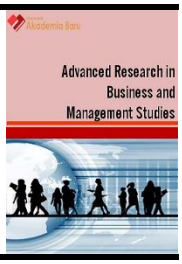
Penerbit Akademia Baru

Journal of Advanced Research in Business and Management Studies

Journal homepage: www.akademiabaru.com/arbms.html
ISSN: 2462-1935



Challenges in Enhancing Solid Waste Management towards Sustainable Environment: Local Council Perspectives

Open Access

Prashanth Beleya[1,*], Cheah Xin Ci[1], Chua Ling Wen[1]

[1] Department of Physical and Mathematical Science – Kampar Campus, Faculty of Science, Universiti Tunku Abdul Rahman, Jalan Universiti, Bandar Barat, 31900, Kampar, Perak, Malaysia

ARTICLE INFO

Article history:
Received 18 June 2017
Received in revised form 25 July 20199
Accepted 2 August 2019
Available online 28 August 2019

Keywords:
Municipal solid waste management; sustainable environment; local council perspective; Malaysia; waste management theory

ABSTRACT

The challenges in enhancing municipal solid waste management towards sustainable environment is crucial and need to be determined from the local council perspective in Malaysia. Sustainable environment is to preserve the current environment state of affairs for the next generation by minimizing waste and establishing solutions to be more productive with such waste. This is a qualitative research focusing on the current management at three different levels: district, town and city. Four critical factors were identified in this study which are data adequacy, policy management, solid waste handling methods and environmental awareness as challenges in enhancing waste management at the local council's level. In conclusion, enhancing municipal solid waste management is not only an environmental agenda, but it deeply contributes to the overall sustainability of necessary areas in terms of energy and cost efficiency that can lead to a cleaner and greener state with more positive repercussions.

1. Introduction

Municipal solid waste problem has received increased global attention to date, even in Malaysia. The increasing amount of solid waste became a horrendous issue, where it leads to quite a number of problems that affects the environment, social, and economy in Malaysia. Therefore, the main purpose of this study is to enhance the municipal solid waste management system for a sustainable environment through four identified factors. They are data adequacy, policy, methods of handling, and environmental awareness between various parties including government, industry, and also consumers. Also, this research is conducted to provide a deeper insight to examine the real causes and eventually, determine effective solutions towards enhancing municipal solid waste management.

Yiing and Latifah [59] mentioned that in Malaysia, landfilling is the method in which the country largely relies. As we shall know, landfilling is said to be more cost-efficient and convenient to be implemented compared with other techniques. However, according to Yiing and Latifah [59], she

mentioned that the rapid increase in population has resulted in the volume explosion of waste which calls for more landfilling areas. This leads to land scarcity and increase in land prices.

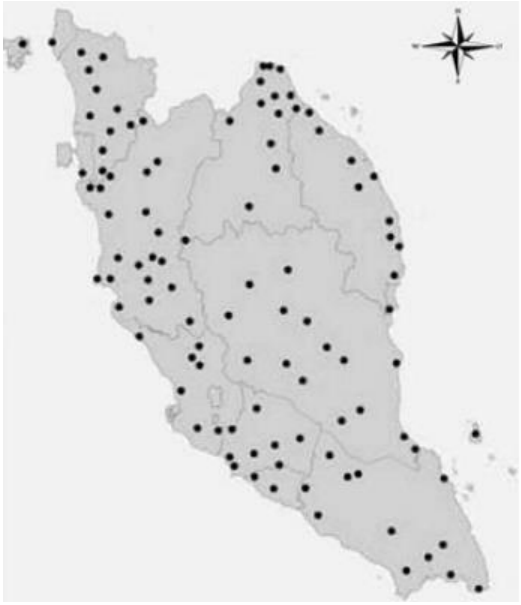


Fig. 1. Black dots indicate existing and closed landfill sites in Peninsular Malaysia, and 80% of the existing sites reaching its full capacity and are expected to be shut down in the next few years [59]

According to Zainu and Songip [61], they mentioned that Malaysians are generating 25,000 metric tonnes of municipal solid waste every single day. Jereme, *et al*., [28] mentioned that it is not a sustainable practice to create solid wastes. As posited by him and Gustavsson, *et al*., [22], waste exists along the supply chain whereby resources are expended during the process of growing, transporting, storing, food preparation and so on. Lim, *et al*., [32] provided that MSW can be handled by destruction, deposit, incineration or decomposing in accordance to Malaysia Solid Waste and Public Cleansing Management Act 2007 (Act 672). However, landfilling is most common in Malaysia followed by incineration. Extensive dependence on the former causes space constraints where most of the landfills have reached its maximum capacity of holding MSW [35]. On the other hand, incineration requires high advancement of technology and enormous costs to process MSW which could be a financial burden to the country, plus it creates air pollution [62]. The amassing amount of waste poses significant social, environmental and economic concerns. From environmental perspective, extensive reliance on landfill can also be a source contributing to atmospheric and hydrologic pollution. The process for organic waste to decompose emits hazardous greenhouse gases that lead to global warming. Methane is one, which is 20-25 times more potent than carbon dioxide and mainly is made up from landfills [37]. Wahidah and Ghafar [59] reports that environment degradation will become more severe as greenhouse gases emission is likely to increase to 50% by 2020 if landfilling remains as the main disposal method. Furthermore, a cost effective and environment friendly solid waste handling and management system becomes increasingly important since both landfilling and incineration are not sustainable and can adversely impact the environment. Lim, *et al*., [32] stated that if a country wants to reduce the solid waste amount effectively and efficiently, it is prominent for the country to have a decent municipal solid waste management system.

Municipal Solid Waste Management System is becoming an important area of research in every country as the amount of waste increases. The municipal solid waste management (MSWM) is an important tool for the country to manage the waste in order to ensure safe and health for human. Furthermore, the system also helps in promoting sustainable environment growth for a long-term effect [9]. According to Chatsiwa, *et al*., [9], there are a few different distinct process can be describe in municipal solid waste management, which is the elimination or reduction, recycling or reuse, treatment or destruction, rendering and disposal of waste into the air, water, or land by different methods. There are a lot innovative methods to manage waste around the world to achieve sustainability. Moreover, municipal solid waste management can be differentiated into five different parts, starting from the generation of waste, storage of waste, collection of waste and transportation to the disposal of waste [24].

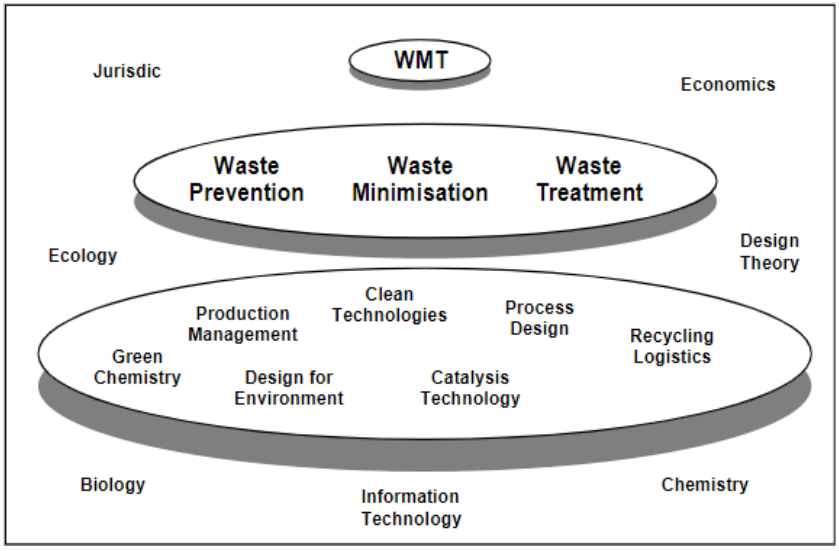
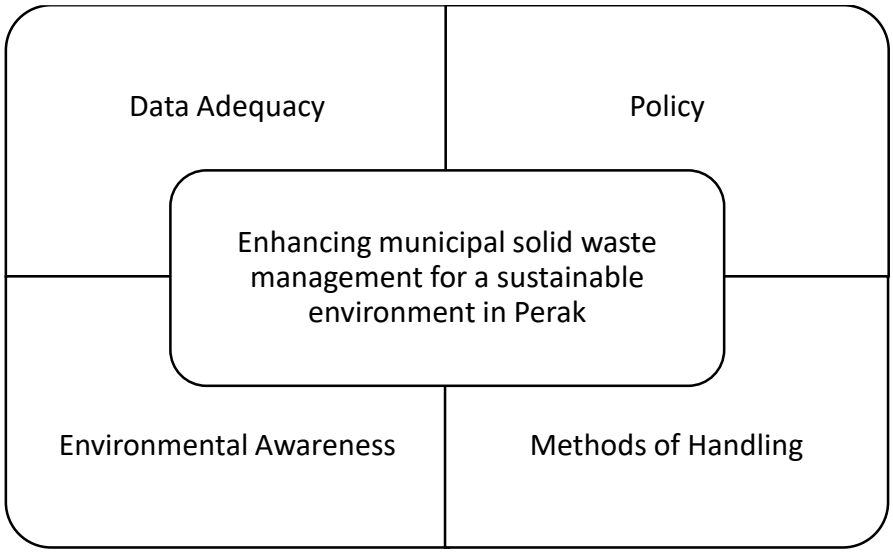


Fig. 2. Composition of Waste Management theory (WMT) [39]

1.1 Background and Issues

Landfill approach is a common yet unsustainable way of managing municipal solid waste. In spite of the convenience, it can cause undesirable effects to the environment and community. Most importantly, the space availability for landfill in Malaysia has become more limited that can no longer be brushed aside. As such, the authorities face challenges in seeking long-term alternatives to better deal with them [61]. Municipal solid waste causes tremendous environmental consequences to the community. The growing weight of waste in Malaysia has caused land going scarce as landfilling is always the main method of waste disposal (80 per cent) for its convenience [1]. Wahidah and Ghafar [59] reports that environment degradation will become more severe as greenhouse gases emission is likely to increase to 50% by 2020 given that landfill being chosen as the main choice for a long period. Other than limited landfill space, the local councils also faces lack of sophisticated art of technology, manpower and infrastructure to curb the issue efficiently and effectively in Malaysia [59]. It is also found that pre-treatment to the disposal is not conducted such as lining system, gas venting and leachate treatment which make the land sites currently in a critical condition [26]. Besides, improper treatment of the dumpsites have also caused undesirable impact that bad odor and toxic gas are released around the areas, which is environmentally hazardous to the population nearby [1].

Research Framework (Developed for Research)



In this research paper, there are two specific objectives which assist the researchers in enhancing the findings. The first objective is to identify the factors affecting the effective implementation of municipal solid waste management system while the second objective is to determine effective solutions in enhancing municipal solid waste management system. The objectives are deliberated using a conceptual framework developed solely for the purpose of this research to guide in identifying the themes from the data collected.

2. Literature Review

2.1 Enhancing Municipal Solid Waste Management System

There is a need to enhance existing municipal solid waste management system in every country because MSW brings detrimental impacts to social, economy and environment [56]. In Malaysia, the government is looking for the most eco-friendly solutions for basic problems of municipal solid waste management which can be accepted by the citizens alike. According to Alias [2], there will be 10.9 million tons of MSW generated in coming 2020. This calls for the enhancement of MSW management in Malaysia to sustain the environment. Landfilling should not be the only way as the heavy reliance on this method will jeopardize the situation. Moreover, issues such as foul smells, emission of greenhouse gases and vermin infestation are mainly caused by landfilling [31]. Therefore, an optimal waste management system should be adopted in order to achieve sustainability.

2.2 Data Adequacy

Data adequacy here refers to the needed and related information being sufficient for the purpose concerned. Without enough data being made available, it could pose challenges to the government authorities in identifying the root causes so as to implementing the right solutions in response. According to Kouloughli and Kanfoud [30], information on the amount of waste generation yearly is an important indicator of municipal solid waste management especially the lifespan of landfill sites. Based on the data, the authorities will be able to undertake proper solid waste management services to overcome the problem [18]. Besides, information on waste generated and its sources from each region shall be collected as it helps the authorities to do proper monitor and control of the waste

management. The figures will be vary depend on the size of that particular region and economic standards [51] as well as the characteristics of the solid waste. To achieve data adequacy, it requires collective actions at all levels which means that industries, stakeholders and the government shall share the respective data on a regular basis so as to ensure the waste operations are under control [50].

2.3 Policy

Policy can be a powerful tool towards more sustainable municipal solid waste management practices. To explain, financial instruments can be adopted effectively so as to achieve meaningful behavioral changes [46]. Therefore, the government can consider to reflect real costs of natural resources in prices by charging economic incentives on the public so that they will concern more on municipal solid waste management [58]. Economic incentives here refer to taxes, fees and subsidies. Continuing from that, regulation also plays a strategic role for the effective municipal solid waste management system. It is comprised of laws, standards, or mandatory management plans to restrict the negative behaviors that affect municipal solid waste. Those who fail to obey the set regulations will be imposed penalties. Huffman [25] provides that France has come out with The National Pact against solid Waste that lists 11 measures to bring down the total solid waste to approximately 50 percent by 2025. Also, it is important to construct well-defined regulations in which constant review and elimination of ineffective municipal solid waste related policies shall be conducted [8].

2.4 Methods of Handling

There are several municipal solid waste handling methods in the world, and to select to methods that suit the country, it involves considerations from wide aspects consisting health, safety, environmental, social, economic and operational risk issues. They need to select the right strategies that are capable to contribute least impacts to the mentioned factors [29]. According to Brunner [6], there are two goals of solid waste management before the word 'sustainability' becomes the buzzword. First off, it is the hygienic considerations for the environment and the second one is to protect human and the environment. There is another purpose of waste management which is more concerned by people today, that is, conservation of resources. Furthermore, according to Sharholy [52], there is an alternative way to handling the municipal solid waste other than landfilling and incineration. It is the innovation derived from incineration, called 'gasification technology'. This process is run by incinerating municipal solid waste but under the condition of oxygen being deficient. Composting food waste is another more attractive method that can be adopted in Malaysia. Saheri, *et al*., [49] believed that by composting food waste, it can be advantageous in decreasing the total amount of MSW, transportation cost spent to deliver the waste to the final disposal, lengthier the landfills lifespan and reducing land use.

2.5 Environmental Awareness

Environmental awareness means being aware of the worth of protecting natural environment and of the reasons that cause environmental degradation to date. Solid waste is interrelated to ecological impacts; a lack of mindfulness will threaten the municipal solid waste issues and so does the environment [20,44,54]. Nonetheless, improving awareness can certainly help the public to be acknowledged with the current issue also, alter their attitudes and minimize barriers at individual stage [17]. Bad human environmental awareness and behavior can bring negative impacts to the

current lifestyle. It is very important to build up a community with a positive and good environmental awareness. Next, according to Desa*, et al*., [13] they clarified that the waste can be used in one-way or another, not all the materials are useless when come to disposal. From customers' perspectives, it is of utmost importance to enlighten such consciousness especially among households. What may has been failing the MSW management is probably due to those who face awareness deficiencies as they are more likely to have ineffective planning and practices. For example, they assume that environment will not affected by feeding the surplus to animals or simply composting the waste on ground [20,38].

2.6 Academic Theory

Waste management theory (WMT) is a theory that emphasizes on reducing the total waste generated by the people. The goal of Theory of Waste Management is to have a deeper insight on waste minimization in reducing harms that affect human health and the environment. Furthermore, WMT also provides a better understanding on the conceptual analysis of waste, the activity and how to minimize the waste through a sustainable approach [43]. As time follows, the waste generation rate will gradually increase with the rising population growth. It poses a notable challenge owing to the fact that land in Malaysia is getting scarce. This is a serious matter when waste has nowhere to be dumped properly. Therefore, scholars designed a theory named WMT which is used to develop an intrinsic solution for the ongoing generation of waste. The theory aims to achieve a sustainable waste management system as well as to attain the environment sustainability. According to Phillips, *et al*., [42], in order to build up a sustainable waste management system, the crucial factor is reducing the waste especially the waste at source. In this theory, waste management is defined as a set of actions from the beginning of the collection of waste until the after-care of waste at the sites of waste disposal. The activities include collection, transport, recovery and operation. Furthermore, the overall management also involves with strategic planning, variety of selections in handling waste, prevention of the pollution of environment and conservation of resources, deciding on the most suitable handling choice with the concern of 'sustainable' effects [43].

3. Research Methodology

3.1 Research Method

The research adopted a case study approach. Case study, as posited by Creswell [11], consists in studying on one or more cases with the use of multiple sources of reliable and necessary data of that phenomenon.

3.2 Sampling Design

3.2.1 Target participants and locations

The target participants of this research were the local councils from three selected sites with different structures and jurisdictions in Perak. This was to collect data on how the authorities manage the municipal solid waste at different levels, from district, town to city. Due to confidentiality, they are named as councils A, B and C respectively.

3.2.2 Sampling method and procedure

In this qualitative research, purposive sampling was employed. This technique allowed the researchers to choose individuals who are able to purposefully inform an interpretation of the research problem [12]. In this study, the local councils responsible for MSW management from three different jurisdictions were chosen as they are information-rich to provide a deeper reflection on the central phenomenon in Perak.

According to Marshall and Rossman [32], interviews using an open and semi-structured approach gain more information during the process. As such, certain questions were prepared beforehand as a guide to further the inquiries. They are generally open-ended and focus in regards to the research problems to yield more detailed information. Furthermore, interviews were digitally recorded and transcribed verbatim or into hard copy formats. Inscribed notes were jotted down for additional notation during the interviews but not for the entirety, because asking questions and writing concurrently can affect effectiveness of data collection.

3.3 Data Analysis

In qualitative research, this step includes preparing and organizing the data collected for analysis and displaying the findings in tables, figures or a discussion [11]. It is followed by developing significant statements from different sources and group them into "meaning units". Next, data of "what" and "how" the phenomenon is experienced is then interpreted and represented in desired forms, typically in a long paragraph or contexts. Below is figure of the flow of data analysis and representation in a qualitative study according to Creswell [11].

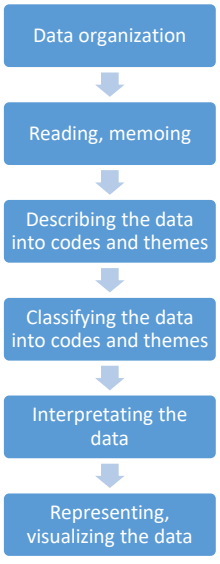


Fig. 3. Data Analysis and representation

3.4 Data Validation

Member checking is used to increase credibility recommended by Creswell [12]. It is conducted post-interview and analysis in which follow-up questions and editorial write-up of the interview answers were sent via e-mail to the respondents for clarification and concurred by them.

4. Findings

4.1 Challenges, solutions and plans by local councils

Council A (District Level)

Factor	Challenges	Solutions and Plans
1) Data Adequacy	- Insufficient data source. There is not enough detail compilation and analysis of data on current status of waste generation, waste source and waste composition in the state. Most local authorities rely on the studies done by federal government on selected urban and sub-urban areas. But different geography, population density, income level, consumption pattern, lifestyle and economic activities make the data not really relevant. Comprehensive localized waste data and information is important as inputs for the development of Action Plan. - Expensive and time-consuming to obtain periodic updates of data. - Increasing complexity of waste stream. Consumer items, for example, electrical and electronic equipment, household cleaning agents, medicines, lubricant oil and packaging material, all contribute to new type of waste that are hazardous. Small amount may cause damage to human health and the environment.	Non available and the current juncture
2) Policy	- Lack of enforcement. - Lack of continuous effort in promoting green activities.	- Dasar Kebersihan Negara to be implemented in coming May. It is an idea in transforming trash into gold. To explain, we often see garbage as something of no value and hence many do not pay much attention to it. Therefore, the authorities plan to change the mindset of the community towards the waste. One is by increasing the salary of a cleaner so that it helps to grow passion in the worker in his job leading to a more productive performance. - Extended Producer Responsibility (EPR) is another policy that will be imposed in future. It is a concept where the producers and importers of certain products are given significant responsibility in tackling litter. One approach they can do is by rewarding those who engage in recycling activities. For example, the customers will be given monetary rewards when they returned the recycled items like Styrofoam or polystyrene in the packaging of a new television

			back to the seller. The government will impose lower tax on those who practices EPR in their business. - Privatization. Act 672 is part of the Federal Law to regulate the solid waste and public cleansing management. Once the local councils accept the Act, it means that the Federal government will take over all responsibilities on MSW management. Some significant changes will take place, take one, it is the standardization of dustbins. Very obvious, the dustbins in Perak are not standardized in terms of size and designs. The waste collection process will become more efficient and effective with the standardization of dustbins. This is because workers will just have to push the designed bins and repeat the same handling process and over time, it speeds up the work. Some states have privatized MSW management. For example, the central area in Malaysia, Pahang, has been taken by Alam Flora.
3)	Methods of handling	- Financial and hardware issue for final disposal system. Hardware here refers to logistics. - Insufficient technologies and facilities. - Insufficient financial support from government. - Lack of internal fund. - Land scarcity.	- Centralization of landfilling sites. There are a total of 13 landfilling sites in Perak. This means 13 are causing troubles – water pollution, land scarcity, financing and technology. In location A, the landfill site will only have another remaining 20 years to go while the open dumping site in location C will last for 5 years or less. The government will be able to improve better capability in the investment of high technology to better manage the landfills as well as adopting other possible advanced method for the waste management. - Adoption of other disposal methods such as anaerobic digester, which is a method of transforming waste into energy. - Upgrade of final disposal system.
4)	Environmental awareness	- Attitude of the community. Most often, people tend to direct the responsibilities of managing waste to the local authorities and sending out complaints whenever some localities are unclean. Nonetheless, it should be inexcusable to say that they are parts of the forces and should bond together in ensuring local environmental quality. What residents can help is by regularly organizing community clean-ups in the neighborhood, rather than behaving persnickety and NIMBY. NIMBY stands for “Not in My Back Yard” and the nuance is about acting out selfish and cares only on own interest within own localities.	- Continuous promotion on green practices. This is to ensure that the people are constantly reminded to engage in green-related activities. - Waste segregation and 3R campaigns. Instead of all waste go to landfills, some should have been segregated and treated in the more proper way such as recycling and composting according to the respective composition. This is also beneficial in lengthening the lifespan of the landfilling sites.

	- Lack of commitment. Another example is the fast food giants like McDonald and KFC which begin phase-out of plastics lids and to go straw-free. The final results, however, is not effective. This is owing to the fact that they are still handling out the plastics items upon request and for takeaways. - Increasing volume of the MSW due to urbanization and lifestyle. As the population growth rate in the country becomes higher, the waste production is brought up and further deteriorated because of consumer lifestyle. As a matter of fact, the majority tend to forgo contemplation of how the community has turned into and what it ought to be in pursuit of the moral lifestyle.	

Council B (Town level)

Factors	Challenges	Solutions and Plans
1) Data Adequacy	- No proper weighing tool or system for waste amount. The figures are estimated based on the number of lorry that goes to the dumping area. To explain, the council obtains the volume based on the number of lorry that goes to the dumping area - Lack of data source. There is no mechanisms or way to get detailed data.	- Implementation of advanced technologies and systems.
2) Policy	- Lack of enforcement. The council do not have specific policies and guidelines on MSW management, thus no clear directions on how to enhance it.	- Compound system. Whoever simply throws litter at improper places will be advised and summoned a fine. For illegal dumping areas, a signboard bearing a warning is placed.
3) Methods of handling	- Insufficient technologies and facilities. - Insufficient financial support from government. - Lack of internal budget. - Limited lifespan of existing disposal sites. - No proper disposal treatment.	- Build a complete sanitary landfill with proper after-care treatment as currently, the council only uses open dumping without treatment. - Joint venture with educational institution to compost waste from wet markets. This has been started since 2018 but at very small scale. The waste will be delivered to the college once it reaches certain capacity. - Implementation of advanced technologies and systems to upgrade the final disposal site.
4) Environmental awareness	- Attitude of the community. - Illegal dumping.	- Weekly 3R campaigns at different residential areas. Unwanted items which can be recycled will be collected and clean-up is conducted together with the local citizens. A notice will be

		given to the residents on Wednesday and the activities runs on Friday. This is to allow the residents to have ample time in preparing and sorting the recycled goods.

Council C (City Level)

Factors	Challenges	Solutions and Plans
1) Data Adequacy	- Lack of data source.	- Implementation of advanced technologies and systems.
2) Policy	- Lack of enforcement.	- Warning and compound system. First caught, the person will be warned and after that, he or she will be compounded. - Strengthening enforcement to effectively control people's behaviors. - Regular patrolling by anti-litter teams who wear normal shirts disguising as normal citizens.
3) Methods of handling	- Insufficient technologies and facilities. - Insufficient financing capability. - Limited land availability.	- Implementation of advanced technologies and systems.
4) Environmental awareness	- Lack of cooperation by the residents regarding the waste collection schedule and types of waste such as bulky waste. - Increasing illegal dumping hotspots of 1300 over. - Extensive reliance on government. The council claims that enhancing MSW management should be not solely rely on the government. Everyone should work together and be committed. - Low participation rate in 3R campaigns and waste segregation activities.	- Early and constant education to raise environmental thoughtfulness as the sustainable approach. - Continuous efforts in promoting green activities. - Giving out free rubbish bins to residential areas. This is still on the first phase and under observation. This aids in reduce cases like missing bins and illegal dumping. A contractor has provided the citizens free bins for every single house in Gugusan Manjoi and as of now, zero complaints are received from the residents.

5. Discussion and Recommendations

5.1 Data adequacy

Actions	Explanations
Collaboration with stakeholders	Collaborating with business organizations and social sectors allows acquisition of the needed data [48]. This can reduce complexity of data acquisition if the government were to analyze each sector by themselves. Credible data on exact waste amount and its composition provides a solid basis to effective MSW management (Ravindra, et al., 2015) [45].
Upgrade of weighing system	In the study by Ojowuro, *et al.*, [41], it is mentioned that MSW composition data is necessary for the management authorities to determine equipment needs. Council A averred that there should be detail compilation and analysis of current waste generation, waste source and waste composition including 'time and motion study' of the collection and transportation.

5.2 Policy

Actions	Explanations
Eco-friendly substitutes	Reusable plastic containers are placed at large-scale stores and event venues and the emergence of eco-business bring a total reduction of waste by 60% at stadiums [48]. In the State of Qatar, eco-friendly substitutes will be introduced in the market to reduce manufacturing of plastic [14,34].
Economic Instruments	Taxation to single-use shopping bags is imposed on consumers in Ireland since 2002, on manufacturers in Denmark and tax revenue gained from this initiative is contributed to the country's wealth [48]. Banerjee and Sarkhel [4] in their reports envisaged that the effectiveness of MSW management can be enhanced with the presence of economic instruments.
Privatization	Perak councils are yet to accept Act 672. If MSW management is privatized, there will be some changes such as standardization of bin. The standardization of bins is deemed to be beneficial in terms of reduced spillage and improved handling process in collecting waste.
Extended Producer Responsibility (EPR)	It is a policy approach in which manufacturers or importer extend their responsibility for proper disposal of the products sold [40]. In China, a series of policies has been issued based on EPR to promote e-waste management system for improved resource utilization and environmental protection [7]. Ritcher and Koppejan [47] in their report asserted that EPR adoption not only aids in fostering recycling of waste but paving way for a more circular economy. Besides, it is also regarded as one of the major waste management legislations by European Union to fight against plastic waste and pollution [19].
Enforcement on Circular Economy and Basel Convention	Circular Economy represents a more sustainable model to the linear economy where the value of resources is maintained as long as possible in the cycle through reuse, repair, recycled and the like [15]. The concept of CE should be developed among the public including consumers, business organizations and local councils to have better understandings to overcome the escalating waste crisis. Economic will benefit from circulating resources, mitigation of supply risks, strong land productivity, nurturing innovation and employment creation leading to a competitive economy [10]. Basel Convention is an international treaty in which its thrust is to protect social health and environment against the negative impacts caused by hazardous wastes. It aims to minimize hazardous waste and is useful to combat NIMBY [5].

5.3 Methods of handling

Actions	Explanation
Development of technologies and facilities	Gupta, *et al*., [21] in their study mentioned that a smart based waste management is growing to become the ultimate need in both developing and developed countries to curb the ever-increasing waste. To abate with the use of landfills, Istrate, et al. (2019) [27] suggest to develop MSW incineration facilities while it also benefits in waste-to-energy generation specifically the electricity. Infrastructure and data sharing technologies plays the significant role to facilitate full visibility of product lifecycle data and to investigate waste management problems, which helps in minimizing waste [16].
Centralization of disposal sites	Sun, *et al*., [55] believed that an integrated MSW system equipped with different technologies is more efficient to improve waste-to-energy rate, leading to a low carbon society. It is supported by another study by Anwar, *et al*., [3] with the results claiming that incorporating several

	technologies of waste treatment at a centralized center is far more efficient and effective especially in terms of attaining net profit compared to the clustered systems and the decentralized, which are similar to current practices in Malaysia.

5.4 Environmental Awareness

Actions	Explanation
Disclosure of information to stakeholders	The fact that landfilling sites is going scarce is not known by many. If this information is disclosed to the people, it can act as a catalyst in encouraging people to actively involving in green-related activities. The people will start doing something when they are well aware of the seriousness of the issues.
Continuous efforts in enhancing awareness	To improve awareness and engagement of stakeholders, continuous actions should be developed for the basis of sustainable growth [57]. The authorities should actively promote 3R campaigns, waste segregation activities and the like to achieve a recycling-based society and ensuring people adhere to the green policies [53]. The people should be constantly reminded of the latest environmental situation and how they can help for a sustainable environment.

5.5 Implication of study

Overall, the research results reveal that the identified factors have an effect on the desired outcome in this study, further supported by data from literature reviews. Data adequacy, policy, methods of handling and environmental awareness are of imperative towards enhancing MSW management for a sustainable environment. Whatever management it is, quality data is a valuable resource to the authorities to draw alternatives for further analysis and study. That is why the researchers see data adequacy as one of the important element or assets to accomplish desired outcome. The same goes to other factors. Well-defined policy acts as a guideline to monitor and control the people in managing waste. Besides, how waste is handled from its inception to its final disposal, in tandem with environmental awareness, can create a hotbed for innovation in enhancing waste management responsibly.

5.6 Conclusion

This study has provided insights into the challenges of MSW management based in local councils in Perak. Enhancing MSW management is crucial for a sustainable environment, and it should be a both government-centric and citizen-centric process. With adequate waste-related data, well defined policies, advanced methods of handling and environmental awareness, it can help to augment the effectiveness in enhancing MSW management for a greener Perak. The results can be further enhanced by gathering more information from other councils. Additionally, future researchers are suggested to construct similar research problem at different locations or from different perspectives so as to acquiring deeper knowledge about the discussed issue.

References

[1] Hamid, Abd, Khairul Bariyah, Mohd Yusoff Ishak, and Mohd Armi Abu Samah. "Analysis of Municipal Solid Waste Generation and Composition at Administrative Building Café in Universiti Putra Malaysia: A Case Study." *Polish Journal of Environmental Studies* 24, no. 5 (2015).

[2] Alias, A. Y. (2010) Amal kitar semula. Berita Harian (January 27), Shah Alam.

[3] Anwar, S., S. Elagroudy, M. Abdel Razik, A. Gaber, C. P. C. Bong, and W. S. Ho. "Optimization of solid waste management in rural villages of developing countries." *Clean Technologies and Environmental Policy* 20, no. 3 (2018): 489-502.

[4] Banerjee, Somdutta, and Prasenjit Sarkhel. "Municipal solid waste management, household and local government participation: a cross country analysis." *Journal of Environmental Planning and Management* (2019): 1-26.

[5] Basel Convention (2011) Retrieved from http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx
[6] Brunner, Paul H., and Helmut Rechberger. "Waste to energy–key element for sustainable waste management." *Waste management* 37 (2015): 3-12.
[7] Cao, Jian, Bo Lu, Yangyang Chen, Xuemei Zhang, Guangshu Zhai, Gengui Zhou, Boxin Jiang, and Jerald L. Schnoor. "Extended producer responsibility system in China improves e-waste recycling: Government policies, enterprise, and public awareness." *Renewable and Sustainable Energy Reviews* 62 (2016): 882-894.
[8] Chalak, Ali, Chaza Abou-Daher, Jad Chaaban, and Mohamad G. Abiad. "The global economic and regulatory determinants of household food waste generation: A cross-country analysis." *Waste management* 48 (2016): 418-422.
[9] Chatsiwa, J., Mujere, N., Maiyana, A.B. 2016. Municipal Solid Waste Management. Handbook of Research on Waste Management Techniques for Sustainability.
[10] Cholifihani, M. (2018). Mitigating the adverse impacts of the circular economy: Implementation and role of governments. In Anbumozhi, Venkatachalam and F. Kimura (Eds.), *Industry 4.0: Empowering ASEAN for the Circular Economy* (pp.261-283). Jakarta: ERIA.
[11] Creswell, J.W. (2013). *Qualitative inquiry and research design: choosing among five approaches. 3rd ed*. United States of America: Vicki Knight.
[12] Creswell, J.W. (2017). *CUSTOM: CEC Edition Qualitative Inquiry and Research Design 3e.* SAGE Publications.
[13] Desa, Asmawati, Nor Ba'yah Abd Kadir, and Fatimah Yusooff. "Environmental Awareness and Education: A Key Approach to Solid Waste Management (SWM)–A Case Study of a University in Malaysia." (2013).
[14] DohaNews. (2017, November 23). Environmental group to launch 'say no to plastic bags' campaign in Qatar.
[15] EC, 2018. Report on critical raw materials and the circular economy: (180116 CRM and Circular Economy Report.pdf.) (b) [pdf] Europe: European Commission. https://content.sciendo.com/view/journals/oszn/29/4/article-p16.xml
[16] Esmaeilian, Behzad, Ben Wang, Kemper Lewis, Fabio Duarte, Carlo Ratti, and Sara Behdad. "The future of waste management in smart and sustainable cities: A review and concept paper." *Waste management* 81 (2018): 177-195.
[17] Evans, David, Andrew McMeekin, and Dale Southerton. "Sustainable consumption, behaviour change policies and theories of practice." (2012).
[18] Fauziah, S. H., and P. Agamuthu. "Trends in sustainable landfilling in Malaysia, a developing country." *Waste Management & Research* 30, no. 7 (2012): 656-663.
[19] Leal Filho, Walter, Ulla Saari, Mariia Fedoruk, Arvo Iital, Harri Moora, Marija Klöga, and Viktoria Voronova. "An overview of the problems posed by plastic products and the role of extended producer responsibility in Europe." *Journal of cleaner production* 214 (2019): 550-558.
[20] Graham-Rowe, Ella, Donna C. Jessop, and Paul Sparks. "Identifying motivations and barriers to minimising household food waste." *Resources, conservation and recycling* 84 (2014): 15-23.
[21] Gupta, Praveen Kumar, Vidhya Shree, Lingayya Hiremath, and Sindhu Rajendran. "The Use of Modern Technology in Smart Waste Management and Recycling: Artificial Intelligence and Machine Learning." In *Recent Advances in Computational Intelligence*, pp. 173-188. Springer, Cham, 2019.
[22] Gustavsson, Jenny, Christel Cederberg, Ulf Sonesson, Robert Van Otterdijk, and Alexandre Meybeck. *Global food losses and food waste*. Rome: FAO, 2011.
[23] Hahladakis, John N., and Hareb Mohammed SJ Aljabri. "Delineating the plastic waste status in the State of Qatar: Potential opportunities, recovery and recycling routes." *Science of The Total Environment* 653 (2019): 294-299.
[24] Hoornweg, Daniel, and Perinaz Bhada-Tata. *What a waste: a global review of solid waste management*. Vol. 15. World Bank, Washington, DC, 2012.
[25] Huffman, M. 2015. Fighting hunger and reducing waste. Feeding America. [online]
[26] smail, Sharifah Norkhadijah Syed, and Latifah Abd Manaf. "The challenge of future landfill: A case study of Malaysia." *Journal of Toxicology* 5, no. 3 (2013): 2400-2407.
[27] strate, Ioan-Robert, Diego García-Gusano, Diego Iribarren, and Javier Dufour. "Long-term opportunities for electricity production through municipal solid waste incineration when internalising external costs." *Journal of cleaner production* 215 (2019): 870-877.
[28] Jereme, Innocent A., Basri Abdul Talib, Chamhuri Siwar, and Rawshan Ara Begum. "Household food consumption and disposal behaviour in Malaysia." *Social Sciences (Pakistan)* 8, no. 6 (2013): 533-539.
[29] Knipe, A. D., 2005. The management of household food waste. Environmental Research and Consultancy. West Morden, United Kingdom.
[30] Kouloughli, Salim, and Salah Kanfoud. "Municipal solid waste management in constantine, Algeria." *J. Geosci. Environ. Prot*5, no. 01 (2017): 85-93.

[31] Lee, Suk-Hui, Ki-In Choi, Masahiro Osako, and Jong-In Dong. "Evaluation of environmental burdens caused by changes of food waste management systems in Seoul, Korea." *Science of the Total Environment* 387, no. 1-3 (2007): 42-53.
[32] Lim, W. J., N. L. Chin, A. Y. Yusof, A. Yahya, and T. P. Tee. "Food waste handling in Malaysia and comparison with other Asian countries." *International Food Research Journal* 23 (2016).
[33] Marshall, C. & Rossman, G. B. (2010). *Designing Qualitative Research (5th ed.).* Thousand Oaks, CA: Sage Publications.
[34] MEP, 2017. Plastics recycling comes to Qatar.
[35] Moh, Yiing Chiee, and Latifah Abd Manaf. "Overview of household solid waste recycling policy status and challenges in Malaysia." *Resources, Conservation and Recycling* 82 (2014): 50-61.
[36] Mrowiec, Bozena. "Plastics in the circular economy (CE)." *Environmental Protection and Natural Resources; The Journal of Institute of Environmental Protection-National Research Institute.* 29, no. 4 (2018): 16-19.
[37] Nahman, Anton, and Willem de Lange. "Costs of food waste along the value chain: Evidence from South Africa." *Waste Management* 33, no. 11 (2013): 2493-2500.
[38] Neff, Roni A., Marie L. Spiker, and Patricia L. Truant. "Wasted food: US consumers' reported awareness, attitudes, and behaviors." *PloS one* 10, no. 6 (2015): e0127881.
[39] Nurminen, Jani, and Eva Pongrácz. "Conceptual model of environmental management system (EMS) of reversed information streams." In *Proc. Waste Minimization and Resources Use Optimization Conference*, p. 6981. 2004.
[40] OECD home: extended producer responsibility. (2019). Retrieved from http://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm
[41] Ojowuro, O. M., B. Olowe, and A. S. Aremu. "Characterization of Municipal Solid Wastes from Lagos Metropolis, Nigeria." In *Waste Management and Resource Efficiency*, pp. 159-166. Springer, Singapore, 2019.
[42] Phillips, Paul S., Paul Clarkson, Nicholas J. Barnes, and Julie Adams. "A UK county sustainable waste management program." *International Journal of Environment and Sustainable Development* 1, no. 1 (2002): 2-19.
[43] Pongrácz, Eva, Paul S. Phillips, and Riitta L. Keiski. "Evolving the Theory of Waste Management: defining key concepts." *WIT Transactions on Ecology and the Environment* 78 (2004).
[44] Quested, Tom E., Emma Marsh, Daniel Stunell, and Andrew D. Parry. "Spaghetti soup: The complex world of food waste behaviours." *Resources, Conservation and Recycling* 79 (2013): 43-51.
[45] Ravindra, Khaiwal, Kamalpreet Kaur, and Suman Mor. "System analysis of municipal solid waste management in Chandigarh and minimization practices for cleaner emissions." *Journal of Cleaner production* 89 (2015): 251-256.
[46] Reisch, Lucia, Ulrike Eberle, and Sylvia Lorek. "Sustainable food consumption: an overview of contemporary issues and policies." *Sustainability: Science, Practice and Policy* 9, no. 2 (2013): 7-25.
[47] Richter, Jessika Luth, and Rob Koppejan. "Extended producer responsibility for lamps in Nordic countries: best practices and challenges in closing material loops." *Journal of Cleaner Production* 123 (2016): 167-179.
[48] Ryoko, S. and Yasuhiko, H. (2013). *Best practices and recommendations for waste reduction towards sustainable consumption.* Retrieved from http://www.foejapan.org/en/waste/policy/pdf/140227.pdf
[49] Saheri, Sanaz, Masoud Aghajani Mir, Noor Ezlin Ahmad Basri, Rawsan Ara Begum, and Noor Zalina Binti Mahmood. "Solid waste management by considering composting potential in Malaysia toward a green country." *e-BANGI* 4, no. 2 (2009): 8
[50] Mouhoun-Chouaki, Saïda, Arezki Derridj, Djaber Tazdaït, and Rym Salah-Tazdaït. "A Study of the Impact of Municipal Solid Waste on Some Soil Physicochemical Properties: The Case of the Landfill of Ain-El-Hammam Municipality, Algeria." *Applied and Environmental Soil Science* 2019 (2019).
[51] Samsudin, Mohd Dinie Muhaimin, and Mashitah Mat Don. "Municipal solid waste management in Malaysia: current practices, challenges and prospects." *Jurnal Teknologi* 62, no. 1 (2013).
[52] Sharholy, Mufeed, Kafeel Ahmad, Gauhar Mahmood, and R. C. Trivedi. "Municipal solid waste management in Indian cities–A review." *Waste management* 28, no. 2 (2008): 459-467.
[53] Taur, Shubham, Sagar Sonawane, Rahi Dhengale, and Nirmal Singh4 Kalpesh Sonawane. "Experimental Evaluation of Incorporating Dry Sludge in Cement Concrete." *Experimental Evaluation of Incorporating Dry Sludge in Cement Concrete* 3, no. 6 (2018).
[54] Stefan, Violeta, Erica van Herpen, Ana Alina Tudoran, and Liisa Lähteenmäki. "Avoiding food waste by Romanian consumers: The importance of planning and shopping routines." *Food Quality and Preference* 28, no. 1 (2013): 375-381.
[55] Sun, Lu, Minoru Fujii, Tomohiro Tasaki, Huijuan Dong, and Satoshi Ohnishi. "Improving waste to energy rate by promoting an integrated municipal solid-waste management system." *Resources, Conservation and Recycling* 136 (2018): 289-296.
[56] Sylvia Adipah, Ofotsu Nana Kwame. A Novel Introduction of Municipal Solid Waste Management. Journal of Environmental Science and Public Health 3 (2019): 147-157

[57] The Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. (2010). Thematic strategy on the prevention and recycling of waste. Brussels, xxx: European Commission.
[58] UNEP. 2014. Annual Report. https://wedocs.unep.org/bitstream/handle/20.500.11822/9420/-UNEP_2014_Annual_Report2015UNEP_Annual_Report_2014_Production_LQ.pdf.pdf?sequence=3& isAllowed=y
[59] Wahidah, S. and Ghafar, A. (2017). Food Waste in Malaysia: Trends, Current Practices and Key Challenges. http://ap.fftc.agnet.org/files/ap_policy/774/774_1.pdf
[60] Moh, Yiing Chiee, and Latifah Abd Manaf. "Overview of household solid waste recycling policy status and challenges in Malaysia." *Resources, Conservation and Recycling* 82 (2014): 50-61.
[61] Zainu, Zaipul Anwar, and Ahmad Rahman Songip. "Policies, challenges and strategies for Municipal waste management in Malaysia." *Journal of Science, Technology and Innovation Policy* 3, no. 1 (2017).
[62] Zhang, Cunsheng, Haijia Su, Jan Baeyens, and Tianwei Tan. "Reviewing the anaerobic digestion of food waste for biogas production." *Renewable and Sustainable Energy Reviews* 38 (2014): 383-392.