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Generation Effects and Management of Municipal Solid Waste: A Review

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Abstract

The heterogenous waste produced commercially, industrially, institutionally and by household activities is called Municipal Solid Waste. It is an unavoidable part of our life which not only affect our environment but also play a key role in life threatening infections. Management of municipal solid waste includes the complete cycle covering all the steps, from inception to final disposal of the waste. The steps include: spotting, collection, storage, effective recycling and final disposal of the household waste in an environment friendly manner. Insufficient service coverage, operational issues in Municipal Solid Waste Management, limited use of recycling processes, improper management of wastes, uncontrolled final disposal, rapid urbanization, life style and weather are the major causes of Municipal Solid Waste generation. Improper disposal of waste results the degradation of environment in the form of surface and ground water contamination through leachate. Soil is contaminated either by direct waste contact or leachate. The burning of waste causes air pollution. Other than environmental degradation, different vectors like rodents, birds, insects and others spread diseases in the society. To solve the problem, an integrated municipal solid waste management system comprises four main levels or processes may be helpful. Prior to these processes, collection and sorting of the waste is necessary. The first level is to access reprocessing facilities for the recovery of secondary materials. It requires comprehensive sorting of the waste. At second level, biological treatment of the food waste takes place. Through this process, the waste can be used to produce fertilizers. The organic waste may also be converted into liquid fertilizers by anaerobic digestion method. Furthermore, energy production by using methane, a by-product of anaerobic digestion method, is also possible. Third level is concerned with the volume reduction of waste by burning. The fourth and last step is the process of ash disposal at landfill sites.

Key words: Municipal Solid Waste (MSW), Municipal Solid Waste Management (MSWM), Metropolitan Corporation Quetta (MCQ).

INTRODUCTION

According to MCQ (Metropolitan Corporation Quetta), The house hold, commercial, industrial and institutional wastes such as Food waste, Garden and Park waste, Paper and Cardboard, Wood and Wood products, Textiles, Rubber and Leather, Nappies and Diapers, Plastics and PET Bottles, Glasses, Metals, Electronic waste, Dust and Ash are known as Municipal Solid Waste.[1]

The constituents of Municipal Solid Waste (MSW) varies in different areas and depends upon the geographic region, people's eating habits, chiefly economic activities and season of the year. [2] and according to Chinese sorting policy, the MSW can be classified into four broad groups as shown in table 1.2. [3]

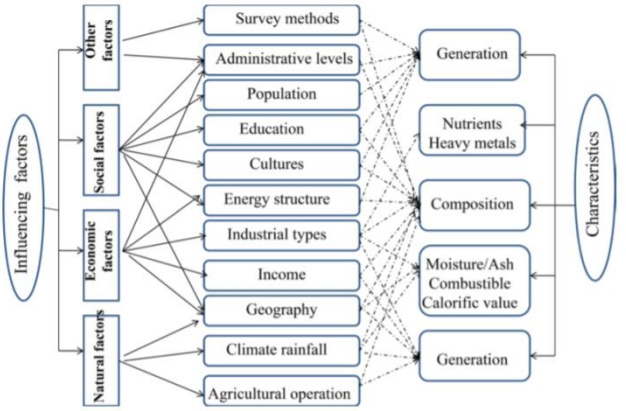

Fig. 1: Factors that affect the rate of waste generation (Han et al., 2018).

Food Waste	Recycling Waste	Landfill Waste	Hazardous Waste
It includes all types of food wastes such as peel of fruits and vegetables, rotted food, etc.	i) Paper ii) Cardboard iii) Textiles iv) Metals v) Glass vi) Plastic vii) Rubber	i) Wood ii) Dust iii) Bricks iv) Ash	i) Paints ii) Heavy Metals iii) Batteries iv) Industrial chemicals

Table: 1.2: Classification of Municipal Solid Waste (Chinese Sorting Policy)

The unexpected high rate of increase in population lead to produce enormous amount of Municipal Solid Waste (MSW). The heterogenous waste produced by household activities, commercially, industrially

and institutionally called MSW is an unavoidable part of our life which can not only affect our environment but also play a key role in life threatening infections.[4]

Due to numerous lifestyles, financial situations and family size, the volume and quality of MSW vary considerably from district to district [5].

An administrator can more efficiently handle and manage the MSW if he knows the exact composition, characteristics and behaviour of the waste. The factors that affect the rate of MSW are summarized in Fig. 2 [6].

Rapid urbanization and growth of the global population is one of the major issues in Municipal Solid Waste Management (MSWM). The aim of this paper is to compile different studies that have been conducted on generation, effects and management of MSW.

METHODOLOGY

The data has been collected through reading by more than 25 research papers available in online search engines, and by interviewing the experts of environmental studies.

Generation of Municipal Solid Waste

Every government provides to its citizens a municipal solid waste management and collection system of some kind. Perhaps, the solid waste management is the most necessary civic service and acts as a condition for other municipal action. As the world population increases; the amount of municipal solid waste, a crucial by-product of human population, increases as well. A decade earlier, municipal solid waste generated per person per day was about 0.64 kg. Today, this amount has increased to 1.2 kg per person per day. It is estimated that by 2025, this amount will likely rise to 1.42 kg per person per day [7].

For the past several decades, solid waste management in the third world countries has not received proper attention. Now, it is a daily life issue and concerns every citizen. In such an alarming situation, development of a fool proof, efficient, environmental

friendly and cost effective municipal solid waste management is highly important.

Management of municipal solid waste includes the complete cycle covering all the steps, from inception to final disposal of the waste. The steps include: spotting, collection, storage, effective recycling and final disposal of the household waste in an environment friendly manner [8]. The present day challenge to the world is the management of huge municipal solid waste in a way that do not compromise on environmental sustainability and safeguard human health as well [9].

Scientific research shows that, about a 25 percent of the global municipal solid waste is not collected at all. Similarly, another 25 percent, after its collection is not managed in the manner it should be. Burning garbage in open air, burying it in the earth without any proper protocol and dumping it in water bodies are some common examples of municipal soil waste mismanagement and serious negligence [10]. According to the environmental scientists, this sorry state of affairs is partly due to the lack of public awareness, and partly due to the absence of recycling facilities, quality research and sufficient research funding [11].

If the condition remains the same, world will have a future characterised by dirty lands, miserable human health condition and environmental (Air, Land and Water) pollution. The need of the hour is to conduct quality research on eco-friendly municipal solid waste management solutions. Further, a pragmatic rather than theoretical approach towards the issue is recommended.

There are numerous issues and problems regarding municipal solid waste management in developing countries. In this regard, various studies have been conducted in the developing countries by the researchers. The relevant studies that may be cited are, Municipal Solid Waste Management: Practices and Challenges in the South-eastern Coastal Cities of Sri Lanka [12]; Municipal solid waste management in Nepal: practices and challenges [13]; Solid waste management in Kolkata, India: Practices and challenges [14]; Municipal solid waste management in Benghazi (Libya): Current practices and challenges [15]; Municipal solid waste management in Bani Walid City, Libya: Practices and challenges [16];

Municipal solid waste management in Malaysia: Practices and challenges [17]. These issues can be placed in the following categories:

1. Insufficient service coverage (i.e. services are delivered to some areas where the others remained neglected).
2. Operational issues in municipal solid waste management by the local governments.
3. Limited use of recycling processes.
4. Improper management of waste that may cause serious human health problems.
5. Uncontrolled final disposal of municipal solid waste.

Municipal solid waste systems in the underdeveloped world usually serve only a part of the total population. The areas which do not have waste collection facilities are generally the low-income population.

A major reason of mismanagement is the lack of funds to deal with the growing amount of waste produced by the rapidly growing cities. Low fees charged and insufficient funds allocation can not finance the required service delivery. Further, the available resources are often given to the high-income areas from where more taxes are collected and people with more political influence live there, so the poor areas remain unserved [18].

However financial problems are not the only reasons for the absence of a sustainable waste collection service. In a significant number of cases, the technical problems also act as impediments to proper service delivery and more population coverage. In developing countries, conventional waste collection methods are often applied and they cannot afford the use of advanced machinery and sophisticated vehicles [19]. Other irregularities of the concerned staff further worsens the problem. Only a small part of the waste collection vehicles fleet pay their duty honestly, where a major number workers usually do not remain in operation.

Local governments in some of the developing countries generally spend from a quarter to half of the total municipal expenditure on municipal solid waste management. In spite of enough expenditure on managing the municipal waste, service level remains low [20]. Waste collected by the municipal authorities ranges from 45

percent to 72 percent of the total generated which serves less than half of the total population. After collection, it is mostly disposed of in uncontrolled open dumps. Such operational inefficiencies of solid waste management operated by municipalities are caused by ineffective institutional structures and organizational procedures. The use of unsuitable technologies also adds to the problem. On the other hand, informal sector has been playing an important role in solid waste management, but the local politics and the general corruption usually disrupt their efficiency [21].

Effects of Municipal Solid Wastes

A major part of the municipal solid waste in the underdeveloped countries is dumped openly in an uncontrolled manner. Such a flawed disposal of waste seriously affects the environment that may damages animal and human health. Moreover, it often results in many other welfare losses. Improper disposal of waste results the degradation of environment in the form of surface and ground water contamination through leachate. Soil is contaminated either by direct waste contact or leachate. The burning of wastes causes air pollution. Other than environmental degradation, different vectors like rodents, birds, insects and others spread diseases in the society.

In the last few decades, the rapid urbanization, bad governance and mismanagement cause the settlements of people and building of housing societies around the uncontrolled and unsupervised dumping sites. These sites which were formerly established far from the cities now have become densely populated areas. Residents of such areas are at high risk of diseases. The nearby uncontrolled and open dumping sites pose a direct threat to their health. In many underdeveloped countries, it is noted that the poverty-stricken homeless people erect their camps even on the dumping sites. Majority of such people are manual labours working on daily wages who frequently visit the city. They interact there with people in one way or the other, and if they are diseased, because of the highly unhygienic conditions of their living area, they may cause a disease spread [22].

The current municipal waste disposal situation is likely to become more serious in the coming years. At present, the dumping

sites are not very far from the waste collection areas. With the increase in population and rapid urbanisation, the governments have to transfer the dumping sites farther. As the governments already allocate less funds to the municipal waste management, hence it will become more difficult for them to transfer huge amounts of waste from the collection to dumping sites. They will need more labour, more vehicles and other equipment, and the overall management cost will increase automatically. Not only this, investments will be needed to build more roads and develop the infrastructure, generating further issues. The problem of already low service coverage will intensify as well.

The land and water pollutants can transfer to terrestrial and aquatic food chains, placing the health of the entire population at risk. In addition to this, air pollution caused by improper dumping and burning of wastes produce dangerous aerosols and volatile compounds, inhalation of which can make people seriously ill [23]. Unfortunately, it is true that the resourceful and high-income populations focus on the removal of waste from their immediate surroundings only, while do not pay any attention to the outside areas. This behaviour needs to be discouraged because the harmful consequences of improper and uncontrolled dumping practices have no regard for social stratification.

Management of Municipal Solid Waste

Lack of proper guideline for selection, designing and operating new landfill sites; and quality research that may provide suggestions for possible upgradation the existing improper dumps of waste are among the other reasons of the current disarray.

To solve the problem, an integrated municipal solid waste management system comprises four main levels or processes may be helpful. Prior to these processes, collection and sorting of the waste is necessary. The first level is to access reprocessing facilities for the recovery of secondary materials. It requires comprehensive sorting of the waste. At second level, biological treatment of the food waste takes place. Through this process, the waste can be used to produce fertilizers. The organic waste may also be converted into liquid fertilizers by anaerobic digestion method. Furthermore, energy

production by using methane which is a by-product of anaerobic digestion method is also possible. Third level is concerned with the volume reduction of waste by burning. It is necessary to burn only a selected part of the municipal solid waste for which there is no other alternative. Though burning of waste is discouraged, but if the purpose is to reduce its volume before the final disposal in landfills, then it may be acceptable. The reason for acceptability is that small volume of waste in landfills helps in reducing land and water pollution. The fourth and last step is the process ash disposal at landfill sites [24].

At present, increase in the amount of waste is because of increase in population. The management of huge amounts of municipal solid waste is becoming difficult day by day. It is necessary to strive for decrease in municipal waste generation, and find sustainable solution for its management. Such solutions should focus on reduction in waste generation, recycling, composting, eco-friendly production, bio digestion and hygienic disposal.

According to an estimate, about half the total household waste is mainly consist of paper, plastic, glass and metals. These materials are potentially recyclable [25]. There is a need of such incentive campaigns which promote participation in recycling activities to minimize the municipal solid waste generation from sources. Cooperation among the government institutions, private sector and nongovernmental organisations (NGOs) is required for the success of the said campaigns [26]. The efficiency of a recycling process depends upon the separation and sorting of recyclable materials. This task is usually accomplished by scavengers i.e. garbage and junk collectors. They collect, separate and sort waste at dumping sites with naked hands. It is obvious that such activities are inefficient and very unhealthy as well [27]. So there should be some well organized system, following proper protocols, for the separation of recyclable materials from the mixed municipal solid waste and the subsequent sorting.

Use of reusable items is very helpful in addressing the issues in municipal solid waste management. This is possible only through collaboration and cooperation between the government and the concerned industry. Use of the so called disposable (single-use) daily

items like plastic bags, cups, bottles, plates, boxes, spoons etc. should be discouraged. Concerned authorities, on one hand, should keep a check on the production of the these items, and on the other hand, should spread awareness, among the public, of the harmful consequences of using these items. Along with this, environmental friendly reusable items should be promoted. These measures will reduce the municipal solid waste volume, hence reduce the environmental pollution.

The degradable bio-products is an excellent option to replace non-degradable items mentioned previously. The environmental friendly nature of these products adds more to their worth. The world generates huge amount of agricultural waste and crops residues, and a considerable amount of organic or food waste is generated by the house holds. These two types of waste have a great potential for production of eco-friendly bio-products. Examples of such products include green packaging and bio-plastic bags developed by using crop or plant starch. They can be easily broken down by composting, burying or exposing to sunlight. Additionally, municipal solid waste volume, and the cost of recycling and transfer from collection to dumping sites can be significantly minimized in this way.

From the governance perspective, incentive based enhanced public participation is required for the activation of waste management market. Special initiatives to boost such activities are needed. An example of such programme comes from Curitiba (Brazil) where waste is purchased by the municipality and vouchers are given to the sellers. The vouchers are later exchanged for different food items. In this way, the practice of open uncontrolled dumping and municipal solid waste in the streets has been minimized to a great extent. This is also an example of treating waste as a resource. Another case study in this context is that of Cuauhtémoc (Mexico) where one bag of principal food items is given for six bags of household waste. People are also given the option to suggest food type inside the food bags. Such initiatives are really helpful in making municipal solid waste valuable and treating it as a resource [28].

Awareness raising campaigns too, are expected to mitigate the present municipal solid waste management crisis, because a better public understanding of the issue is necessary. Along with this,

inclusion of household waste management in the regular curricula is highly recommended. The concerned authorities are required to encourage the participation of masses in suggesting strategies to deal with the problem. For this purpose, the authorities should work for effective communication [29].

One way to address the issue in the areas which are low-income, and where proper municipal waste collection facilities are not available, is to take the responsibility of waste collection by the areas themselves. The system of waste collection should be in accordance with the economic standing of the area. For example they may hire private paid waste collectors to transfer the waste to larger collection points. If a household cannot afford a paid waste collector, it will have to carry out the work itself. The purpose is to prevent the unhygienic and uncontrolled open dumping, and to transfer the municipal solid waste to the reprocessing facilities where it can be made useful [30].

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