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Waste Management System- A Comparative Study of Waste Management Systems in Malaysia and Canada

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Abstract

Minimizing waste production is a top priority in waste management, as it has the least adverse impact on environmental sustainability by reducing materials entering solid waste or recycling streams. This study offers a comprehensive overview of Canada's waste management landscape, serving as a model for Malaysia. The analysis covers policies, waste diversion programs, reduction initiatives, disposal practices, and energy-from-waste projects. Many Canadian regions show promising possibilities in waste policy frameworks, suggesting the need for explicit waste disposal targets to enhance action on reduction and diversion. For construction, renovation, and demolition (CRD), individual producer responsibility is advocated over collective Extended Producer Responsibility (EPR) due to industry distinctiveness. In Malaysia, dwindling disposal sites prompt the study, aiming to overcome challenges by assessing government recycling initiatives and addressing public indifference. While Malaysia faces disposal site shortages, the study recommends the adoption of successful Canadian waste management strategies. The article provides an insightful analysis of Municipal Waste Management (MWM) issues in Malaysia, offering a roadmap for both countries to navigate challenges and implement effective waste management practices.

Keywords: Environment, Waste Management, Waste Disposal, Waste Reduction, Sustainability.

Introduction to waste management system

Waste management is a pivotal challenge in the contemporary global landscape, deeply intertwined with environmental sustainability, public health, and economic prosperity (Duodu et al., 2022). Many countries are under escalating pressure to meet legally binding targets with recycling and waste management (Vorobeva et al., 2023). This comparative study delves into the intricate tapestry of waste management systems, juxtaposing the approaches undertaken in two distinct yet interconnected nations: Malaysia and Canada. Both countries grapple with the complex task of balancing rapid urbanization, industrial growth, and the

preservation of natural ecosystems against the looming specter of waste generation. Understanding and contrasting the strategies, policies, and infrastructural frameworks employed in these nations can shed invaluable light on effective waste management practices, offering insights and potential solutions applicable not only to these specific contexts but also serving as a blueprint for other regions facing similar challenges.

Canada's success in waste management strategies stems from its holistic approach, which combines a robust policy framework with effective waste diversion programs, reduction initiatives, investment in energy-from-waste projects, and a focus on individual producer responsibility. By implementing comprehensive policies at both the federal and provincial levels, Canada sets clear targets and regulations to guide waste management practices. Diversion programs, including recycling and composting initiatives, incentivize residents and industries to reduce waste sent to landfills. Additionally, Canada prioritizes waste reduction efforts, promoting reusable products and minimizing packaging to prevent waste generation. Investment in energy-from-waste projects further reduces the volume of waste destined for landfills while generating renewable energy. Moreover, Canada advocates for individual producer responsibility, holding producers accountable for managing the waste generated by their products, which incentivizes product design for easier recycling and disposal. This integrated approach has positioned Canada as a leader in sustainable waste management practices, offering valuable lessons for other nations seeking to enhance their waste management systems. A comparative study of waste management systems in Malaysia and Canada is important for understanding the complexities of waste management and informing evidence-based decision-making to address this pressing global challenge.

Overview of Malaysia and Canada

Malaysia is a tropical nation with a landmass of 329,847 km2 that is located in Southeast Asia's center region. It is situated between the latitudes defined by the Equator and 7' north and the longitudes 100 and 120 east (Jalil et al., 2022). The South China Sea divides the nation's two regions, West Malaysia and East Malaysia. The Peninsular, which consists of 11 states, is West Malaysia. On the island of Borneo, there are two states called Sabah and Sarawak that make up East Malaysia (Chin, 2020; Lai et al., 2022). Kuala Lumpur is the federal government's headquarters, while Putrajaya is the capital city. A few nations encircle Malaysia. Thailand borders Malaysia to the north, Singapore and Indonesia to the south, and the Philippines Islands to the east. Figure 1 below shows the map of Malaysia.

Figure 1: Malaysia Map
Source: Malaysia Map (2021)

Canada has ten provinces, three territories, and 13 subnational divisions. Local government is governed differently in each region. Long ago, colonial North America included the area that is now Canada (Ray et al., 2021). Midway through the 19th century, the region gained independence while maintaining ties to the British throne (Eidsvik, 2016). The British North America Act, often known as the Constitution Act of 1867, was passed on July 1, 1867, establishing Canada and its first four provinces, Ontario, Québec, New Brunswick, and Nova Scotia (Smith, 2018). Canada has diverse natural scenery as a country with several distinct geographical regions. The Canadian Shield's most significant physical area is Hudson Bay, covering half of the nation (Li Yung Lung, 2018). Lowlands predominate in Canada's southeast, surrounded by the Great Lakes (Lake et al.) (Olson et al., 2020). In 2020, there will be 38 million people living in Canada, which is only 10% as many as in the United States (Urrutia et al., 2021). The largest city in Canada is Toronto, and Ottawa is the national capital. English and French are the spoken languages (Ray et al., 2020). Figure 2 below the map of Canada.

Figure 2: Canadian Map
Source: Hasehoch (2023)

Waste Management Challenge

Malaysia faces a pressing waste management challenge due to population growth, industrialization, and a surge in diverse waste types, leading to a strain on suitable disposal sites (Bonnet et al., 2023; Harper et al., 2019). In addition, the rapid expansion of the economy will change the structure of solid waste (Fazeli et al., 2016). More serious waste issues have arisen due to lifestyle changes, particularly in urban regions (Zhou et al., 2018). Managing urban solid garbage has emerged as one of Malaysia's most pressing environmental concerns due to the country's rapid economic expansion and population growth, inadequate infrastructure and knowledge, and land constraints (Yong et al., 2019). Despite government efforts to promote recycling, limited progress has been made due to public disinterest (Moshood et al., 2022). The country heavily relies on landfills, with a substantial number already nearing their capacity (Kaza et al., 2018; Akhtar et al., 2021; Alao et al., 2022). Experts warn that at the current rate, available landfill space might vanish by 2050 (Kaza et al., 2018; Guillard et al., 2018).

In Malaysia, trash disposal has increased gradually along with population development, and most of the waste is dumped in landfills. Malaysia now has 165 landfills, eight sanitary landfills, and three inert landfills for materials like sand and concrete, according to the National Solid Waste Department (Kaza et al., 2018; Akhtar et al., 2021; Alao et al., 2022). Due

to its straightforward disposal process, low cost, and ability to restore the landscape, landfills are the most popular technique for disposing of MSW (Law et al., 2020; Li et al., 2022; El-Saadony et al., 2023). Approximately 82.5% of the collected waste is discarded at these sites, with the remaining minimal amounts being treated, recycled, or dumped illegally. A lack of money to modernize the landfill sites and lax enforcement are two problems with the building of solid waste disposal sites, as is the lack of a proper engineering design and landfill bottom lining system (Fenta, 2017; Thöni & Matar, 2019 Kathuria, 2022).

The waste treatment facility featured in the 9th Malaysian Plan is shown in Table 1. Because existing landfill sites are quickly filling up, it becomes harder to dispose of trash by landfilling (Fauziah et al., 2012). Local authorities controlled one hundred fifty-five disposal sites throughout Malaysia in 2001 (Fazeli et al., 2016). However, the existing practices must stop immediately since they harm the environment (Flannery et al., 2016). If nothing is done to minimize garbage, no space will be available by 2050 (Kaza et al., 2018; Guillard et al., 2018).

Table 1
Solid Waste Management Facility Plan

Facilities/project	Operated capacity (tons/day)
Taman Beringin Transferred Station, Kuala Lumpur	1700
Thermal Treatment Plant at Labuan	40
1st cell for Selong Sanitary Landfill at Johor Bahru	1200
1st cell for Bukit Tagar Sanitary Landfill at Hulu Selangor	1500

Source: Economic Planning Unit (2006)

Currently, over 23,000 tonnes of waste is produced each day in Malaysia. However, this amount is expected to rise to 30,000 tonnes by 2020 (Yong et al., 2019). The amount of waste generated continues to increase due to the increasing population and development; less than 5% of the waste is recycled (Soh et al., 2019). Since Malaysia produces more waste than it recycles, waste management is a severe issue (Chen et al., 2021). Malaysia discards more than 30,000 tons of municipal solid waste (MSW) daily, or 1.17 kg of waste per person (Ahmed et al., 2023). The most significant contributor to MSW was food waste, followed by plastic, paper, mixed organics, wood, and other materials (Qonitan et al., 2021). Domestic garbage is the primary source of the 0.5 to 0.8 kilogram per person per day per capita creation rate (Kasavan et al., 2020). According to the 9th Malaysia Plan, around 45% of future waste will be food, 24% of plastic, 7% of paper, 6% of iron and glass, and other materials (Bashir et al., 2020). Malaysia's waste output surpasses its recycling capacity, disposing of over 30,000 tons of municipal solid waste daily (Ahmed et al., 2023), with food waste ranking as the primary contributor, followed by plastic, paper, and other materials (Qonitan et al., 2021). This disparity highlights the critical waste management issue in Malaysia.

Due to population increase and changing demographics in Canada, the issue will worsen within 30 years (Meadows & Randers, 2012). The existing approaches to waste management, which mostly rely on thermal conversion through burning, do not promote recycling and waste minimization (Idumah & Nwuzor, 2019). This is not a long-term, practical approach for society. Prohibiting organic fraction municipal waste (OFMSW) from being dumped in landfills is a prominent global trend (Makarichi et al., 2018; Norouzi & Dutta, 2022). Canada emphasizes reducing household waste production by repurposing materials like paper, textiles, and electronics, aligning with a robust recycling culture (Ammendolia et al., 2021; Jorgensen, 2019; Pandit et al., 2019). The main reason is that the landfill spaces will be

insufficient by 2050. In Canada, home trash may accumulate very quickly. Reducing the quantity of garbage that households produce in the first place is the most excellent strategy for dealing with it (Ammendolia et. al., 2021). Creating new items from materials like printer paper, textiles, plastic bags, and electronics (which may contain various metals) is possible. Households can also use old or worn-out clothing as cleaning rags (Jorgensen, 2019; Pandit et al., 2019).

Landfilling is Canada's most widely utilized MSW treatment method, where most MSW has been disposed of (Mukherjee et al., 2020; Thapa et al., 2022; Aslam et al., 2022). According to data from the prairie provinces of Canada, there were approximately 15 times as many landfills per person in 2015 than there were in the United States (Richter et al., 2018; Ghosh et al., 2021; Bolingbroke et al., 2021). Permanent land disposal is frequently seen as the least desired option in many waste management hierarchies despite landfilling's popularity in Canada (Sharma & Jain, 2020; Degenstein et al., 2021; Huang et al., 2022). Groundwater contamination by leachate and landfill gas emissions are typical worries (Swati et al., 2018; Ozbay et al., 2021).

Canada produces 35.5 million tonnes of garbage, 20% to 40% of which comprises OFMSW. This quantity of OFMSW may produce 12,000 kWh of renewable energy annually (Norouzi et. al., 2022). Canada's current waste management systems can only collect 2.6 million tonnes of OFMSW from landfills. The percentage of organic waste in Canada was diverted from municipal waste for every province (Nazari et al., 2021). Most of organic waste was diverted from the environment in New Brunswick (57.57%), followed by Nova Scotia (46.84%), Prince Edward Island (36%), British Columbia (35.33%), Alberta (34.62%), Ontario (34.27%), Manitoba (25.38%), Newfoundland (21.57%), Saskatchewan (16.98%), and Yukon (15.69%) (Norouzi et al., 2022). These provinces use biological and thermochemical conversion techniques, including composting, AD, hydrothermal carbonization (HTC), pyrolysis, gasification, and incineration, to establish OFMSW (Mukherjee et al., 2020; Awashti et al., 2022).

In Canada, Longueuil (Montreal), Quebec, Canada, implemented a complete system to manage high-strength brewery wastewater from a new Molson-Coors plant (Norouzi & Dutta, 2022). This plant can produce up to 8450 Nm3/d of biogas and 3350 kg of fuel oil equivalent per day (72% CH4). To increase the effectiveness of anaerobic treatment and reduce energy expenses, biogas produced in this unit heat the wastewater entering the system (Su et al., 2021). A high-efficiency biogas plant and a water wash biogas upgrading facility have recently been installed in Metro Vancouver's Lulu Island WWTP in British Columbia (Martin, 2015). This plant can produce RNG from raw biogas at up to 800 Nm3/hr. FortisBC's gas grid receives an injection of upgraded RNG (McCabe et al., 2020).

The plethora of research focusing on waste management, encompassing solid waste in Malaysia, underscores the critical significance of effective waste management systems. This extensive body of research underscores the vital importance of understanding waste management paradigms. Consequently, this paper aims to conduct a comparative analysis between the waste management systems of Malaysia and Canada. The researcher chose Canada as Malaysia's role model because of the exciting garbage management system by the Canadian country. There are many research concentrate on waste management in Malaysia.

For example, Zainal et al (2020) advocate for a Circular Economy approach, emphasizing the application of the 3Rs principle to minimize waste and maximize resource yields. Conversely, Chen et al (2021) outline plastic waste production and management options in Malaysia, encompassing landfill, recycling, and incineration methods. Ooi et al (2021) investigate emissions reduction in municipal solid waste management, considering valuable products valorized from MSW. Furthermore, Tang et al (2021); Chua et al (2019); Liew et al (2021) discuss energy recovery from municipal solid waste, contributing to the discourse on sustainable waste management practices in Malaysia.

The environment and human health are seriously endangered when household hazardous wastes are improperly disposed of, such as by pouring them down the toilet, spilling them on the ground, dumping them in storm drains, or throwing them out with the trash (Stachowitsch, 2018). The eight categories of controlled solid waste (commercial, construction, household, industrial, institutional, imported, public, and others) are separated, stored, collected, transported, transferred, processed, recycled, treated, and disposed of as part of SWM services (Aziz et al., 2021).

Recycling waste is, therefore, always desirable. Recycling, however, is an expensive and energy-intensive activity. Therefore, if recycling systems are to be used, waste systems' effectiveness and efficiency are vital (Idumah & Nwuzor, 2019; Kabirifar et. al., 2020). To measure the scope of recycling activities, the waste diversion rate (DR), a jurisdictionally equivalent index, is frequently used (Umar et al., 2021; Mensah, 2022)

Solid Waste Management System

In Malaysia, solid waste is classified into three main categories, each overseen by a specific government department. The first category is Municipal Solid Waste (MSW), which falls under the jurisdiction of the Ministry of Housing and Local Government (MHLG). Hazardous waste is managed by the Department of the Environment (DOE), while Clinical waste is under the purview of the Ministry of Health (MOH). The management of solid waste is currently under the responsibility of the Ministry of Housing and Local Government, with collaboration from the business sector. The Ministry of Natural Resources and Environment is to develop an environmental performance index(EPI) to gauge the environmental management performance of every state in collaboration with Universiti Teknologi Malaysia (UTM) under the 10th Malaysia Plan (2011-2015) (Garske et al., 2020). The cabinet has agreed to the ministry's proposal, which also had the support of the various federal agencies. Malaysia is in 54th position among 163 countries worldwide under the Global EPI 2010 based on quantitative data obtained from the World Health Organization, United Nations Global Environmental Monitoring System, government agencies, NGOs, and academia (Babajide, 2021).

Malaysia established the Solid Waste and Public Cleansing Management Corporation to manage operations and the National Solid Waste Management Department to serve as the regulatory agency (Moh, 2017). The corporation would supervise the concessionaires and take over the municipal governments' management of solid trash. However, local authorities would still monitor the cleanliness of the regions under their control (Marello & Hellwege, 2018). On August 30, 2007, the Solid Waste and Public Cleansing Act 2007 was published in the official gazette to lay the groundwork for the federal government to take over solid waste management and privatize solid waste treatment (Ahmad et al., 2019). Three additional policies also saw consequential changes. They were the Site, Drainage, and Building Act of

1974, the Local Government Act of 1976, and the Town and Country Planning Act of 1976. The Act has severe consequences for violations (Hassan et al., 2021). Anyone found engaging in illegal dumping, storage, or treatment faces a fine of between RM 10,000 (EUR 1980) and RM 100,000 (EUR 19,802), as well as a possible five-year prison sentence (Wils, 2002). The Act includes eight categories of restricted solid waste, including garbage from residences, businesses, government buildings, construction sites, institutions, industrial zones, and other sources that may occasionally be included. The services for managing regulated solid waste include separation, storage, collection, transportation, transfer, processing, recycling, treatment, and disposal (Moh, 2017). As a result, the government has established a new solid waste management system (Chi et al., 2015). Malaysia has launched the Solid Waste and Public Cleansing Management Corporation to manage operations and the National Solid Waste Management Department as the regulating authority. In addition to overseeing the concessionaires, the corporation would take over the municipal authorities' solid waste management (Maiyaki et al., 2019). However, local authorities would still monitor the region's cleanliness under their control (Ghani et al., 2019).

While in Canada, all waste management laws passed at the federal, provincial, territorial, and local levels include penalties (Moh, 2017; McCoy et al., 2020). The range of punishments varies substantially from one piece of legislation to another. Municipal officials, the provincial ministry, or the department in charge of the environment typically enforce. The severe punishment for failing to provide notice to import or export hazardous waste is a CND$1 million fine and three years in prison, according to the Canadian Environmental Protection Act (CEPA) (Kagan, 2019). The maximum penalty and jail sentence under the Transportation of Dangerous Goods Act is $100,000 CND. The maximum penalty for violating the federal Hazardous Products Act is a CND$1 million fine and two years in prison (McDonald & Timoshkina, 2007). Penalties are also established by provincial law, which varies from province to province (Milmanda et al., 2019).

In 2007, a provincial strategy was approved: Too Good to Waste, a roadmap for waste reduction and management in the province (Bel & Warner, 2015; Blom-Hansen et al., 2016). The strategy identifies the desired outcomes as developing innovative approaches to waste management, recycling, and resource recovery and reducing waste disposal in landfills (Ghaffar et al., 2020). The "Guidelines for the Management of Biomedical Wastes in Canada" by the Canadian Council of Ministers of the Environment contains precise suggestions for handling biomedical waste. The Guidelines include suggested practices for separating, packaging, storing, disinfecting, moving, incinerating, and disposing of biomedical wastes (Windfeld et al., 2015). Many other standards and guidelines are also released by professional societies, Environment Canada, and Health Canada (Wynes et al., 2017). In Canada, pretreatment technologies have gained momentum along with the growth of biogas plants over the past few decades and have been effectively used to stabilize and improve methane production. Mechanical, thermal, chemical, biological, and additives (hybrid) are the five categories into which pretreatment technologies can be divided (Ruiz et al., 2020; Norouzi et al., 2022). The hydrolysis stage is regarded as a rate-limiting phase among the four phases of hydrolysis, acetogenesis, acetogenesis, and methanogenesis since the composition of OFMSW is particularly complicated. Pretreatment technologies' primary objective is to advance the hydrolysis phase (Zamri et al., 2021).

The Strategies to The Effective Waste Management System

In Malaysia, the operation of waste management was first privatized in 1994 (Alam & Siwar, 2015). Alam Flora Sdn Bhd is gradually taking over the rubbish collection service and public area cleaning (Tiew et al., 2019). The consortia were given instructions to manage the solid waste for a temporary duration to streamline the process (Roberts et al., 2018). The government has not yet decided on full-flash privatization because new legislation based on the National Waste Bill has not yet been passed (Jereme et al., 2015). Most solid waste management will continue to fall under the purview of Local Government until privatization is fully implemented (Luthra, 2019). The public sector cannot transfer all duties to the private sector even though the current large-scale privatization implies a more thorough transfer of activities and functions than the earlier semi-privatization initiatives (Lapidus, 2019). Since the privatization of waste management was started at the federal level, it will be the Federal Government's responsibility to ensure the consortia adhere to the standards, laws, and regulations that the Government requires (Jereme et al., 2015). This is accomplished by the Ministry of Housing and Local Government's Department of Local Government.

In contrast, the Department of Environment's (DOE) primary tasks are general pollution control and Environmental Impact Assessment (Zhang et al., 2016). The public sector cannot transfer all duties to the private sector even though the current large-scale privatization implies a more thorough transfer of activities and functions than the earlier semi-privatization initiatives (Easton & Piper, 2019). Since the privatization of waste management was started at the federal level, it will be the Federal Government's responsibility to make sure the consortia adhere to the standards, laws, and regulations that the Government requires (Jereme et al., 2015; Alam & Siwar, 2015). This is done through the Department of Local Government at the Ministry of Housing and Local Government (MHLG). However, the Environmental Impact Assessment (EIA) of waste treatment facilities is primarily the responsibility of the Department of Environment (DOE) (Busmah et al., 2021). The federal government established the National Solid Waste Department, and the legislation establishing it was passed into law in 2011 (Moh, 2017; Kaza, 2018).

During the 2015 United Nations Climate Change Conference (COP21), Malaysia vowed to make every effort to fulfill that commitment to the Paris Agreement. Therefore, Terengganu, one of the states governed by Malaysia, was committed to achieving the goals, thrusts, strategies, and action plans outlined in the 11th Malaysia Plan document (2016-2020), which was based on the National Solid Waste Management Policy (Karim et al., 2020; Ghazali et al., 2021; Ravichandran & Selvaraj, 2021). Based on the available literature, several studies have evaluated urban solid waste management in Malaysia using different methods, namely Life Cycle Assessment (LCA), Geography Information System (GIS), Decision Support System model (DSS), Solid Waste Management Resource Recovery Tool model (SMART), and Integral Dynamical Model, being the most popular method (Ismail & Hanafiah, 2021; Khan et al., 2021; Gervasi et al., 2021; Balasbaneh & Sher, 2021; Rezvani et al., 2023). National Solid Waste Management Department noted that there are too many saturated landfills in Malaysia despite the Government spending RM1.9 billion on solid waste collection and public sanitation. One hundred thirty-seven landfills, including 21 sanitary landfills, are now in use throughout Malaysia, while 174 have already been closed (Tang, 2020; Hussein et al., 2021; Baba-Nalikant, 2023; Masdek et al., 2023).

In Canada, three WMS efficiency indicators were used to systematically evaluate waste management system (WMS) efficiency from 1998 to 2016. Examining temporal changes in

waste diversion operations and ranking the performance of the jurisdictions using a qualitative analytical framework are the study's main goals (Richter, 2021; Mensah, 2022). All jurisdictions have experienced rising trends in the Waste Management Output Index (WMOI), and it is advised that additional government subsidiaries and incentive programs be implemented. The declining diversion gross domestic product (DGDP) ratio trends are seen, except in Nova Scotia (Mensah et al., 2023). It seems that the GDP growth from Sector 562 was not helping to divert garbage. Canada spends around $225 for every ton of waste managed (Vasigh & Rowe, 2019).

In Canada, the technology, business, and new laws and regulations imposed on trash all contributed to a substantial improvement in the waste management sector (Fatimah et al., 2020; Vanapalli et al., 2021). Trash systems adopted a more organized approach to garbage management (Fedotkina et al., 2019; Steenmans et al., 2021). Many early incinerators without air pollution controls were shut down and replaced with contemporary waste-to-energy plants when the Clean Air Act was enacted in the Canada United States in 1970 (Makarichi et al., 2018; Abas et al., 2019). To address our mounting garbage problem, the solid waste sector has recently turned to various technologies, including composting and recycling (Doorga et al., 2022). SWM processes have significantly impacted human history and will continue (Andeobu et al., 2022). With recycling and other technological advancements, the current waste-management sector in the industrialized world has gone a long way, and it will continue to expand and adapt to the community's demands (Smol et al., 2020; Sharma et al., 2020). Many solid waste management systems (SWMS) adjustments have not yet been implemented in developing nations (Shaban et al., 2022; He et al., 2022). Solid waste management in the developing world is entirely wrong; many countries' current SWMS are more akin to past SWMS in the developed world (Pal et al., 2022).

To effect improvements upstream, increased cross-Canada cooperation between the federal government and industry stakeholders is essential in Canada. The National Zero Waste Council, which is made up of representatives from municipalities, provincial governments, recycling councils, and major merchants, might facilitate this collaboration (Xavier et al., 2021; Marchildon et al., 2021; Gagnon et al., 2022). Governments can take advantage of this momentum and become more involved in Council activities, individually or through CCME (Haberly, 2014; Austin et al., 2014). Some possibilities include leading a steering group or working group on data, including other industry stakeholders who want to participate, and providing additional funding (Agenda, 2015; Fund, 2015).

Conclusion

Compared to both countries, Canada follows the most efficient way of system management. This is because when the country can dispose of and at the same time produce biogas, the sustainability of the environment in the country is well maintained compared to Malaysia's disposal in landfills. If, in the future, Malaysia can produce biogas from the disposal of waste, environmental sustainability could be implemented. Each country already run the disposal system for years. However, to make sure the system implemented is suitable for the population and to achieve the goal of the United Nations to gain environmental sustainability, Malaysia can make the country of Canada an example to implement the disposal system more systematically. The situation worsens in Malaysia when there is a lack of appropriate policy, necessary technology, and favorable public perception of waste management. The human

and environmental health of the nation is at risk due to current practices such as unregulated waste dumping. A sustainable municipal solid waste management (MSWM) system is urgently needed to support the economic growth of rapidly emerging nations. Compared to Malaysia and Canada, if Malaysia could collaborate with ASEAN countries for an excellent disposal system and implement a tax-free or tax-reduction system for the companies that consume eco-friendly products, Malaysia could achieve a more excellent disposal system and improve environmental sustainability.

The disposal facilities also should be reformed to the new type of garbage used in Canada. For example, Malaysia's government and authority bodies should change the old garbage box to the new type of RORO Garbage box. The idea is to ensure that garbage collector workers can work safely and healthily without significant injuries or harm to body health. Next, to make it easy for the garbage collectors to collect it. Furthermore, the savage of time to collect the garbage in one time. This idea could also create enough space for the citizens to throw the rubbish correctly into the RORO Garbage box, as the current garbage box is not enough due to the population increase, and the wastage produced by the citizens increases yearly. The time for collecting the garbage can also be done three times per week compared to every day as the RORO Garbage has ample space and takes time to full enough for the collection process. Figure 3 shows the old type of disposal lorry, while Figure 4 shows the innovation dumping lorry for the community.

Figure 3: Old garbage dumping collecter lorry
Source: (*SWM Environment Collects 45 Tonnes of Post-flood Waste in Johor*, 2021)

Figure 4: The new type of dumping collector lorry
Source: Opoleva, (2023)

The action to transform the garbage into biogas should be widespread in Malaysia as the space for landfills is almost to be complete in less than ten years from now. These actions support an eco-green and environmentally friendly system as it changes the garbage into a valuable product for plant fertilization while saving the place of landfills. Using biogas in plantations could also increase the quality of the plant's products as biogas is one of the excellent parts of naturally transformed fertilization. Figure 5 shows the complete process of the biogas plant. Some countries can transform biogas into flammable gas. This type of gas could be done and resold to the factory using the gas energy in their production phase.
Moreover, this type of gas is eco-friendly and will not cause air pollution as it is made from natural products. Figure 6 shows the process of biogas transmission to the gas process. In the future, Malaysia will be a role model to the Asian countries for the other countries' garbage systems. The innovation toward environmental sustainability should be done immediately as now we are facing many types of natural disasters due to the lack of environmental system management.

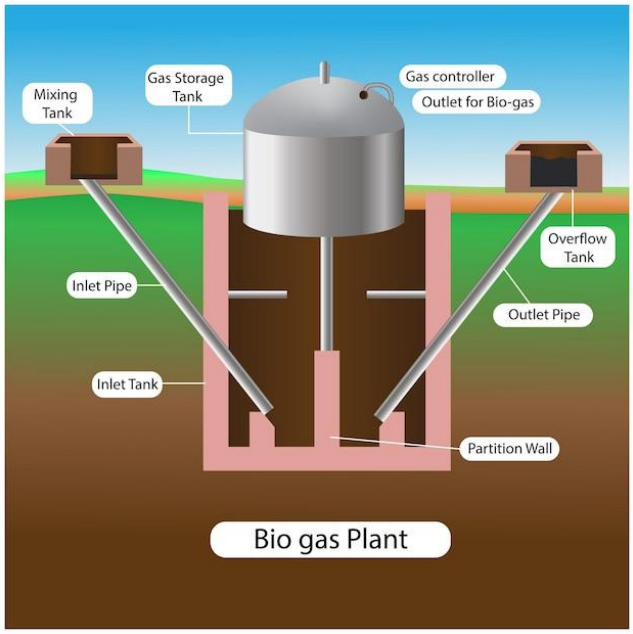

Figure 5: Biogas Plant
Source: Biogas Plant Premium Vector (2022)

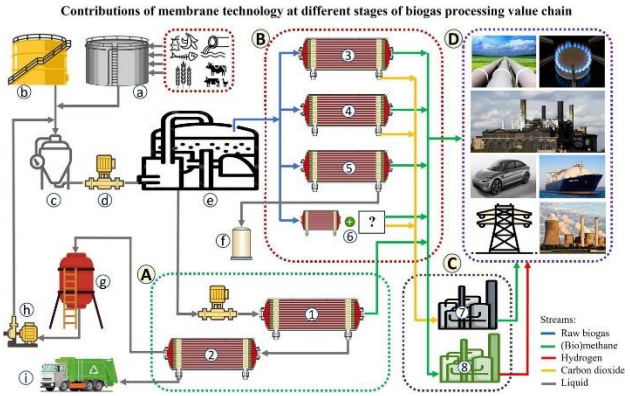

Figure 6: Biogas process
Source: Hosseini et. al, (2023)

Overall, while both Canada and Malaysia aim to manage their waste effectively, differences in policy frameworks, infrastructure, resource availability, and cultural factors can result in varying strategies and outcomes in waste management practices. Adopting successful strategies from Canada could help Malaysia improve its waste management systems and address challenges such as disposal site shortages and public indifference. By comparing policy frameworks and governance structures, identifying best practices, and highlighting socio-economic impacts, such studies inform evidence-based decision-making and foster international collaboration to improve waste management globally.

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