and his staff provide assistance for the site visit and briefing about the operation of the landfill.

4. FINDINGS AND DISCUSSIONS

E-Idaman Sdn. Bhd. (E-Idaman) is a jointly owned by Metacorp Berhad and Cenviro Sdn. Bhd. to undertake the waste management business in the Northern region of Peninsular Malaysia namely Perlis, Kedah, Penang, and Perak. In 2004, E-Idaman formed Environment Idaman Sdn. Bhd. (ENVI) to undertake the Solid Waste Management and Public Cleansing Management concession by the Federal Government and subsequently formed Green Resource Recovery Sdn. Bhd. (GRRSB) in 2015, to tap into the non-concession area of businesses such as recycling, composting and landfill management. As a concession company, E-Idaman delivers the best environmental services to meet society's growing needs. To date, E-Idaman has successfully operated in the state of Perlis and Kedah, covering 13 local authorities of more than 300,000 premises, with 6,000 workers. Collaboration with 3 local authorities in Perak is also on going to further expand our operations.

Solid waste generation in Malaysia largely contributed 65% by household, 28% by industry and 7% by commercial and institutional (Department of Statistics in Malaysia, 2020). Waste is divided into wet and dry waste. In Kedah, waste dispose is around 1400 or 1600 tonne per day. Domestic waste about 60% which are the highest waste disposal. Another 40% are green waste which consists of barks, trees, leaves, etc. Figure 1 shows the distribution of Kedah/Perlis – Household Waste Composition 2017.

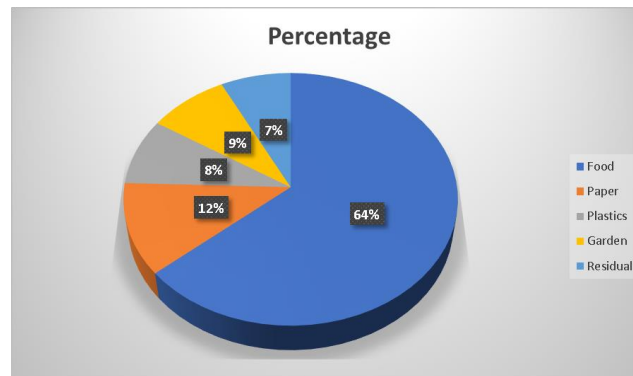


Fig. 1: Household Waste Composition of Kedah and Perlis 2017 (1450 Tonne /Day)

The elements of solid waste management in Malaysia are divided into two (2) parts, which are government concession and non-concession. Government Concession is awarded by the Federal Government to undertake the waste collection and public cleansing management services for the Northern region of Peninsular Malaysia. Currently operating in the states of Kedah and Perlis. Under solid waste collection, E-Idaman Sdn. Bhd. via its subsidiary Environment Idaman provides innovative waste collection and disposal services for municipal wastes under the Government's concession, focusing on creating a sustainable environment to meet the demand of growing population. To date, E-Idaman manages the operations in the state of Perlis and Kedah, covering 13 local authorities of more than 300,000 premises, with 6,000 committed employees and fleet of over 300 vehicles. E-Idaman caters a comprehensive solid waste solution that includes: (1) Domestic waste, (2) Recyclable waste, (3) Green waste and (4) Bulky waste. Another government concession offered by E-Idaman is the public cleansing management. Services include under this are: (1) Road Sweeping, (2) Grass Cutting, (3) Drain cleaning, (4) Public toilets cleaning, (5) Dry & wet markets cleaning and (6) Beach cleaning.

Non-concession is run by GRRSB, that provides services which are not covered under the government's concession in delivering a sustainable and holistic approach of integrated waste management in Malaysia. Non-concession covers providing private waste collections to non-concession areas such as industrial parks, commercial and institution areas which are not bound to the government concession. It consists of garbage collection for industries which is known as Institution Commercial and Industry (ICI) where the industries need to pay for the services. This is the core income for E-Idaman. Another service offered is the private cleaning services which include grass cutting and drain cleaning at private residential areas and premise cleaning services. This is specifically done to cater the needs of growing demand from the public due to their strong support and trust on our service quality based on the current operation of government concession services.

Further, as an action to promote sustainable waste management, the Malaysian government has launched Sustainable Strategic Plan including smart partnership, waste to resources, facilities, sustainable program, technology and innovation and awareness program (5R). The smart partnership involves participation of waste management disposal company, non-governmental organisations (NGO), private sector, academic institutions and community groups. Through collaboration of E Idaman with NGO and private sectors such as Yayasan Sultanah Bahiyah, SwCorps and Ministry of Housing and Local Government, they are able to sale the recyclable items, create a donation channel and promote the sustainable waste activities to community groups. Communities are encouraged to recycle their waste instead of transfer to landfill. In order to increase the recycle activities by public, E Idaman has initiated 2-bins system, a system that each household is allocated with 2 bins for the purpose of segregating wet waste and dry waste. Further, E-Idaman also introduced drop off facility that operate at 15 local authorities in Kedah and 1 center in Perlis. In addition to drop off point, E Idaman also established Drive Through Recycle Center (DTRC) at Kangar and Kulim. The DTRC is a convenient drop off point for recyclable and financial incentives also given to individuals who return recyclables to the centers. Beside drop off their waste, communities also can sell their recycle items at moveable buy back centre (BBC) that use multi purpose truck that stationed at approved location.

Communities in Kedah and Perlis are also equipped with 1,501 recycle cage in Kedah and 168 cage Perlis, respectively. E-Idaman also established material recovery facility (MRF) that encourage, and ease recycle activities focusing on food waste such as Pusat Komuniti Lestari Taman Tunku Sarina, Jitra, Pusat Komuniti Taman Angsana, Kulim. Communities are free to drop off their food waste into self- service rubbish cage which will be recomposed as a fertilizer. This fertilizer will be used to fertilise community vegetable garden which is freely distribute to local communities. In addition to collaboration with NGO, private and communities, E Idaman also collaborate with academic institution such as Universiti Utara Malaysia, Universiti Teknologi Mara, Manjung and Universiti Sultan Azlan Shah to promote green campus zero waste initiative. The objectives of green campus zero waste are to promote sustainability in managing waste in the campus and to embed ownership of the area to the varsity community. Waste generation from eateries, cafeteria, offices and residential are separated and treated as source. Using integrated facilities, the green waste is composted for landscaping. Other recyclables used cooking oils and e-waste are transferred to MRF facility that transformed waste to baled products and sold to industrial buyers. Only the residual waste is transported to landfills for treatments.

Waste management has become an imperative given that most cities are running out of landfill sites. With increasingly limited land availability and the steady growth of cities, governments need to implement effective and sustainable waste management solutions including waste to energy technologies (WTE). For E Idaman, waste to resource plan only involve the recycle for life (RFL) program that promote waste separation and recycled activities for sustainable community. Food wastes and green wastes will be processed on site to be utilised by the premise while the recyclables, used cooking oil and e-waste will be collected and transported for further processing and to be sold to industrial buyer.

E-Idaman also equipped with facilities that able to enhance sustainability waste management as display in Figure 2 below. Among facilities possessed by E Idaman is multi resources collection vehicles (MRCV) is a four compartment trucks that cater for bulky waste, residue waste, food waste and recyclables. The use of MRVC will reduce time collection of waste as a single truck able to cater for all type of waste except for green waste. Meanwhile, the use of one-man operator side loader increases the waste tonnage from 8 tons to 14 tons per trip. Another advantage of single operator side loader is minimizing the number of worker and collection time from 2 minutes to 48 seconds to upload waste.



Fig. 2: Waste collection and transportation facilities

In order to enhance sustainable waste management, E Idaman adopted new technologies to monitor and to implement the effective waste management practices. E Idaman introduce E-Aduan system, Automatic Vehicle Locate System (AVLS), Mresponz, Geographical Information System (GIS) and drone technology. E-Aduan system that enable an efficient management of customers feedback (complaints, queries and compliments) and action taken starting from feedback receive until it is close. Figure 3 explain the flowchart of E Idaman online system (E- Aduan). The process begins with receive feedback from customer followed by verification of the feedback complaint, investigation and rectification by service department, closing the compliant and ended with corrective and preventive plan.

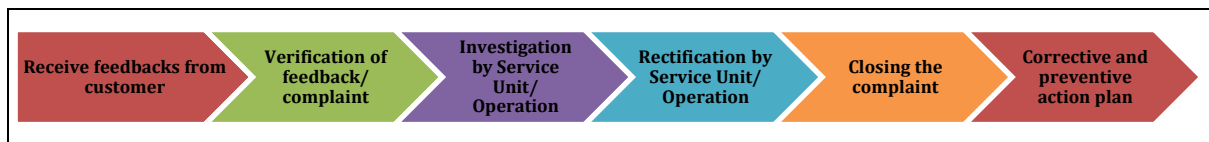


Fig. 3: Flowchart of E-Aduan

E- Idaman also digitalised waste collection management by adopting Automatic Vehicle Locate System (AVLS) an integrated system of GSM and GPS technology that work together in the form of digital and web-based fleet tracking system which gives real-time report from the ground operation to the management screen monitoring. This system is not only for precise fleet tracking, but it also provides vast information on the fleet activities for instance real-time alerts on any speeding, idling, power-cut, panic, ignition or hotspot event.



Fig 4: Automatic Vehicle Locate System (AVLS)

Similar to AVLS, E-Idaman also create MResponz a mobile application for Workforce Tracking and Response Management that compatible with all Android based smartphones and tablets with the intention to monitor the activities, locations and work progresses of the supervisors on the field for waste collection and public cleansing management services. Meanwhile the Geographical Information System (GIS) is an application of GIS that plays an important role in managing inventory data starting from preliminary data collection on the ground using the Global Positioning System (GPS) technology to data storing, analyzing and visualizing using map and inventory.

GIS also can be used in route optimization where the best and cost-effective route can be selected to increase operational performance and efficiency.



Fig. 5: MResponz mobile application



Fig. 6: Drone technology

5. CONCLUSION

This study aims to explore the practices of sustainable waste management conducted by E-Idaman. E-Idaman aspires to inculcate a sustainable and innovative approach in managing waste by introducing initiatives beyond business as usual, taking into consideration the symbiotic relations between the people, nature, and economy, and ultimately preserving the environment for the benefit of both the present and future generations. Its service units available in each district in Perlis, Kedah and Perak and act as our frontline that oversees the day-to-day operations. They are the champion in handling the basic operations, ad-hoc and event requirements for waste removal, public cleansing, and disposal within their respective operational areas. It is hoped the findings from this study provide indicator on the effectiveness of the SWPCMC Act 2007 in dealing with waste management focusing on Kedah environment. Furthermore, this study also may provide an insight to evaluate the successful of SDG 11 implementation by Malaysian government in making cities and communities development sustainable.

REFERENCES

- Abas, M.A. & Wee, S.A. (2014). The issues of policy implementation on solid waste management in Malaysia. *International Journal of Conceptions on Management and Social Sciences*, 2(3), 12-17.
- Abd Manaf L. A., M. A. A. Samah, & N. I. M. Zukki, (2009). Municipal solid waste management in Malaysia: Practices and challenges, *Waste Management*, 29 (11), 2902–2906.

- Baaki, T. K., Baharum, M.R. & Ali, A.S. (2019). Determining a conceptual framework for safe and sustainable health-care waste management (SSHCWM) implementation in health-care facilities, *Journal of Facilities Management*, Vol. 17 No. 1, pp. 40-56. <https://doi.org/10.1108/JFM-11-2017-0059>.
- Brohan, M.A., Dom, N.C., Ishak, A.R., Abdullah, S., Salim, H., Syed Ismail, S. N., & Precha, N. (2021). An analysis on the effect of coronavirus (COVID-19) pandemic movement control order (MCOs) on the solid waste generation in Peninsular Malaysia. *Environmental Science and Pollution Research*, <https://doi.org/10.1007/s11356-021-17049-6>.
- C., G.G., Patil, Y.B., K.T., S. & Prakash, A. (2018). Conceptual frameworks for the drivers and barriers of integrated sustainable solid waste management: A TISM approach, *Management of Environmental Quality*, Vol. 29 No. 3, pp. 516-546. <https://doi.org/10.1108/MEQ-10-2017-0117>.
- Chandler, A.J., Eighmy, T.T., Hjelm, O., Kosson, D.S., Sawell, S.E., Vehlow, J., van der Sloot, H.A. & Hartlén, J. (1997). Municipal solid waste incinerator residues, *Studies in Environmental Science* 67, Elsevier Science B.V., Amsterdam.
- Department of Statistic Malaysia (2020), accessed at <https://www.dosm.gov.my/v1/index.php?r=column/pdfPrev&id=TjM1ZlFxb3VOakdmMnozVms5dUIKZz09>.
- EPA South Australia 2014: Retrieved from https://www.epa.sa.gov.au/environmental_info/sustainable_facility_tools.
- EPA South Australia, 2019. Retrieved from https://www.epa.sa.gov.au/environmental_info/waste_management/illegal_dumping.
- Hacer, A.K. & Braida, W., (2015). Sustainable municipal solid waste management decision making: Development and implementation of a single score sustainability index, *Management of Environmental Quality: An International Journal*, 26 (6), 909-928, <https://doi.org/10.1108/MEQ-03-2015-0028>.
- Ismail, M. K., Mohd. Ghazi, T. I., Hamzah, M. H., Abd Manaf, L., Mohd Tahir, R., Mohd Nasir, A., & Omar, A. E. (2020). Impact of Movement Control Order (MCO) due to coronavirus disease (Covid-19) on food waste generation: a case study in Klang Valley, Malaysia. *Sustainability*. 12. 1-17. 10.3390/su12218848.
- Kawai, K. & Tasaki, T (2016). Revisiting estimates of municipal solid waste generation per capital and their reliability, *Journal of Material Cycles Waste Management*, 18, 1–13, DOI 10.1007/s10163-015-0355-1.
- Marques, I.C.P., Serrasqueiro, Z. & Nogueira, F. (2021), Covid-19 and organisational development: important signs of a new pillar for sustainability, *Social Responsibility Journal*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/SRJ-10-2020-0415>.
- Ministry of Energy, Green Technology and Water Malaysia (2017), accessed at <https://www.pmo.gov.my/wp-content/uploads/2019/07/Green-Technology-Master-Plan-Malaysia-2017-2030.pdf>
- Moh Y.C. & Abd Manaf. L. (2014). Overview of household solid waste recycling policy status and challenges in Malaysia, *Resources, Conservation and Recycling*, 82, 50-61.
- Mwanza, B.G., Mbohwa, C. & Telukdarie, A. (2018), Municipal solid waste management in Kitwe City: An engineering management perspective, *Management of Environmental Quality*, Vol. 29 No. 6, pp. 1075-1092. <https://doi.org/10.1108/MEQ-10-2017-0120>.
- Ofori, D. & Opoku Mensah, A. (2021), Sustainable electronic waste management among households: a circular economy perspective from a developing economy, *Management of Environmental Quality*, forthcoming <https://doi.org/10.1108/MEQ-04-2021-0089>.
- Omran A., A. Mahmood, H. Abdul Aziz, & G. M. Robinson (2009). Investigating households' attitude toward recycling of solid waste in Malaysia: A case study, *International Journal of Environmental Research*, 3(2), 275–288.
- Permana, A.S., Towolioe, S., Absul Aziz, N. & Siong Ho. (2015). Sustainable solid waste management practices and perceived cleanliness in a low-income city, *Habitat International*, 49 DOI: 10.1016/j.habitatint.2015.05.028.
- Singh, A. & Sushil (2021), Integrated approach for finding the causal effect of waste management over sustainability in the organization, *Benchmarking: An International Journal*, Vol. 28 No. 10, pp. 3040-3073. <https://doi.org/10.1108/BIJ-08-2020-0419>.
- Valizadeh, J., Mozafari, P. & Hafezalkotob, A. (2021). Municipal waste management and electrical energy generation from solid waste: a mathematical programming approach, *Journal of Modelling in Management*, forthcoming.