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FOOD WASTE COMPOSTING: A SUSTAINABLE WORKABLE SOLUTION FOR FOOD WASTE MANAGEMENT IN MALAYSIA.

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Abstract

Food waste has significant environmental consequences in addition to economic costs. Food waste consumes the resources necessary to grow, produce, and distribute it to customers, as well as emitting greenhouse gases that contribute to climate change. The average monthly cost of treating food waste incurred by each Malaysian household is likely to increase from RM210 to RM400 by 2025 if food waste is not managed properly. Malaysians produce an estimated 24% or 4,046 tonnes of avoidable food waste out of 17,000 tonnes of food waste. Considering the severity of the situation, the main objective of this paper is to provide a solution to reduce food waste in Malaysian landfills by providing a workable and affordable food composting system to homes, restaurants and hotels. Food composting has various benefits where the compost can reduce or replace the use of chemical fertilizers. The successful implementation of food waste composting solutions can provide a positive impact to the environment, economy, and society directly and indirectly. This is a form of circular economy that would sustain the business and household and make it profitable and beneficial to the society and the environment in the long term. The proposed method involves several components, which are food waste separation, container for temporary storage on-site, compost pick up to be sent to a central compost facility, central compost facility, and distribution to farmers. For this solution to succeed, there are three aspects to focus on. Firstly, instilling awareness to get the buy-in from business owners and households. Other than that, the composting system must be cost-efficient and easy to use. Lastly, there should be concerted efforts from government, industry players and society to ensure the success of the project. To start the initiatives, the government can set a policy to encourage food composting such as subsidies and tax-cuts. And hotel and restaurants should invest in the project and involvement of society would accelerate the success of the implementation of this project.

Keywords: *Food Industry, Composting, Green Environment, Sustainable, Zero Waste*

INTRODUCTION

According to Housing and Local Government Minister Datuk Seri Reezal Merican Naina Merican, food waste disposal costs Malaysian households on average RM210 per month, or RM2,600 per year. The cost of treating food waste incurred by each home is likely to reach RM400 by 2025 if food waste is not managed properly. Malaysians produce 38,000 tonnes of solid trash per day, of which roughly 17,000 tonnes is food waste. An estimated 4,046 tonnes, or 24%, is avoidable food waste, according to the report (BERNAMA, 2022).

Food waste has significant environmental consequences in addition to economic costs. Food waste consumes the resources necessary to grow, produce, and distribute it to customers, as well as emitting greenhouse gases that contribute to climate change. Food waste that ends up in the landfills rots and releases methane, a greenhouse gas that is even more potent than carbon dioxide. An important point to highlight is that the Housing and Local Government Ministry reported that there are about 38,699 tonnes of solid waste generated by Malaysians each day. That averages to 1.17kg of solid waste per person daily. Despite the many landfills in Malaysia, it is still not sufficient to accommodate the large amount of trash produced. The landfills have a life expectancy of about 20 to 25 years. However, the landfills in Malaysia will be full at 10 times faster than that, which is about within 2 to 3 years. As the population rises, the amount of solid waste produced is predicted to increase.

Other than food waste reduction and separation as an effective method to manage food waste, it is recommended that food waste management to include conversion of food waste as value-added products (Wong, 2022). Other methods include advanced incinerators. However, according to Fabian & Lou (2019), incinerators came under intense public pressure to protect public health. They made up around 18% of all airborne respirable particles that are hazardous to human health. Furthermore, Food waste from food producers, including those who make beer, soy products, and bread, is turned into animal feed in Singapore. On-site and off-site food waste management treatment technologies are advised for use in other sectors. Food composting is selected as the method in this paper due to the problem of household waste, with focus on residential areas and restaurants as it produces food wastes that go directly to the landfills (Menon, 2022).

Currently, there is no centralized food composting system in Malaysia. It is done in silos at households. Numerous schools have allocated space in the school compound for composting bins; however, it is not fully utilized as usually only a single canteen operator adds on to the bins and the responsibility of managing the compost falls on the contractor that is responsible for landscaping. It increases the number of tasks to respective party and turns out to be unsustainable.

Moving into 2022, switching onto sustainable practices have become our beacon of hope in our effort to combat or reduce the effects of climate changes. Many countries have scrambled to pledge their efforts to achieve a set of sustainable goals. Food waste management is a matter that may look simple but contributes exponentially towards global warming. Moh and Abd Manaf (2014) state that most of the waste in Malaysia comes from municipal solid waste (MSW). MSW consists of food waste, paper, plastics, diapers and more. According to Dato' Dr Nadzri bin Yahaya, the Director General of National Solid Waste Management Department, most of the food waste will end up in the landfills. It is the current waste disposing method of choice for developing countries such as Malaysia where 70% to 90% of our MSW is disposed of in a landfill (Ismail and Manaf, 2013). The problem from this is that Malaysia does not pre-treat its waste before dumping it into the landfill. This can be especially hazardous and harmful as the practice of open dumping the MSW includes the dumping of industrial, public and hospital waste (Hassan et al., 2006). Comparing Germany to Malaysia, Germany pre-treats its MSW by filtering out organic and biodegradable wastes first, therefore ensuring that the mass of their landfill is not as high (Hassan et al., 2006).

According to Johari et al. (2012), landfills in Peninsular Malaysia emitted 310,220 tonnes in 2010. The study has also projected that the methane gas emission will increase to 370,000 tonnes per year by the year of 2020. According to the Ministry of Housing and Local Environment Kuala Lumpur, there is a significant amount (63%) of organic and biodegradable waste that can be extracted out of our MSW.

Challenges of Food Waste Management and The Research Objective

In low- and middle-income countries, landfilling is the most important option for waste disposal methods because it is indeed the easiest and the cheapest way to dispose of waste. However, is it a sustainable choice for the country? Landfills are used to dispose of waste materials that cannot be recycled or reused. They are renowned for causing a wide range of environmental and health issues. One major problem with landfills is contamination. Owing to the lack of financial allocations for this, there is unfortunately a lack of environmental abatement measures that can mitigate the contamination issues caused by landfills. In addition, although proper abatement measures are being placed, there is no guarantee that there will be no contamination. Hence, it is very worrying that if the usage of landfills is not being controlled, they might be built near to housing areas or on agricultural land which is not ideal. An example of contamination caused by landfills is the emission of methane gas which is a potent greenhouse gas that can absorb heat and contribute to climate change. At the same time, landfills also have a negative impact on our biodiversity.

Among developing Asian countries such as Malaysia, Thailand, Vietnam, India, and Indonesia, almost 70-90% of waste is being disposed of in landfills while most European countries have emphasized recycling and incineration as the main waste disposal methods. Developed Asian countries such as Korea and Japan also have proceeded with incineration as their waste disposal method. In Germany for example, the waste is being distributed and treated first where recyclable and biodegradable wastes such as foods will not be sent to the landfills. This then contributes to the steady reduction in the number of operated landfills. Ultimately, the best way to reduce the number of landfills is by reducing the amount of waste produced by recycling.

Recycling allows the wastes to be segregated where the recyclable items can be reused again, and biodegradable wastes can be composted. Based on a paper written by Moh and Abdul Manaf (2014), the biggest portion of waste produced by Malaysians is food waste. Therefore, composting food waste appears to be the most logical method for resolving this issue. However, it is unfortunate that composting is not widely practiced in Malaysia despite its importance. Prior to composting, the wastes should be segregated first as only food waste and biodegradable items can undergo the compost process.

The current compost system in Malaysia requires a lot of work and monitoring processes from the house owner which leads to the low acceptance of the programme. Since the composting is being performed at home, this will lead to unpleasant smells that can disturb the neighbours. If the area is not being treated frequently, it may attract snakes, rats and other pests that can bring diseases. In addition, composting takes a long time hence a large space is needed. However, not every house in Malaysia has spacious backyards. There is also an issue with fire hazards. Based on these drawbacks, it seems only natural for the government to explore other food composting systems that are workable with the situation in Malaysia.

Hence, the most important question that needs to be answered is how to make a system that is more acceptable to our society to ensure a higher acceptance rate. The solution proposed in this study is to create a compost system where the food waste from residential houses and restaurants in Malaysia is separated, stored temporarily at the in-site storage, and collected to the central compost facility where it will be made into fertilizer. Indeed, the Malaysian government has launched programmes for domestic food compost to be used as fertilizers for plantations.

During this program, they provide step by step guides on how to make fertilizers from compost in their backyard. However, as mentioned, this method is unable to be practiced widely in Malaysia. This could be due to the lack of space, the foul smell, and the time it consumed. On the contrary, although the proposed solution has a similar concept to this, the proposed solution is better mainly because the participants do not necessarily have a big

backyard space to store the food waste as it will be collected and the problem with foul smelling compost can be eliminated because the composting is done at the facility, not by the participants. However, this proposed solution will not be a success without the system acceptance, adoption, and support from the government. The objective of this study is to introduce a workable system of composting food waste generated by residential houses and restaurants in Malaysia. This system should be affordable and able to ensure high utilization of composts. To achieve this objective, it is pertinent for the research to answer the research questions:

- How can we reduce food waste in landfills?
- What can be done to make the system more acceptable?
- What can we do to prevent composts from ending up in landfills?

The study is important to fill the gap of finding a sustainable solution of a workable composting system for food waste generated by households, restaurants, and hotels. The daily waste generated in Malaysia consists of 31% to 45% of food waste each day, based on the National Solid Waste Management Department in 2012. This research will provide a solution in reducing this problem which at the same time reduces landfill gas emissions. This study will be able to provide a two-pronged solution for food wastage in Malaysia whereby it reduces solid waste in landfills and converts food waste into organic fertilizers.

Besides that, food waste treatment facilities that exist in Malaysia are not able to treat food waste in large capacities. Based on Wong (2022), even in Hong Kong, the facilities that are set up by the government have a relatively low capacity and a solution by the private sector is needed in order to find an affordable solution to convert food waste to organic fertilizer. Food waste should be seen as a resource rather than something that pollutes and takes up valuable landfill space.

Food Waste Management

Almost one-third of food that is intentionally grown by humans are not consumed and left as waste. There are either proactive approaches or reactive solutions when it comes to managing food waste. Food waste can be managed in a variety of methods such as composting, producing animal feed, sending it to incinerators or as the current practice, sending it straight to the landfills. In general, waste must undergo either recycling or thermal treatment. However, since they can be quite costly and cumbersome, landfill has become the most widely used waste management system.

There are also a selection of composting systems namely bins and in-vessel systems. Bins with wire mesh or wooden frames allow for optimum air circulation, are affordable, and take minimal time to put together. Three chamber bins speed up compost output by allowing for different stages of decomposition. Small amounts of food waste are usually composed in bins (Risse & Faucette, 2017). This three-bin system is capable of handling large amounts of material. It also enables for tiered composting, with one portion dedicated to storing compostable materials, another to active composting, and yet another to drying or finished compost.

Other methods that require little attention and labour include in-vessel systems or aerated containers. Exporting food waste to a central compost facility or a local farmer may be the best solution. Farmers can begin composting their own food waste by employing kitchen leftovers. Farmers can acquire free compost feedstock on a wider scale by putting up a system of collecting it from businesses and organisations and having it delivered to the farm site. Some businesses may pay the farmer to pick it up or drop it off for waste disposal. Farmers can choose the scale that works best for their farming operation (Risse & Faucette, 2017).

In-vessel systems, which use perforated barrels, drums, or specifically constructed containers are easy to use, turn, require little effort, are not weather sensitive, and can be used in urban and public settings. The initial outlay can be substantial, yet handling volumes are usually minimal.

Composting - Issues and Challenges

According to Wong (2022), the challenges faced in adopting food waste composting in Hong Kong households was the low participation rate whereby only 36 out of thousands of housing estates participated. The primary challenges encountered in the application of composting, based on the study, are undesirable odour, maintaining the quality of decomposed items, and a lack of space.

Because of the existence of the bacteria that assist in digesting the food waste in the composting process, such bacteria could spread diseases if the composting bin is not correctly set up. Furthermore, because compost attracts animals such as rats, these rodents may carry diseases. This must be taken into consideration in designing the central composting facility set up to prevent disease spread and to overcome the disadvantages as stated.

The challenges faced are integration of federal government policies, state, and local council policies. Without a blueprint of a long-term plan, the implementation of food waste composting will not be successful. Besides that, the composting initiative will face a stumbling block if there is no allocation of funds for the initial investment of the central composting facility, logistic costs, on site composting bins and maintenance costs in the long run.

Other issues to take into consideration is that quality of food compost depends on the quality of food waste. The central composting facility operators must understand the nature of the food waste compost supplied by household residents and restaurant operators. Some food waste, for example, may contain far more and higher-quality ingredients than others. As a result, the quality of compost can change substantially over time depending on the type of organic waste utilised in its creation.

Besides the literature mentioned in the previous subsection, Le Pera et al. (2022) states that compost will still emit greenhouse gases when it is stored in the open and during transportation. Besides that, the disadvantage of composting is surface or groundwater leaching and runoff during the decomposition process of the (Nkoa, 2014).

Other challenges mentioned in the study by Wong (2022) is the lack of compost outlets led to the compost ending up in landfills. The study stressed the need to view the idea of waste management as resources rather than as waste as stated in Wilson et al. (2015).

PROPOSED IMPLEMENTATION FRAMEWORK

There are two (2) types of food wastage, pre-consumption, and post-consumption wastages. Composting pre-consumer food waste is the simplest. It is just food waste from the preparation process that is never seen by the consumer. Because this food waste is usually separated from the rest of the waste stream, no extra steps are required to keep pollutants out of future compost.

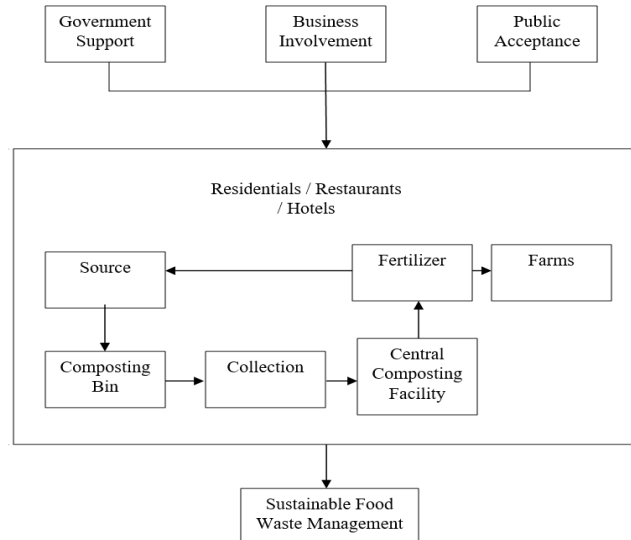
It differs with post-consumer food waste because it is mixed with other types of waste. This makes it more difficult to manage. After a person is done eating, the excess food most likely ends up with other wastes that are not compostable. Therefore, a decision must be made on how to separate food from other garbage.

This can be accomplished by having a separate trash can dedicated solely to food waste. Depending on the feasibility, flexibility, volume, labor, atmosphere, and attitude of the business or institution, either the kitchen staff or the customer can separate it. It could be used as a teaching tool or a way to demonstrate an organization's proactive environmental policy.

Taking into consideration on the change management approach as listed in Figure 1, the proposed framework of implementation is established.

Figure 1

Framework for a sustainable Food Waste Management system



The comprehensive framework proposed in Figure 1, involves government support, involvement from businesses, public acceptance, and a cost-effective composting system.

Governmental Support

As mentioned in the challenges in implementation of food waste management, particularly food waste composting, the success is strongly determined by government support. The initial process of creating a long-term plan requires the government to produce the blueprint of food waste management relating to the goal to reduce solid waste in landfills.

As stated in Wong (2022), the waste blueprint of Hong Kong 2035 identified reducing MSW per capita rate by 40-45% as one of its medium-term goals. The action plan is divided into six areas which are: “Waste Reduction, Waste Separation, Resources, Circulation, Industry Support, Innovation and Cooperation, and Education and Publicity”.

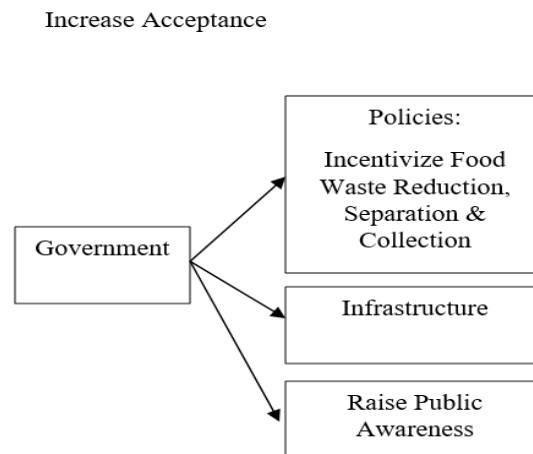
At the same time, the government will need to put effort into increasing public acceptance and awareness on the advantages of food waste composting in order for them to be motivated in this initiative. The government could set up policies to incentivize food waste reduction and separation for composting, by giving tax rebates or tax cuts. Economic incentives perform better in boosting waste recycling, according to a study conducted in Hong Kong's high-rise and high-density centres. The weight of collected recyclables per household has a substantial positive connection (Yau, 2010).

Besides that, the government needs to allocate space for the central composting facilities. The costs for the initial set up, maintenance of facilities, temporary composting bills and logistics must be allocated for this proposal to be sustainable.

In Hong Kong, the food waste management is carried out in phases (Wong, 2022). Since July 2018, the government has provided 'Food waste collection and recycling service' where food waste is collected daily. The pilot scheme's second phase will gather food trash on a wider scale, eventually encompassing domestic food waste. Therefore, this proposal will focus on food waste composting at Putrajaya and Cyberjaya.

Cyberjaya is selected because it is dubbed as a smart city and is very big on sustainability. With the Cyberview Smart City Action Plan at its core, Cyberjaya is in compliance with the Sustainable Development Goals (SDG) of the United Nations, with special focus on developing resilient infrastructure, promoting inclusiveness and sustainable industrialization, and encouraging innovation. Along with Cyberjaya Low Carbon City Framework, this also complements Malaysia Smart City Framework. Cyberjaya and Putrajaya are cities with available space for composting facilities.

Figure 2
Government Role in Ensuring Public Acceptance



Besides government support to increase awareness and acceptance, regulation must also be set to ensure the safety measures and quality of compost at the central compost facility. For example, the European Union set ensures that digestate is properly sanitised by establishing temperature-time profiles throughout the process or, alternatively, by using additional treatments such as pasteurisation or composting (Le Pera et al., 2022). Subsequently the government needs to set up regulations for better separation of food waste for more efficient recycling in the domestic sector, as well as the commercial and industrial sectors.

Business Involvement

The government should then partner up with businesses with the expertise in composting. The composting facilities can be a combination of publicly or privately managed. The government can fund food waste compost companies to a certain extent based on the blueprint laid out. Based on the policies to be implemented as mentioned above, restaurant and hotel operators must also cooperate fully.

Public Acceptance

The tricky aspect of making this work is for the public to participate. They are the key component into making the system work. Without the public involvement, the government resources and business involvement will be futile. There must be a big amount of food waste to be collected at the temporary compost bins in order for the initial costs set-up of the central composting facility and food waste management system to be worth the effort.

Without public acceptance and involvement, the main goal of reducing food waste at landfills will not be reached. The government's intense campaign and movement to educate as well as give incentives to the public and businesses will be able to get the buy-in from the public.

The food waste management system involves the following:

- i. **Source**
Source will be on-site, where it could be either at the residential houses, restaurants, and hotel. Waste will be separated at source. There will be an option for the residences to install a sink grinder that links (through an underground piping network) to the food waste bins. Here, the sink will grind the food waste and send it straight to the on-site composting bin.
- ii. **Composting bin**
The composting bins are temporary on-site food waste bins located centrally close to the source. For example, in a residential area, there will be one central composting bin where all the underground pipes are directed towards it. The size of the bins will be designed small enough to take up minimal space, but large enough to not overflow to accommodate the pick-up schedule. Here, the food waste is already grinded and considered to be semi-processed.
- iii. **Collection**
A specialized lorry will pick-up the semi-processed food waste and bring it to the central compost facility. Pick-up frequencies are two times a week.
- iv. **Central Compost Facility:**
As the food waste is delivered to the central compost facility, it will go through a composting process where the end product is organic fertilizers. The composting process of choice is the in-vessel composting. This method is especially beneficial as the food waste is contained in the vessel and not exposed to the air. Overall, there will be no problems of bad odour and rodents at the facility.
- v. **Distribution**
The end-product of the composting process will be distributed into two channels. One is to give back the compost for the residence to use as fertilizer for their personal gardens. This gives the incentive for the residents to participate in the whole composting process as they can benefit from it. Other than back to the residences, the compost/fertilizer will be sold to farmers. This will contribute towards the cost of the whole composting system.

DISCUSSION

Implementation of the proposed framework should take into consideration the change management approach. It is critical for the government as implementer to adapt Kotter 8- Step change model to establish the need for sustainable food waste management in Malaysia as listed in Figure 3. Collaboration with industries that are specifically relevant corporations will accelerate the implementation. For example, a collaboration with the hospitality industry (restaurants and hotels) will ensure that the volume for composting will increase, and therefore more output of fertilizers. This does not burden the participating industries, but instead make it easier for them to dispose of their daily waste.

The vision of the change initiatives needs to be established and communicated to get citizen buy-in. Short term win and empowerment to the people are the recipe for success. The food waste management needs to be inculcated in the way of living of the people in Malaysia; hence becoming part of the culture. All resistance needs to be managed well by considering the concept introduced by Lewin and Kubler Ross (Ian Palmer et.al, 2017).

Figure 3
Three Change Management Theories



Ian Palmer et.al (2017)

The researchers believe that with the right exposure and incentives, different parties from different industries and residential will participate in this process as it will ease and benefit the contributor and end-user. Composting may be an appealing economical alternative as landfilling becomes prohibitively expensive, as well as a value-added opportunity. According to Risse & Faucette (2017), many states in the United States currently have laws requiring counties to compost. Oregon and Washington are working on legislation that will make it mandatory for all businesses to compost all organic waste, including food waste. This approach can be adapted by Malaysia in order to achieve the same result.

CONCLUSION

Food Waste Composting can be a sustainable solution for the food industry as well as the public. It would contribute to the government objective to achieve a zero-waste goal. To achieve this goal, it can be concluded that there are three major aspects for the sustainability of this composting system. Firstly, to ensure acceptance from business owners and households, the government needs to spread awareness through campaigns. Secondly, it is of utmost importance to avoid burdening business owners and households, by ensuring that the system is cost-effective. Thirdly, the government needs to allocate funds to subsidise the costs and incentives to motivate the public to participate.

Malaysia has the potential to increase the amount of recycling of waste. Food composting contributes to the percentage of recycling. Even in 2014, other nations like Austria and Korea, recycled or composted more than 50 percent of their MSW. In the same year, Hong Kong recycled and composted about 37 percent of its MSW despite the challenges it faced. The country aims to achieve the waste recovery rate to 55 percent by 2035. These proven successes and planning by the government can be made as a yardstick for Malaysia.

Moving forward, past studies proved to be beneficial. Past studies can be referred to especially on the lessons learnt and challenges such as in paper by Wong (2022) on Hong Kong's waste management. It highlighted the first problem was the lack of a long-term vision and planning, the amount of MSW has overgrown, lack of trust in government among the general public, lack of a sustainable recycling strategy, and lack of capacities in using recycled products. Due to this problem, the government role, as explained in figure 2, is critical for any waste management to be seen as a resource rather than pure waste.

It is also noteworthy to look into other potential products of food waste to be used in other industries besides agriculture. In aquaculture, the use of compost as fish-feed is also a good potential. Food waste fermented into protein powder could successfully cultivate several freshwater fish species. The food waste-based then will be further treated by adding feed supplements. It was discovered that the fish that fed on the food waste-based pellets had faster growth rates and improved immunity than their counterparts that were on commercial diets, at costs that were, on average, 20 to 30 percent lower.

The infrastructure to be prepared by the government must leave room for flexibility for any new developments in products that can be derived from food waste. The allocated space and design of the infrastructure of the central composting facility must be able to adapt to future discoveries to make food waste composting sustainable.

REFERENCES

- Hassan MN, Theng LC, Allgaier G, Stegmann R (2006). Landfilling. In solid waste management in Asia. An e-book of teaching and training modules for higher education in the waste management sector. *The TUHH Hamburg University of Technology, Hamburg, Germany*. pp. 165-185.
- Fabian, N. Lou, L.I.Y, (2019). The struggle for sustainable waste management in Hong Kong: 1950s-2010s. *Worldwide Waste Journal of Interdisciplinary Studies*, <https://www.worldwidewastejournal.com/articles/10.5334/wwwj.40/>
- Ian Palmer, Richard Dunford and David A. Buchanan (2017), *Managing Organizational Change: A Multiple Perspectives Approach (Third Edition)*. New York: McGraw Hill Education
- Ismail S. S., & Manaf, L. A. (2013). The challenge of future landfill: A case study of Malaysia. *Journal of Toxicology and Environmental health Sciences*, 5(6), 86-96. <https://doi.org/10.5897/JTEHS12.058>
- Johari A, Ahmed SI, Hashim H, Alkali H, Ramli M. Economic and environmental benefit of landfill gas from municipal solid waste in Malaysia. *Renew Sustain Energy Rev* 2012; 16:2907–12.
- Kotter, John P. *Leading Change*. Boston, Mass: Harvard Business School Press, 1996.
- Kozlov, G., Alekseev, E., & Chermenskaya, T. (2022). Biocatalysis and Agricultural Biotechnology Use of industrial composts for the degradative disposal of pesticides. *Biocatalysis and Agricultural Biotechnology*, 42(1), 102378. <https://doi.org/10.1016/j.bcab.2022.102378>
- Le Pera, A., Sellaro, M., & Bencivenni, E. (2022). Composting food waste or digestate? Characteristics, statistical and life cycle assessment study based on an Italian composting plant. *Journal of Cleaner Production*, 350(1), 131552. <https://doi.org/10.1016/j.jclepro.2022.131552>
- Malaysian households lose RM210 per month in food waste disposal costs (2022), BERNAMA, <https://www.bernama.com/v2/en/general/news.php?id=2075596>
- Menon, P., (2017). Prolonging life of dumpsites. *The Star*, <https://www.thestar.com.my/metro/focus/2017/09/21/prolonging-life-of-dumpsites/>
- MHLG, (2004): Interview by C. Kuscke with the Ministry of Housing and Local Government Kuala Lumpur.
- M. Risse & B. Faucette (2017). *FOOD WASTE COMPOSTING: Institutional and Industrial Applications What Is Compost?* 1–8.
- Moh, Y.C., & Abd Manaf, L. (2014). *Overview of household solid waste recycling policy status and challenges in Malaysia*. *Resources, Conservation and Recycling*. <https://doi.org/10.1016/j.resconrec.2013.11.004>

- Nadzri (2013). Development of a National Strategic Plan for Food Waste Management in Malaysia
- Nkoa, R., 2014. Agricultural benefits and environmental risks of soil fertilisation with anaerobic digestates: a review. *Agron. Sustain. Dev.* 34, 473–492. <https://doi.org/10.1007/s13593-013-0196-z>.
- Waste to Energy, 2022, <https://www.mida.gov.my/waste-to-energy-for-a-sustainable-future/>.
- Wilson, D.C., Rogero, A.C. (2015). Background, definitions, concepts and indicators. Global Waste Management Outlook Eds. United Nations Environment Programme.
- Wong, M. H. (2022). Integrated sustainable waste management in densely populated cities: The case of Hong Kong. *Sustainable Horizons*, 2(2), 100014. <https://doi.org/10.1016/j.horiz.2022.100014>
- Yau, Y., 2010. Domestic waste recycling, collective action and economic incentive: the case in Hong Kong. *Waste Manag.* (30). 2440–2447.

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Tarikh : 20 Januari 2023

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Tuan,

**PERMOHONAN KELULUSAN MEMUAT NAIK PENERBITAN UiTM CAWANGAN PERAK
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Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

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Saya yang menjalankan amanah,

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

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Setuju.

27.1.2023

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