

SUSTAINABLE DEVELOPMENT IN MALAYSIA

A CASE STUDY ON HOUSEHOLD WASTE MANAGEMENT

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Abstract: Sustainable development (SD) is a concept which first originated in the 1970s when the developed world undertook massive development project in terms of cutting and clearing forests and constructing high rising buildings and spacious highways. Development of a country is essential to meet the needs of its people and to provide people with the latest infrastructure, high rising buildings and recreation facilities. However, the development process concerns the world community as it affects the natural environment. The ecological balance breaks down and environmental degradation occurs at an alarming rate. Therefore, the world community started thinking about protecting the environment while implementing development activities. Environmental degradation also occurs from intensive industrialization of a country. Therefore, to protect the environment, the world community proposed sustainable development. Sustainable development has three components: economic development; social development; and environmental protection. A sustainable development project requires that in any development project, these three components of SD must be taken into consideration and implemented properly so that the environment is not adversely affected. This paper focuses only on a small aspect of environmental protection, that is, proper management of household waste. This paper discusses how household waste in Malaysia can be converted into vermicompost for use in plantations and agriculture. The production of vermicompost may reduce the amount of organic waste in the country and help to maintain a clean and fresh environment. Vermicompost can also reduce emission of methane gas which causes global warming. Descriptive and analytical research methodology has been applied in this research paper.

Keywords: Environment, household waste, landfills, vermicompost

I. INTRODUCTION

Many countries in the world are involved in development. People are industrializing their countries to produce goods to be sold on the local and international markets. They are undertaking massive development projects to build the latest designs of residential and business buildings, to construct spacious highways, tourist resorts etc. Development is needed to enhance the quality of the lives of citizens in a country. Development projects affect the environment, ecology etc. Therefore, for the past few decades people have been talking about sustainable development. There are three components of sustainable development: economic development, social development and environmental protection. The focus of this paper is on environmental protection.

There are many factors that contribute to the degradation of environmental quality. One of the factors that contributes seriously to the degradation of environmental quality is household and industrial waste. For example, household waste emits nitric oxide and methane gas that contribute 20% to the greenhouse effect. Therefore, household waste should be managed in a way which can minimize the emission of dangerous gas such as methane gas which causes global warming and it is 21 times more potent than carbon dioxide [8].

This paper will discuss and analyze the Malaysian experience of strategic planning for household and supermarket waste management project called vermicompost. The production of vermicompost can effectively minimize the emission of heat-trapping gases and can stop air and water pollution. Vermicompost is an environment friendly organic fertilizer that can be used for plantations, nurseries and in agriculture. Vermicompost can effectively replace chemical fertilizer and can protect healthy environment. It is easy to prepare vermicompost as no machinery is needed. As stated above, descriptive and analytical research

methodology has been applied in this paper to analyze data obtained from books, journal articles, government working papers and laws on sustainable development, newspapers, and magazines. Secondary data has been collected and used in this paper to describe the amount of organic waste produced in Malaysia everyday and how it can be utilized to produce vermicompost which can be used as natural and environment-friendly manure for nurseries, plantations and in agriculture.

II. THE CONCEPT OF SUSTAINABLE DEVELOPMENT

The concept of sustainable development arose in the mind of the world community in the 1970s. From that time there have been discussions in different forums on how to formulate a sustainable development policy. The discussions continued and finally the World Commission on Environment and Development was formed. In 1987, this Commission prepared and presented a report on the environment and development which is known as the Brundtland Commission Report 1987. This Commission was formed under the United Nations. The Brundtland Commission Report defined sustainable development in a broad sense which is often quoted by academic scholars and planners of sustainable development. The definition in the Report was "Sustainable development is the development which meets the needs of the present without compromising the ability of the future generations to meet their own needs" [10].

This report of the United Nation's Brundtland Commission in 1987 marked the beginning of the sustainable development concept that has generated a lot of literature and commentary on the issue. Even though many of the concepts of sustainable development existed before, the Commission's report started the process of making sustainable development an important issue on the world stage from 1987. Sustainable development is not a one way traffic; it involves not only economic development but also social and environmental development. We have to bear in mind that while we are developing our country to meet the needs of people, we must not destroy the environmental and ecological balance. We have already caused a lot of harm to the environment which is nowadays known as 'global warming' and 'climate change' and we are suffering from its adverse effects. So, sustainable development ensures a developed world with secured and healthy environment for all: human beings, animals and plants.

The definition of sustainable development given above (although a good definition) has benefited the developed world at the expense of the third world or developing world. Because the definition asks for slow development so that the natural resources used

for development purpose can be replenished naturally. So, the developing world now has to consume renewable resources at a rate that is less than Nature's ability to replenish. This will ensure environmental renewal and a sustainable environment. However, the issue is whether developing countries will accept the Brundtland Commission's definition when the developed world has used its natural resources more than the nature's ability to replenish and (thus caused environmental degradation), which is against the definition of sustainability provided in the Brundtland Commission Report. There is a defect in the definition of United Nations Brundtland Commission: it does not include environmental degradation issues. Economic development may cause environmental and ecological problems. So, any sustainable development project must address environment protection.

Under the sustainable development concept, societies need to manage three types of capital (economic, social and natural) which may be non-substitutable and whose consumption might be irreversible [13]. According to Daly [12], natural capital can not necessarily be substituted by economic capital. While it is possible that we can find ways to replace some natural resources, it is much more unlikely that they will ever be able to replace eco-system services, such as the protection provided by the ozone layer, or the climate stabilizing function of the Amazonian forest. In fact, natural capital, social capital and economic capital are often complementarities. A further obstacle to substitutability lies also in the multifunctionality of many natural resources. Forests, for example, do not only provide the raw material for paper (which can be substituted easily), but they also maintain biodiversity, regulate water flow, and absorb CO².

The Brundtland Commission identified a number of "common challenges" which the world faces today such as population and human resources, food security, species and ecosystems, energy, industrial development, and urbanization etc. The Commission linked those challenges to international environmental problems in terms of its scope, nature and the solution. Potential policy decisions are needed to address the environmental problem and to meet the needs of the people as more than half of the population in the world is poor. Sustainable development requires meeting the major needs of all people and extending opportunity to satisfy their aspirations for a better life [40].

Earlier we have said that sustainable development has three elements: economic development, social development and environmental protection. Here, we identify two pillars of sustainable development i.e. economic development and the consumptive use of the

world's natural resources in ways that are sustainable. We need to consume world's wealth with the realization that resources are finite and we need to reserve some of the resources for the future generation [10].

To meet the needs of people, we are moving towards industrialization and producing goods to meet the needs of people, but at the same time, this is degrading the quality of the environment. Industrialization processes in the middle of the eighteenth century created abundant consumer products and at the same time created industrial waste that started polluting air and water. At that time industrialization gained momentum and automation in industry promoted mechanization act which eventually replaced human labor with machine [18]. Industrialization has its merits and demerits. The benefit of industrialization was a shift from a rural and agrarian economy to an urban and industrial economy [9]. Industrialization enabled manufacturers to supply good quality products at a cheaper price. As a result, demand, supply and production of goods increased. This was the good side of industrialization. The negative side was that it led to the depletion of natural resources and environmental degradation by dumping pollutants into the rivers or by the roadside [18].

During the past decade, the concept of sustainable development attracted significant attention from researchers, governments of different countries and international environmental organizations. The reason is clear, that is, the increased rate of environmental pollution and degradation. According to Srivastava and Srivastava [33], deepening environmental concerns and perceptions of increased risk to health and safety of community residents from industrial activities has led to a significant increase in research interest at the interface of industrial operations and environmental management.

Gandhi et al, [18] developed a general conceptual framework on sustainable development which is known as the Four Forces' model of sustainable development. Gandhi's 'Four Forces' model was based on Michael Porter's 'Five Forces' framework [28] which has made a significant contribution to the process of sustainable development. The 'Four Forces' model is a structured approach of explaining the need, cause and the process of sustainable development which places emphasis on five central questions as follows:

- 1) What is the state of environment now? (Current sustainable development)
- 2) How did the environment get there? (Environmental degradation)

- 3) Where does the environment to go? (Future sustainable development)
- 4) Why do the environment to go there? (Greening force)
- 5) How the environment to go there? (Greening process)

The above five questions related to sustainable development are very important as they show the position of sustainable development in a country and how to reach the targeted sustainable development.

III. HOUSEHOLD WASTE MANAGEMENT IN MALAYSIA: CHALLENGES AND PROSPECTS

As the population is increasing, especially in urban areas, the volume of solid waste is also increasing in developing countries including Malaysia. Therefore, it has become a great challenge for any developing country to properly manage household solid waste. Similarly, the Malaysian government is also taking up this challenge and it has been able to tackle solid waste management skillfully and efficiently. The following sub-topics explain the challenges, efforts, plans and success story of the Malaysian government in disposing of and utilizing household solid waste.

A. Household waste production scenario in Malaysia

Kuala Lumpur produces 3,500 tons of domestic and industrial waste per day. At present per capita household waste generation in Kuala Lumpur is about 0.8 to 1.3 kg per day. 50% of the waste produced in Kuala Lumpur is organic waste [8]. Let us compare the waste production rate in the world with Malaysia. The population of solid waste in the world is increasing day by day specially in the third world countries. As the population in the world is increasing, the amount of solid waste generation is also increasing by a tremendous amount. In 2000, the estimated global waste generation was 318 million tons. With an annual increase of approximately 6%, global solid waste generation is expected to reach about 518 million tons in 2008 and 585 million tons in 2010 [27], [38]. Various factors contribute towards the status of waste management in a given country such as weak enforcement, lack of technology, ineffective policy and lack of monitoring and implementation of policy [27]. Malaysia, being a rapidly developing country, faces similar problems of deficiency in latest technologies and facilities to cope with the ever-increasing rate of waste generation [17].

Now let us see the total area of Malaysia, its current population and the statistics of organic household waste generation. The total area of Malaysia is 329,750 km². In 2007 it had a population of 24.8

million. Currently it has 25.5 million people. The per-capita GDP of Malaysia is \$14,400 [35]. In 2006, the daily generation of organic waste increased in Peninsular Malaysia (known as West Malaysia) from 13,000 tons to 19,100 tons [2], [5].

The urban population, like other countries in the world, is generating more organic waste than the rural population in Malaysia. The urban population constitutes more than 65% of the total population in Malaysia. Municipal solid waste (MSW) generation in Malaysia has mushroomed more than 91% over the past 10 years [1]. The upsurge in the generation of organic waste is due to the rapid development of urban areas, increase in per-capita income, rural-urban migration, and the increase in consumption pattern caused by development. Table 1 in the Appendix shows the trends of waste generation in major urban areas in Peninsular Malaysia from 1970 to 2006. Table 1 shows that in major cities in Malaysia, the production of household and supermarket waste increases more than 90% every 10 years. So, it becomes a great challenge for the Kuala Lumpur municipality to collect, dispose of and recycle this huge amount of organic waste as it needs a large number of employees to collect and dispose the waste; large areas of landfills and above all millions of dollars are paid as salary to the waste management employees.

As stated above, the escalating rate of organic waste in Malaysia is the result of changes in consumption habits of people as their per-capita income has increased. Nowadays they can afford to buy more consumer goods than before. Waste in Malaysia is dominated by organic waste, which comprises more than 40% of the total waste stream. In the 1980s and 1990s, the average organic waste was approximately 50% consisted of processed kitchen waste and food waste. Table 2 in the Appendix depicts the composition of waste generated in Malaysia from 1975 to 2005. The generation of plastic and paper waste was high in 1985 due to the implementation of the Malaysian Food Regulations Act (1985), which recognized the use of various types of plastics and paper as safe and suitable packaging materials [26].

The trend decreased slightly from 1990 to 1999 due to the economic downturn, but grew quickly in 2000 with the introduction of more hygienic types of plastic-and paper-based packaging materials into the market. This resulted in an increasing percentage of organic waste in the MSW stream. However, in 2007, organic waste contributed approximately 46%, followed by paper waste (14%) and plastic based waste (15%) [17], [23].

From Table 3 in the Appendix, we can see that the waste disposal in Malaysia has increased from 2002

to 2006 and it has been targeted that from 2006 to 2020 waste disposal will increase substantially. This is a positive plan of the Malaysian government to dispose of waste materials hygienically. The recycling rate was 5% in 2002 and increased to 5.5% in 2006, which is a very low rate of increase. Recycling is very important in the effective management of waste material; for example, using the waste materials for preparing compost fertilizer. It would have been encouraging if the recycling rate had increased to 11% in 2006. This would have been possible by adopting proper planning and management. Similarly, using waste materials for preparing compost manure is of immense importance but the increase rate is very minimal and disappointing. In 2002, composting preparation was 0% and in 2006 it increased to 1%. It is very disappointing progress. If it had been increased to 10% in 2006, that would have been very encouraging. The use of organic waste for preparing agricultural manure will reduce the amount of organic waste and will also meet the deficiency of fertilizer for agriculture. Another important factor is that compost or vermicompost contains very good nutrients for the soil. It increases the fertility of soil, increases the production of crops and also decreases the number of harmful insects to crops.

Figure 1 in the Appendix shows that the MSW generated increased to 6.0 million tons in 1998 due to the average per-capita generation of 0.5–0.8 kg/day [23], [30]. By the year 2000, the production of domestic and commercial waste reached 8.0 million tons per year. It is to be mentioned here that one quarter of the total solid waste that is 2.6 million tons was generated in the Klang Valley alone [3], [24]. Figure 1 shows that the solid waste generation rate in the 1980s was 0.5 kg/day, which increased to 1.3 kg/day by 2006. According to Arugamuthu et al. [3], the current rate of solid waste generation was expected to reach 1.5 kg/day in most cities in the year 2007.

B. Disposal mechanisms of household waste in Malaysia

The management of solid waste in Malaysia has developed gradually. Municipal solid waste (MSW) management was quite primitive until the late 1970s. At that time, the local district health offices cleaned only the streets and carried away the household wastes to municipal disposal sites which were assigned as authorized dumping grounds. When the generation of household waste increased, the frequency of collection also increased, so that the organic waste did not cause harm to the health of the people. In order to increase the efficiency of the disposal of household waste, the government of Malaysia delegated waste management to four private consortia. The privatization of urban solid waste

management in Malaysia was initiated in 1993 with the objective of providing an integrated, effective, efficient, and technologically advanced solid waste management system. At that time local authorities (LAs) dealt with the waste disposal management, but they faced some problems such as finance, lack of expertise, illegal dumping, open burning, and a lack of proper solid waste disposal sites. Although the work was privatized, privatization in fact did not solve the problems [1].

It is important to adopt campaigns among the general people about cleanliness and public health. Therefore, the Malaysian government undertakes such campaigns from time to time to make the people aware of environmental consciousness and the recycling process. In 1988, the government introduced the Action Plan for a Beautiful and Clean (ABC) Malaysia, and recycling campaigns. These campaigns continued for several years. The campaigns were successful as the government was able to create environmental awareness and knowledge of waste management among the public to a satisfactory level. A survey carried out in 1999 showed that 59% of respondents were moderately aware with some basic knowledge and were mildly alert to the management of solid waste [21]. The campaign for recycling and reuse of waste materials should continue. It will bring good results in the long term.

C. Household waste and environmental degradation

The thousands of tons of household waste produced every day in Malaysia are a great headache for the government to collect and dispose of properly to ensure a clean and fresh environment in Malaysia. If household waste and supermarket waste are not disposed of or recycled properly, it would seriously affect the environment. Millions of tons of organic waste are rotting in landfills and producing a toxic poisonous substance called leachate which is contaminating our rivers and seas. This organic waste also emits greenhouse gases such as nitric oxide and methane which is 21 times more potent than carbon dioxide [8]. Thus, household waste can cause environmental degradation in Malaysia if it is not properly treated.

Daily MSW generation in Peninsular Malaysia today exceeds 19,000 tons. Approximately 75% of this is collected and disposed of in 130 landfills and dumps [2]. 20% of the organic waste is burned or dumped into rivers or at illegal sites, while 5% is recycled. Malaysia's main option of waste disposal has been landfills, although alternatives have been explored. Table 3 indicates the current waste management methods in practice since 2002 and it also indicates the proposed technologies to be used by 2020. The

Malaysian government proposes to gradually establish several MSW incineration plants, simultaneously emphasizing the 3Rs (reduce, reuse, and recycle) in the future, as envisioned in Part X of the SWPCM Act 2007.

As stated above, 20% of organic waste is burned or dumped into rivers or at illegal sites. The Malaysian government has to take proper steps to stop the dumping of organic waste into rivers or at illegal sites. Such illegal dumping of organic waste will seriously deteriorate the environment by polluting water and air and people will not be able to use the water in the river. Moreover, the river cannot be used for safe purpose. It will generate diseases, smells and above all it will create a dirty environment.

As seen above, the Malaysian government is also trying to establish some incineration plants but the issue is whether these plants will be environmental friendly or not. If such plants produce carbon dioxide or methane gas, then they would be dangerous for the environment. The Malaysian government has been trying to prepare a solid waste management Bill for the last 10 years and the Bill was ready in 2007 for approval by the Parliament. The Bill has been enacted as law by the Parliament of Malaysia in 2007. This law is known as the Solid Waste and Public Cleansing Management Act 2007 (SWPCM Act 2007). It is expected that this Act will bring major positive changes to the management of organic waste.

Solid waste disposal poses a serious problem especially in urban areas. With income in the urban population, more and more solid waste is generated. Increase in solid waste generation creates increasing problem of solid waste disposal, collection and the availability of solid waste disposal sites etc. Household waste may cause environmental degradation leading to unsustainable world. As I mentioned earlier, solid waste is produced in thousands of tons per day in Malaysia. If this organic material is not treated properly, it will cause environmental degradation. It will pollute air, water and also increase global warming

Bangladesh can be cited as a good example of environmental degradation due to mismanagement of household waste [6]. In Dhaka, the capital city of Bangladesh, the collection and disposal of waste was privatized by the Dhaka City Corporation but due to lack of proper monitoring and co-ordination, solid waste is dumped on public roadsides by sub-contractors in open places. The government cleansing authority collects the waste from the roadsides and disposes of it in landfills. However, the waste is not collected from roadsides regularly and frequently. As a result, obnoxious smell comes out, people find it very

difficult to move around the waste sites because of the obnoxious smell, huge amount of methane gas is emitted and the environment is seriously degraded. In Bangladesh, the residents are required to pay for disposing of the waste. A few people in Dhaka city practice recycling of waste [6].

If we compare Malaysia with Bangladesh, Malaysia is much better for timely collecting and disposing of waste in the landfills. In Malaysia, it is prohibited and a criminal offence to dump waste on the roadside. The Malaysian government maintains cleanliness and fresh environment everywhere in the country to attract huge amount of local and foreign tourists. Strong enforcement of law, up-to-date technology and effective policy implementation are required to make the project successful [17].

D. Household waste management rules and regulations in Solid Waste and Public Cleansing Management Act 2007

To manage solid waste in Malaysia in an efficient way so that it does not cause environmental degradation, the Solid Waste and Public Cleansing Management Act 2007 (SWPCM Act 2007) was passed as law in 2007. The SWPCM Bill was under review for 10 years before it was finally approved in August 2007 as an Act. The Act is administered by the Ministry of Housing and Local Government. The main objective of the Act is to provide for and regulate the management of controlled solid waste and public cleansing for the purpose of maintaining proper sanitation and for matters incidental thereto [41]. The Act improves and ensures high-quality services in solid waste management [1].

The Act (SWPCM Act 2007) was enacted based on the similar Acts in Japan, Denmark, Switzerland, Germany, and the United States and it mainly focused on public cleanliness management. It adopts the best management practices in solid waste management from the above countries. The main strategies are to implement efficient solid waste treatment, interim treatment, and final disposal of solid waste. The strategies also include the 3R issues, which cover management and regulations. The Act includes the management of amenities from roads and toilets to drains, food courts, and grassed areas by the roadside. The Act covers the management of solid waste from commercial centers, public sites, construction sites, households, industrial zones, and institutions.

Prior to the implementation of the SWPCM Act 2007, solid waste management and public cleansing were the responsibility of the LAs, and were normally subcontracted to smaller waste management service providers. Appointing smaller designated parties to service specified areas resulted in more efficient

management in the early stages of implementation. However, with the increasing costs of waste management, the situation resulted in subcontractors not being paid promptly, leading to drastically reduced efficiency. With the passing of the Act, the authority governing solid waste and public cleansing was shifted from state governments and LAs to the Federal Government [41]. The management cost is shared by these two former parties. LAs direct funds to a Federal Corporation that directly manages solid wastes. The new management system stops the unsustainable system that emerged from subcontractors and unprofessional contractors.

A Corporation named Solid Waste and Public Cleansing Management Corporation (the Corporation) was established under the Solid Waste and Public Cleansing Management Corporation Act 2007 [32]. This Corporation works under the Federal government and the function of the Corporation includes every aspect that is deemed necessary to ensure the implementation and success of an effective and integrated solid waste management plan. The function includes recommending and implementing policies and strategies pertaining to solid waste management services, implementing improvement measures for existing solid waste management services, enforcing the law, and establishing institutions to undertake research activities. Its function also covers the recommendation and implementation of relevant standards, monitoring of compliance with the Act, and promoting participation by people and creating awareness among the public [1].

The SWPCM Act requires residents to pay for the waste collection and disposal service provided by the licensed concessionaire (private authority) under the Act. The Act provides for penalty provisions for consumers who refuse to pay waste disposal fees. If any consumer fails to settle the waste collection fees, the licensed concessionaire may take the case to the Tribunal for Solid Waste Management (the Tribunal). This Tribunal has the power to impose a fine of up to RM5000 (US\$1316) and RM50 (US\$13) for each day of the continuation of the offence. Charges will be imposed on the owners of facilities, the occupiers of residents, LAs, or any individual who receives solid waste management services [34].

The Act also listed the responsibility of the waste generator to conduct waste separation in order to promote recycling and retrieve valuable components from the waste stream. Under clause 74 of the Act, it is an offence if a person fails to separate solid waste generated by the premises. On conviction of the offence, the person is liable to a fine of up to RM1000 (US\$277). The Act defines "solid waste" as unwanted material generated by any process that requires

disposal by the Act or any other written law. The definition excludes scheduled wastes that are prescribed under the Environmental Quality Act 1974. The term “controlled solid waste,” used throughout the Act, includes waste generated from the commercial and construction sectors, households, industry, institutions, and the waste import sector. It also covers the waste generated in public places under the LAs. Therefore, parties involved in generating these wastes are liable under the Act [1].

The SWPCM Act introduces 3Rs: reduce, reuse, and recycle. This is an important campaign included in the Act. The implementation and enforcement of the 3Rs are also listed in the Act under Part X, in which solid waste generators are required to reduce the generation of solid waste; to use environment friendly materials; to limit the generation, import, use, discharge, and disposal of specified products; to implement coding and labeling on products to promote recycling; and to utilize any method to reduce the adverse impacts of MSW (Municipal solid waste) on the environment, i.e., to reduce, reuse, and recycle MSW. Although waste minimization is emphasized in the Act, the techniques to reduce waste generation are not specified and the options are too generalized [1]. Failure to comply with the law will make the offender liable to a fine of up to RM10 000 (US\$2632), up to 6 months imprisonment, or both.

E. Present and future plan for sustainable waste management in Malaysia: producing vermicompost

The government of Malaysia has plans to manage household waste efficiently to ensure a clean, fresh, and sustainable environment. The government of Malaysia is encouraging the people (as we have seen in SWPCM Act 2007) to manage solid waste for the following purposes:

- 1) recycling solid waste;
- 2) reuse of waste;
- 3) making compost manure from organic waste. It is becoming a worldwide practice to use organic waste for agricultural purposes, because it reduces the volume of landfilled waste and provides a valuable agronomic resource.

Tognetti et al. [36] studied composts and vermicomposts from a municipal composting plant in northwestern Patagonia, both having undergone a thermophilic phase, and a nonthermophilic backyard vermicompost. Their effects on soil biological and biochemical properties and plant growth were evaluated in laboratory incubations and a greenhouse trial, using a degraded volcanic soil amended at rates of 20 and

40g/kg of vermicompost or compost. Between the two municipal products, the vermicompost had significantly larger nutrient concentrations than the compost; when mixed with the soil, the vermicompost also had higher microbial populations size and activity, and produced increased ryegrass yields [36].

The Malaysian government has undertaken a plan to use organic waste to produce vermicompost. If 50% of organic waste (1750 tons) produced per day in Kuala Lumpur can be effectively converted into vermicompost, it will not only extend the life span of landfills in Malaysia but also will substantially reduce the emission of toxic and poisonous gases that are released into our atmosphere and rivers [8].

Vermicomposting has many benefits for the society. It promotes a clean and fresh environment, and reduces the emission of methane gas which causes the deadly greenhouse effect or global warming as said earlier. It will also save millions of dollars spent by Kuala Lumpur City Corporation (DBKL) for disposing of waste in landfills. It will also replace chemical fertilizers with organic vermicompost which will reduce crop pests and increase the fertility of the soil in a natural way. Chemical fertilizers have been proven to be dangerous for the soil, crops and human health. This vermicompost could be used for nurseries, landscaping, vegetable plating projects in housing areas and the additional compost can be used for agricultural purposes. Vermicomposting is very cost effective and a natural way to dispose of the city’s organic waste [8].

It is very easy to make vermicompost. In vermicomposting, expensive equipment is not needed [25]. In villages or even in towns if there is space to deposit organic waste, vermicompost can easily be made. House owners and students can be involved in this project. Students might find this project very interesting and at the same time they will be able to reduce and recycle the organic waste and produce huge amounts of compost that can reduce the use of chemical fertilizer. From the day of collection, it takes only three to four weeks to make vermicompost in a hot climate. Vermicompost can be a source of income for the producers as it can be sold after being properly packaged.

Earlier, some benefits of vermicompost were stated. However, there are other benefits:

- 1) It will save millions of dollars spent by Kuala Lumpur City Centre (DBKL) for only disposing of the waste in landfills.
- 2) It will increase the lifespan of landfills. It will minimize landfill usage, save land and reduce methane gas emission and leachate production.

- 3) It will reduce waste, minimize the local municipal, city hall and contractor's problem in the disposing and management of waste.
- 4) It is possible to produce vermicompost naturally. High technology equipment is not needed.
- 5) No system upgrade is needed. Worm reproduction will be able to handle the increased amount of organic solid waste.
- 6) Vermicompost is an eco-friendly natural manure prepared from biodegradable organic waste and is free from chemical input and is not polluted.
- 7) There are no side effects to the use of vermicompost. It does not have any adverse effect on soil, plant and the environment. It improves nutrients in the soil (both macro-nutrients and micro-nutrients).
- 8) It is easy to learn how to make vermicompost. It is easy and suitable for households, the community and schools to adopt as an environmental project.
- 9) Vermicompost is in fact high quality organic manure. It has been proven that vermicompost manure can protect plants against disease. Hence, the use of pesticides on crops can be reduced. Pesticides are in fact harmful for environment as well as for the human and animal beings [8].

Ndegwa and Thomson [25] conducted research on organic waste management. They studied the result of combining two processes of composting of organic waste such as a) pre-composting followed by vermicomposting and b) pre-composting followed by composting. The findings were that a system that combines the two processes not only shortens stabilization time, but also improves the product quality. Combining the two systems resulted in a product that was more stable and consistent. It had less potential impact on the environment and for compost-vermicomposting (CV) system, the product met the pathogen reduction requirements [25].

Recently, decomposing of organic waste by using earthworm known as red wigglers has been widely accepted and is being practiced. In this process the earthworms used break down organic waste to make compost manure which is known as vermicompost as mentioned earlier [15], [19], [20], [22]. The earthworms consume the microorganisms that grow upon the waste. After consuming the waste materials, the earthworms produce fecal material or worm castings which are more fragmented and microbially active than what they consume [14], [15].

The campaigns for preparing and using compost or vermicompost for agriculture can promote soil fertility, quality products and biodiversity [39]. Vaarst,

[39] in this recent article published in the *Journal of Sustainable Development*, promotes and encourages farmers to implement and practice organic farming, because it enhances soil fertility, minimize soil poisoning, protect agricultural lands against many negative side effects of the use of agro-chemical products. Organic farming also promotes food quality, good health of people and good ecology. According to Vaarst [39], organic farming methods include intercropping, mulching, use of compost manure, crop rotation, using non-chemical pesticides, strictly limiting the use of synthetic fertilizers and synthetic pesticides.

F. Sustainable development model

The sustainable development model shown in the Appendix below has three important components which cannot be separated from each other. Those components are: a) Economic development; b) Social development; and c) Environmental protection. The combination of these three components of development can ensure sustainable development. Sustainable development may mean different things to different people. But to be specific, objectively, it means that countries may develop by industrialization, by erecting high rising charming and beautiful buildings, spacious and well-designed road infrastructure, recreation parks, gardens, lakes etc. However, this development must not deteriorate the natural beauty of the environment. Another important point is that the development process cannot use up all the natural resources for the present generation. Some of the resources should be reserved for future generations to meet their own needs. If the development projects of a country are guided in this way, they will be bearable, equitable, viable and sustainable for the society, human community, animal and plant community and the ecology.

G. Theoretical framework and flow chart for sustainable waste management in Malaysia

The diagram in the Appendix shows a model of sustainable household waste management in Malaysia. The mechanism proposed here is to use the organic household waste for making vermicompost. The definition of vermicompost has been given above. There are a few objectives of making vermicompost as written above and the most important are to reduce the amount of organic waste and to reduce the use of landfills. Other objectives are to reduce air and water pollution, emission of obnoxious smells, reduce the production of deadly germs which may cause so many diseases for both human and animals, and to reduce the production of methane gas which is very dangerous for the outer atmosphere as it traps the heat of the sun and causes global warming (greenhouse effect).

Making vermicompost is not difficult as has been said earlier. It does not need any factory, building, or machinery. The only things needed are to collect the household waste and dispose of it on some designated lands. Then an earthworm is used to feed this waste and to quickly decompose this waste. The earthworms eat the organic waste and produce fecal material which is very rich in nutrients and very good for the plants and vegetables. If the vermicompost is mixed with soil it becomes very fertile and can produce abundant organic crops which are not possible when we use chemical fertilizers. In fact, chemical fertilizers have many defects and problems which vermicompost does not have.

Vermicompost can be used as manure for nurseries, plantations and for agriculture and it can minimize environmental degradation, pollution and emission of obnoxious smells and deadly methane gas. Last but not least, vermicompost can promote clean and fresh air, water and a healthy environment for all including animals and plants.

IV. CONCLUSION AND SUGGESTIONS

Malaysia produces thousands of tons of waste per day which is usually disposed of in landfills. When it is dumped in landfills, it emits methane gas which contributes to the green house effect and climate change. So, the Malaysian government thinks that this huge amount of organic waste should be managed efficiently so that it does not make the cities and villages dirty and pollutes the air and water or emit the dangerous methane gas. For this purpose, the Malaysian government enacted the Solid Waste and Public Cleansing Management Act 2007 [32] to ensure proper and efficient management of the thousands of tons of waste produced in Malaysia every day. The Act gives the duty of the collection and disposal of waste to private organizations under license. It is the duty of the Solid Waste and Public Cleansing Management Corporation (the Corporation) to take after the acts of the private organizations known as solid waste management concessionaires to make sure that they are carrying out collection and disposal properly and efficiently.

The SWPCM Act 2007 also requires residents to separate non-organic waste from the organic waste. This is an appreciable provision in the Act, because if the non-organic waste such as plastic, paper, glass, can etc. are separated from organic waste in each house, then the work of the private concessionaires (solid waste management concessionaires) will be reduced and the non-organic waste can be sent to the relevant industries for reuse. Such recycling and reuse of non-organic waste will reduce the amount of waste substantially and will protect the environment from

degradation. It is compulsory for every house to separate the non-organic and organic waste. This rule has been provided in clause 74 of SWPCM Act 2007. If any person disregards this rule, he will be liable for an offence and on conviction will be fined RM1000. The case can be taken to the Tribunal for Solid Waste Management (The Tribunal) for a decision. Thus, the Act ensures that household waste is properly managed and disposed of and that it is separated for recycling. Such an attempt by the government of Malaysia undoubtedly will ensure good management of waste materials on the one hand and a neat, clean and healthy environment on the other hand.

The SWPCM Act 2007 uses the 3Rs formula: reduce, reuse and recycle. Recycling and reusing of both non-organic and organic waste will reduce the amount of waste produced everyday and it will save time and cost for the responsible private concessionaires while managing the waste materials. The Corporation must monitor the functions of waste management concessionaires so that they can perform their duties properly and efficiently. If they fail to carry out their duties properly, legal action can be taken by the Corporation against the responsible residents or the private concessionaires under the Act.

Recycling of solid waste is very important. The SWPCM Act 2007 (Malaysia) has made it compulsory for all Malaysian to separate different types of solid waste at home before it is collected by the designated concessionaires. This plan is a great plan for Malaysia and it must be implemented properly by the SWPCM Corporation. The Corporation must monitor regularly the recycling function of residents and supermarkets and implement this law effectively. This will ensure the reduction of solid waste to a great extent. It has other benefits such as non-organic wastes: plastics, glasses, papers and cans can be reused in the relevant factories. So, those factories can minimize production cost and can maximize profit in the business. On the other hand, the private authority which is responsible to return the used plastics, glasses, papers and cans to the relevant industries; can earn money by selling these recycling waste to those industries. Another benefit of this recycling process is that it will ensure a clean, fresh and sustainable environment for all. It will also save the environment in Malaysia from degradation, obnoxious smells and methane gas.

The recycling project has another benefit of producing compost or vermicompost from the organic waste. The SWPCM Act 2007 also makes it compulsory for residents and supermarkets to separate the organic waste from other non-organic waste before it is collected by the assigned concessionaires. So, the people who want to produce vermicompost, can collect the

organic waste from these private authorities. The Kuala Lumpur City Corporation (DBKL) has already undertaken a robust and large project to producing of huge volume of vermicompost to be used for nurseries, plantations and agriculture as stated earlier. So, it is hoped that the Malaysian government will be successful in managing the household and supermarket organic waste efficiently and effectively.

The Malaysian government’s master plan to use organic waste for producing vermicompost is a great plan. It will reduce organic waste substantially. The process will also reduce the number of dumping landfills and the emission of methane gas. It will reduce water and air pollution. This will ensure a healthy and fresh environment in Malaysia and will substantially contribute to the reduction of methane gas emission. The vermicompost is good manure for plantation and agriculture as stated earlier. So, by using the organic waste for making vermicompost, the Malaysian government and its people will be benefited from this natural manure. Farmers will not need to buy chemical fertilizer which is expensive and harmful for soil, crops and the environment. So, the finding of this paper is that using household organic waste for making vermicompost will be very beneficial for Malaysia and for the world environment.

APPENDIX

Table 1. Generation of municipal solid waste in major urban areas in Peninsular Malaysia (1970-2006)

Urban centre	Solid waste generated (tonnes/day)				
	1970	1980	1990	2002	2006 ^a
Kuala Lumpur	98.9	310.5	586.8	2754	3100
Johor Bharu (Johor)	41.1	99.6	174.8	215	242
Ipoh (Perak)	22.5	82.7	162.2	208	234
Georgetown (P. Pinang)	53.4	83.0	137.2	221	249
Klang (Selangor)	18.0	65.0	122.8	478	538
Kuala Terengganu (Terengganu)	8.7	61.8	121.0	137	154
Kota Bharu (Kelantan)	9.1	56.5	102.9	129.5	146
Kuantan (Pahang)	7.1	45.2	85.3	174	196
Seremban (N. Sembilan)	13.4	45.1	85.2	165	186
Melaka	14.4	29.1	46.8	562	632

The statistics shown in Table 1 are taken from Periathamby and Hamid [27]

Table 2. Waste composition (percentage of wet weight) in Malaysia from 1975 to 2005

Waste composition	1975	1980	1985	1990	1995	2000	2005
Organic	63.7	54.4	48.3	48.4	45.7	43.2	44.8
Paper	7.0	8.0	23.6	8.9	9.0	23.7	16.0
Plastic	2.5	0.4	9.4	3.0	3.9	11.2	15.0
Glass	2.5	0.4	4.0	3.0	3.9	3.2	3.0
Metal	6.4	2.2	5.9	4.6	5.1	4.2	3.3
Textiles	1.3	2.2	NA	NA	2.1	1.5	2.8
Wood	6.5	1.8	NA	NA	NA	0.7	6.7
Others	0.9	0.3	8.8	32.1	4.3	12.3	8.4

NA, not available

The statistics shown in Table 2 are taken from Periathamby and Hamid [27]

Table 3. Methods of waste disposal in Malaysia

Treatment	Percentage of waste disposed		
	2002	2006	Target 2020
Recycling	5.0	5.5	22.0
Composting	0.0	1.0	8.0
Incineration	0.0	0.0	16.8
Inert landfill	0.0	3.2	9.1
Sanitary landfill	5.0	30.9	44.1
Other disposal sites	90.0	59.4	0.0
Total	100.0	100.0	100.0

The statistics shown in Table 3 are taken from Periathamby and Hamid [27]

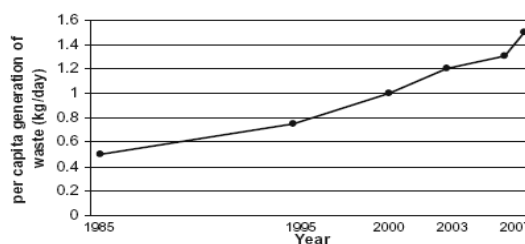
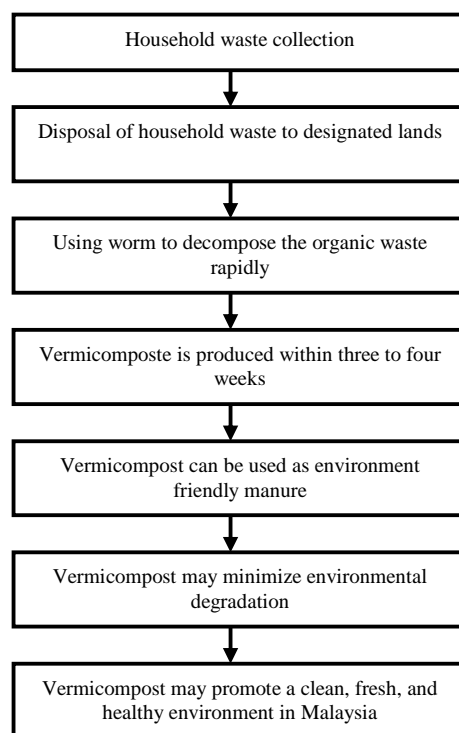
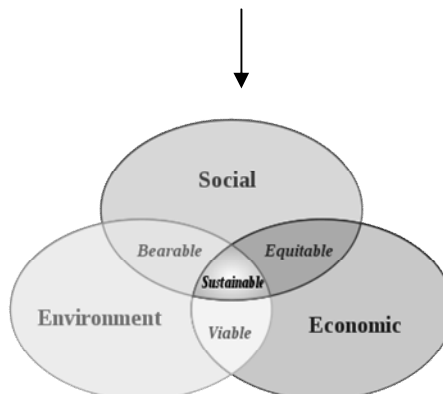


Fig. 1. Increasing trend in per-capita generation of municipal solid waste from 1985 to 2007
The statistics shown in Figure 1 are taken from Periathamby and Hamid [27]

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SUSTAINABLE DEVELOPMENT MODEL



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