J. Res. Technol. Eng. 3 (4), 2022, 01-10

Journal Of Research Technology & Engineering
www.jrte.org

Solid Waste Management in Kalmunai Municipal Council

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Received:25 May 2022; Revised: 15 August 2022; Accepted: 30 August 2022; Available online: 10 Oct 2022

Abstract: Solid Waste Management (SWM) is a severe global concern. Developing countries like Sri Lanka are not an exception to the issue. This analysis mainly targets Kalmunai Municipal Council (KMC), an urban area and a coastal region in the Eastern Province of Sri Lanka. This study focuses on developing a sustainable waste management system in the area. The data is collected from related reports, analysis articles, journals and websites for further knowledge. This study recommends the methods of waste management and disposal method and draws a feasibility study for better sustainable management toward a clean & healthy setting in Kalmunai Municipal Council (KMC).

Index Terms: Municipal waste, solid waste management, sustainability, waste treatment

1 INTRODUCTION

Solid waste is one of the major environmental challenges all over the world. Studies show that in 2016, around 2.01 billion tons of solid waste was generated worldwide. In the current situation and urbanization, it is expected to increase by 70% from 2016 to 3.40 billion tons in 2050, according to studies by the World Bank Group [1]. Similarly, in Sri Lanka, the increase in solid waste has become a growing issue due to the increase in population, industrialization, urbanization, and change in people's lifestyles. Hence, it causes many health and environmental problems that harm living organisms' survival and human wellbeing.

Solid Waste Management (SWM) is the strategy or the technique of collecting, storing, transferring, transporting and appropriately processing waste with the concern of public health as well as environmental considerations along with economics until the disposal of the solid wastes. It also focuses on controlling waste generation as well. In developing countries, inefficient Municipal Solid Waste Management (MSWM) highly impacts mankind and their surroundings through unsustainable waste management like open landfills or uncontrolled burning, thanks to restricted technologies and monetary restrictions. In such low-income countries, waste is disposed of in unregulated open dumps or the waste is burned. This creates severe environmental impacts as well as health and safety consequences.

In Sri Lanka, several Local Authorities (LA) take responsibility for solid waste management. These are Provincial Council (PC), Municipal Council (MC), Urban Council (UC), and Pradeshiya Sabha (PS). In Ampara District, there are two Municipal Councils among the three municipalities in the Eastern Province of Sri Lanka. One is Kalmunai Municipal Council (KMC), and the other is Akkaraipattu Municipal Council (AMC). Likewise, there are 24 Municipal Councils in Sri Lanka, the legislative bodies that supervise the vastest towns and first-tier municipalities in the country. Municipal Councils (MCs) are devolved under the Provincial Councils (PCs) in the Local Government System of Sri Lanka [2].

Kalmunai Municipal Council (KMC) is located in South Eastern coastal region in Ampara District of the Eastern Province of Sri Lanka and bounded by Batticaloa on the North, Indian Ocean on the East, Navithenvely Divisional Secretariat Division on the West, and Karaitivu Divisional Secretariat Division and Sammanthurai on the South, is geographically found in the latitude of 7° 25' 24" N to 7° 27' 25" N and on the longitude of 81° 45' 31" E to 81° 50' 32" E at an elevation of 9 meters above the mean sea level [3]. Fig. 1 below shows the location map of KMC.

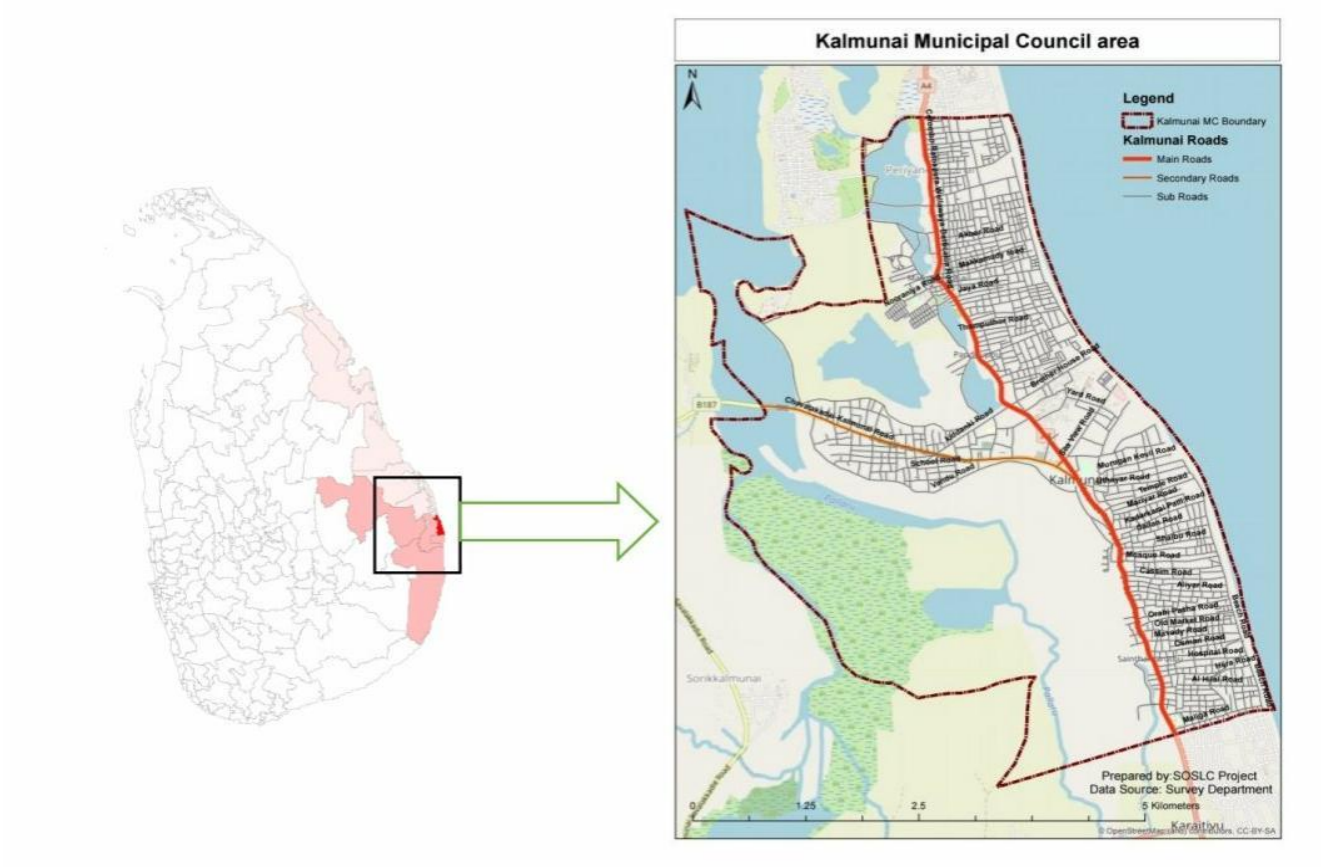

Fig. 1. The location of the study area, (KMC)

The KMC consists of varieties of mixed regions such as residential, commercial, agricultural, and fishery from the pre-set of its land use. [3]

1) Residential areas: where single-family housings and multi-family residential predominates.

2) Commercial areas: where industries, trades and businesses like office complexes, shopping malls, service stations, and restaurants take place. And types of industries such as micro industries, small industries, and medium industries are run based on the availability of raw material at local.

3) Agricultural areas: where framing and cultivation carried out. Paddy, coconut, horticulture and other field crops are cultivated and livestock rearing is maintained in the agricultural area.

4) Fisheries areas: where fishes are caught in large quantities for commercial purposes. (Inland

fisheries and Ocean)

Kalmunai Municipal Council (KMC) covers an area of 22 square kilometers (sq. km) which signifies 0.5 per cent of the Ampara district. The total population of KMC is 88541, which leads to a density of 4024.59 persons per square kilometer and 24675 families living in KMC [4]. The statistical details of the demography of KMC are listed below in Table 1.

Table 1. Statistical details of demography of KMC

Total Area (sq.km)	22
No. of families	24675
Population	88541
Population Density (person per sq.km.)	4024.59

KMC is divided into four zones and 23 wards within the Municipality to better manage the Municipality, and there are 76 Grama Niladari Divisions under the Divisional Secretariat [5, 6]. According to the divisions of the Local Authority (LA) of the government, the wastes generated from all the households in KMC are collected daily, and they are majorly disposed of in open dumping, which is an inappropriate procedure that results in polluting the environment as well creates health hazards to the public. [7]

2 SOURCES OF WASTE GENERATION

Research conducted by the Food and Agriculture Organization (FAO) of the United Nations indicates that in Sri Lanka, 7000 Megatons of solid waste is generated per day, from which Western Province dispenses more than 60 per cent and Eastern Province dispenses 8.5 per cent of the total waste generation of the country [8]. Several types of waste resources generate waste and are released into the environment every day. Within Kalmunai Municipal Council (KMC), 65 metric tons of solid wastes are generated daily, where the Municipality collects 60 to 80 per cent of the municipal solid waste [7]. The main types of waste resources are listed below as:

1. Residential Wastes
2. Industrial Wastes
3. Commercial Wastes
4. Institutional Wastes
5. Construction and demolition Wastes
6. Municipal service Wastes
7. Process Wastes
8. Agriculture Wastes

Among these types, all the sources are considered Municipal Solid Waste, except agricultural wastes [9].

Within KMC, 60 per cent of the waste (1937 metric tons) is generated from residential households, 24 per cent of waste (370 metric tons) is generated from commercial sectors, and 6 per cent of the water comes from streets. Also, the municipality has a huge amount of construction and demolition waste [7]. The types of waste generated within the municipality are listed in Table 2 below.

Table 2. Estimation of Municipal Solid Waste amount produced in KMC

Types of Waste	Waste Percentage
Biodegradable waste	89%
Plastic waste	3%
Metal waste	6%
Rubber waste	1%
Glass waste	1%

3 MANAGEMENT OF WASTE AT THE SOURCE

Managing the waste at the source is the most important step for which the public should be given the necessary instructions to follow. The rules and regulations should be implemented by the Waste Management Authorities in KMC so that it is possible to manage the Municipal Wastes to a significant amount because the considerable participation of the public is very important for sustainable waste management.

3.1 Separate The Waste At The Source

The waste should be separated according to the colour code to be easily handled. Waste segregation colour codes are as follows:

Green - food or biodegradable waste
Orange- plastic waste
Red. - glass waste
Blue - paper waste
Brown - metal and coconut shell
Yellow - Toxic waste

With the implementation of government restrictions, rules and regulations, it is suitable to manage municipal solid wastes significantly. Conducting awareness programs will enrich the knowledge of public considerations for the productive management of waste at the source. And only well-separated wastes should be transported to the facility. Also, recyclable waste should be separated from general waste so that the collection system will take the recyclable waste to the material recovery facility.

3.2 Enable Possible Methodologies To Reduce The Waste At The Point Of Waste Generation

The waste that goes into the facility should be reduced in all possible ways. Motivating the public for home composting and home-based biogas production is a good approach to reducing biodegradable solid waste in KMC. As mentioned above, 90% of the waste here is biodegradable waste, and 60% is residential waste. It will enhance organic compost and biogas, which can be used for individual agricultural purposes and fuel consumption. This will increase the economy and will help to reduce the pollution from the excess amount of waste. Subsidies from the government can also encourage industries to make organic compost and biogas production. Also, people should be instructed to reduce waste generation as much as possible.

4 COLLECTION AND TRANSPORTATION TO THE FACILITY

Waste collection and transportation are the fundamental aspects of any waste management system. Besides, they are critical challenges in towns and cities to collect and transport waste. As mentioned earlier,

the collection of solid waste is carried out by the Local Authorities, PSs, UCs, MCs and PCs. All the local waste management authorities collect the waste to maintain the region clean and clear. The entire waste collection will be transported to the facility, where it will be appropriately unloaded by the authorities for sustainable management.

KMC is divided into four zones to manage a large amount of waste in small quantities. However, proper knowledge is essential for the workers and the public to collect the waste because substantial participation is essential to enhance household waste collection efficiency. The public should be provided proper knowledge of waste handling, separation, storage and processing at the source to efficiently collect and handle the waste to transport to the facility. In KMC, nearly 1200 to 1400 metric tons of Municipal Solid Waste are collected per month, which indicates 66 per cent of efficiency in waste collection [7].

Research indicated that the road network in KMC makes it difficult to collect the waste as it does not allow large tractors and vehicles into the narrow road paths [7]. Such limited conditions reduce waste collection efficiency significantly. Therefore the current resources and waste collection mechanisms within the municipality should be established to improve the collection efficiency.

Moreover, two land masters, eight tractors, two compactors and a truck (a totally of 13 vehicles) are used to collect and transport the waste to the facility, and 75 human labourers, including health workers, drivers and supervisors, are appointed for collection and transportation [7]. Thus the safety of the workers is the most crucial aspect. They should have been given the essential safety instruments and proper uniforms.

5 Possible Suggestions And Proposals For The Sustainable Waste Management At The Facility

After transporting the waste to the facility, it should be unloaded safely. After that, waste sorting should be done, and proper management techniques will be applied to different waste types. Some methods and mechanisms are suggested below, mainly for some kinds of wastes.

5.1 Food Waste Management

Composting on a commercial scale is a suitable option to reduce the waste that goes to the landfill by sending it to the composting site from the facility. Thus the greenhouse emission from the landfill will be reduced. Composting is an eco-friendly process by which food waste undergoes decomposition by aerobic microorganisms. The end product, compost, can be distributed to the agricultural areas within the Municipality. Therefore, it contributes in a social, environmental, financial, and economically beneficial manner. Several composting methods depend on the quantity of waste to be processed, land availability, climate conditions and financial implications. A suitable method should be chosen according to the capability that can be managed.

Biogas production on a commercial scale is another possible solution for food waste management because food waste contains a huge energy potential for generating energy. The anaerobic digestion of microorganisms degrades the organic matter in the food waste. The product, methane gas, can be used as a fuel for transportation or heat or electricity generation.

5.2 Agriculture Waste Management

Agricultural waste or plant waste can be used to produce biodiesel or ethanol as biofuels. Ethanol is a

substitute for gasoline that can be produced from the crops such as corn stalks that is rich in cellulose. Biodiesel is a substitute for diesel that can be produced from the crops such as unproductive oil seeds, which are rich in lipids.

Producing bioplastic is a new technological approach for sustainable agricultural waste management than disposing of it in landfills. Bioplastic can be produced from corn and sugarcane and can be used instead of petroleum-based plastic.

Design and develop natural fibre products such as plastic and Styrofoam substitutes from sugarcane's stalk, which is the waste after the juice is extracted. The natural fibre product is a great alternative; it is compostable and degradable after use. Composting is also applicable for agricultural waste as well as food waste.

5.3 Plastic Waste Management

There are several new technologies used to recycle and upcycle plastic waste. For that purpose, plastic sorting is essential because several types of plastics are available, from which all types of plastics cannot be recycled or upcycled. Fig. 2 below shows the different types of plastics from which type1 and 2 are commonly recyclable. Type 4 and 5 depend on the items; some can be recyclable, and some can't. Type 3, 5 and 7 cannot be recyclable at all.

Fig. 2. Types of Plastic

Nowadays, plastic waste is manipulated under several new innovative ideas that draw towards a circular economy as a closed loop. The sorted plastic waste items can be sent for upcycling processes with new quality and environmental value. Some examples of upcycling methods are listed below:

- Manufacture eco-bricks from compacted bottles
- Produce cutting boards from bottle caps
- Construct 3D printing street furniture and stylish public furniture
- Manufacture mats rugs, bags, shoes, and waste sorting bins from recycled plastic waste material.

5.4 Paper Waste Management

Recycling paper at the recycling factories is an option to deal with paper waste. The paper collected in the facility can be sent to the paper factory to produce new paper.

Rather than that, manufacturing new valuable products from paper waste will add some economic benefits to the waste. Developing paper-based business industries or creating self-employment within the society is much more profitable and will reduce the paper waste that goes to the landfill from the facility. Some commercial end products from paper waste are producing paper bowls, paper plates, paper packets, paper

bags, paper baskets, paper vases, paper frames for photos, paper earrings, and paper wall hangings. So many creative products can be manufactured by upcycling the paper for short-term or long-term usage or decorations. Some paper products are shown in Fig. 3.

Fig. 3. Paper-based new products

Furthermore, manufacturing industrial products on a commercial scale from pulping the paper, molding it to the desired shape and compressing. After it dries, it will be newly upcycled eco-friendly end products such as egg trays, book covers, cardboard packages etc.

5.5 Metal Waste Management

Metal waste can be recycled again and again without any property change. Copper, aluminium, brass, iron, steel are commonly recycled metal types. However, some metallic items such as paint cans, propane gas tanks cannot be recycled. So recyclable metals should be sorted properly. After that, it can be sent to the metal recycling factories where they will undergo different processes like shredding melting purifying and solidifying. Then the brand new end products will be distributed to factories and people who need the metal.

6 Final Disposal of Remaining Material

Finally, the remaining material at the facility should be disposed of properly. The common final disposal method used is landfilling. The currently existing method in KMC is open dumping which creates so many health hazards and pollutions within the municipality. Sanitary landfilling is the most desirable method for final disposal because it is worked out without creating any hazardous impacts on public health and the environment. However, it needs high capital costs and expert labourers. The waste is allowed to decompose into biologically and chemically inert material within an isolated setting from the environment in a sanitary landfill. A schematic diagram of a sanitary landfill is shown in figure 4 below.

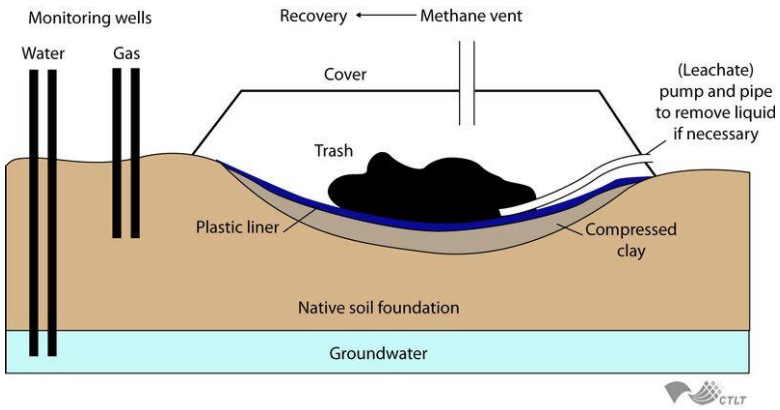

Fig. 4. Sanitary Landfill [Source: http://ocw.jhsph.edu]

However, the remaining hazardous waste material should be separated earlier and transported to the hazardous waste management facilities for recycling, landfilling or incineration properly.

7 DISCUSSION

As per the estimation of waste generation, in Sri Lanka, approximately half kilograms of waste is produced by a single person per day. Thus an effective mechanism should be handled for better management practices. Solid Waste Management in KMC is not conducted effectively and efficiently. Because there are so many restrictions in the area causes for unproductive Solid Waste Management (SWM) system.

An adequate integrated strategy should be executed necessarily because the end-of-pipe solution will not drive the community towards sustainability. To be sustainable, the well-scheduled waste management strategy shown in figure 5 is the best approach. The proper application of this will help to protect the environment and the resources alongside energy consumption that will result in getting maximum benefits from products and to lead the minimum level of waste generation.

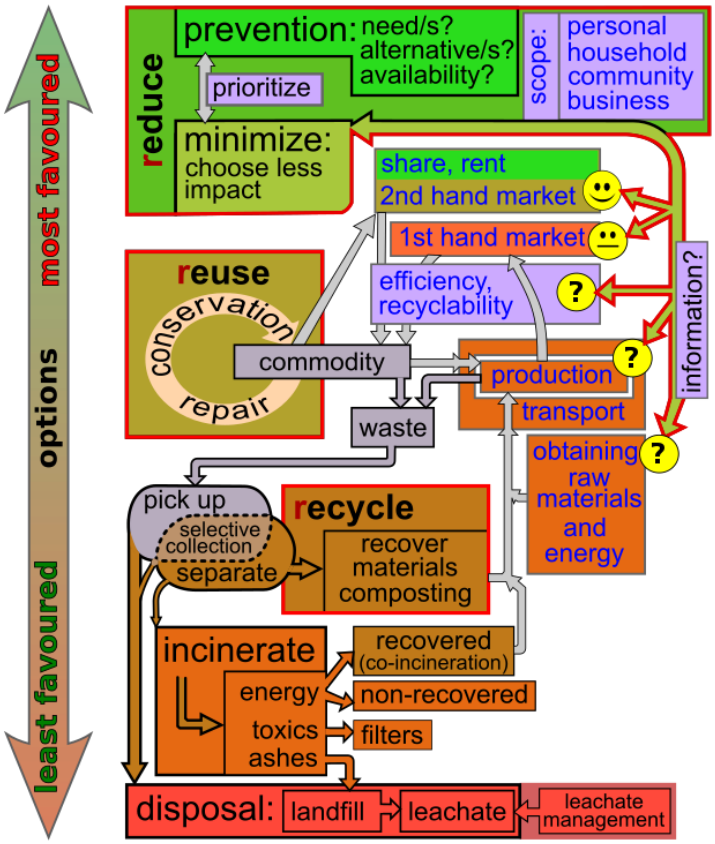

Fig. 5. The Enhanced Structure of Waste Management Strategy

Some alternative ideas for a long term solution for waste disposal.

• Introduce waste-based power plants

Use a particular kind of well-prepared solid wastes to burn for the power plants. Even though it has the main limitation that it will require a huge capital cost for the construction of a power plant based on waste since Sri Lanka is a lower-middle-income country but can be applied by modifying the existing power plants located in Ampara District to implement this idea. This will help to reduce the excess municipal waste collected and the fuel consumption for the plant. However the steps for waste based power plant is in progress. For an example, Bio Energy Solution (pvt) Ltd located in Ninthavur in Ampara district is the power plant that generates electricity from rice husk.

• Acquire new techniques to use the waste as a fuel

Similarly well prepared solid wastes can be introduced within the industries to use as a fuel within the industry for the own industrial requirements also will prevent from creating a huge waste collection.

8 Conclusion

Waste Management is a huge problem in Sri Lanka. Primarily in urban areas, it's a big challenge to execute a sustainable solution. This study of waste management plan covers the sources of waste generation in KMC, how to reduce the waste generation at the source, how to manage the waste at the source applying possible methods and techniques, and finally the disposal methods of the remaining material and some alternative ideas. This will help to maintain sustainability in Municipal Solid Waste Management (MSWM) in KMC to protect and improve human life as well as the environment settings clean and healthy. Moreover, the implementation of this plan will save the environment for our future generation. Besides, it

will be harmful and can affect the economy.

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