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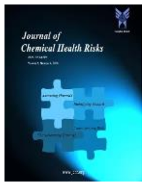

Best Practices in the Disposal of Municipal Solid Waste and use of By-Products– A Global Perspective

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KEYWORDS

Disposal, Municipal Solid Waste, Global Perspective

ABSTRACT:
The global experiences of Municipal Solid Waste Management (MSWM) in different cities have shown how important it is to plan and implement an integrated MSWM method that focuses on making municipalities run better so that all stages of MSWM can be done in a way that is sustainable. As part of MSWM, waste is generated, separated, transported, transferred or sorted, recycled, treated, disposed of, and overgrown materials are used. Participation of all stakeholders mentioned (Teshome et al., 2022) is needed for this method to work, while taking into account the environmental, financial, legal, institutional, and technical factors that are unique to the area (Al Ansari, 2012) is also important. Life Cycle Assessment (LCA) can also help narrow down the options and create a thorough plan for dealing with trash [Gunamantha, 2012]. Therefore, the MSWM method needs to be carefully chosen so that residents don't have to deal with any negative health and environmental effects [Suthar and Sajwan, 2014].

The global experiences of Municipal Solid Waste Management (MSWM) in different cities have shown how important it is to plan and implement an integrated MSWM method that focuses on making municipalities run better so that all stages of MSWM can be done in a way that is sustainable. As part of MSWM, waste is generated, separated, transported, transferred or sorted, recycled, treated, disposed of, and overgrown materials are used. Participation of all stakeholders mentioned (Teshome et al., 2022) is needed for this method to work, while taking into account the environmental, financial, legal, institutional, and technical factors that are unique to the area (Al Ansari, 2012) is also important. Life Cycle Assessment (LCA) can also help narrow down the options and create a thorough plan for dealing with trash [Gunamantha, 2012]. Therefore, the MSWM method needs to be carefully chosen so that residents don't have to deal with any negative health and environmental effects [Suthar and Sajwan, 2014].

So, local governments need to strictly enforce environmental laws and keep a closer eye on people's civic duties for long-term trash collection, storage, and disposal, as well as the health risks of poor MSWM, which can be seen in the visible trash in most cities of the Global South [Usman et al., 2017]. As a way to prevent people from doing things that are bad for the environment, breaking rules about waste should also be punished [Vazquez, 2020]. Additionally, local governments must make sure that garbage collection services reach all areas, including poor and minority neighbourhoods [Olukanni, et al., 2020]. Getting to a circular economy and sustainable growth will also require local governments to make better MSWM policies that focus on reducing waste, reusing items, and recycling [Muheirwe et al, 2022].

A "sanitation" system is one that collects, treats, and disposes of wastewater and sewage in an appropriate manner so that it does not pose any health risks to humans. Potential danger can take the shape of microscopic diseases, chemical poisoning, physical damage, or biological agents. Ecosystem health depends on the proper disposal of human waste, including solid waste, sewage, sullage, and grey water from homes, businesses, and farms. Pee and faeces can be safely and readily disposed of with the use of a sanitation system (Dobe et al., 2011; WHO, 2018). An approach to ecological sanitation could be

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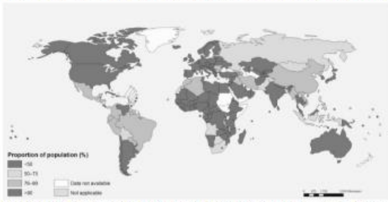
described as "the regulation of all those factors in man's physical environment which exert or may exercise a detrimental influence on his physical development, health and survival" (Menzies, 1951). If we want to make the world a healthier and less sickly place, we must do something. Improvements in health and living situations are its primary aims. One may make the case that managing noise, pollution, industrial waste, and solid waste is all part of environmental sanitation. Collecting indicators from public health, socioeconomics, natural resources, and water conservation, the Environmental Sanitation Indicator (ESI) is a compilation of metrics. Here, common metrics include water supply, sewage treatment, solid waste management, vector control, socioeconomic level, and hydro resource risk.

In order to make these indicators even more useful for environmental sanitation, more data on the towns and/or regions can be added by following the steps in the ESI's Basic Manual. The Global Sanitation Situation Inadequate sanitation and a lack of resources make an estimated 2.4 billion people worldwide particularly vulnerable to infectious disease transmission and illness, according to a 2015 Joint Monitoring Programme by the World Health Organisation and the United Nations Children's Fund. Figure 1 illustrates that around one-third of the world's population lacks access to basic sanitation, as measured by the percentage of individuals using contemporary sanitation facilities. Their current method of disposing of waste water and excrement is unsafe. There have been and will be further attempts to alleviate this problem, but 40% of the world's population still lives in areas without access to basic sanitation. The figure does a poor job of showing how accessible sanitation is in rural areas compared to urban areas. On the African continent, 84% of city dwellers and 45% of rural residents have access to decent sanitation, indicating a large gap between the two. World Health Organisation statistics from 2000 shows that only 31% of rural dwellers had access to adequate sanitation, despite the fact that 78% of Asians live in metropolitan areas. Assuming they are well-built, composting toilets or VIPs are usually sufficient.

However, increased cleanliness is not always easy to achieve; for example, in rapidly expanding urban slums. An important health intervention is improved sanitation facilities; however, they will only be useful if people not only use and maintain them properly, but also practise very good personal and domestic hygiene (Carr and Strauss, 2001). The World Health Organisation and the United Nations Children's Fund both agree that access to safe drinking water, adequate sanitation, and practicing good hygiene are foundational to health, survival, and development (2006). Regardless, according to Moe and Rheingans (2006), 1.1 billion people do not have access to improved water sources, and 2.6 billion do not have basic sanitation. About 9.1% of all diseases and 6.3% of all deaths worldwide are caused by water pollution, poor sanitation, and lack of personal hygiene (Prüss-Üstün, et al., 2008).

Figure-1: Proportion of World population using improved sanitation facilities (%)



Source: WHO (2015), Map Production, Information Evidence and Reaearch (IER)

Importance of Clean Water in India

The sanitation system in India has been the subject of several research during the last two decades. In their study of the Baigas of Dindori District, Samnapur Block, Madhya Pradesh, Dwivedi and Sharma (2007) examined personal hygiene, sanitation practices, and environmental cleanliness. Thus, 100 families with 494 persons using pre-tested organised routines were examined using a semi-participant random selection technique. Researchers concluded that environmental sanitation was satisfactory but not great for people's personal hygiene.

Public support for environmentally responsible waste management practises is crucial to the creation of efficient MSWM systems [Almulhim and Abubakar]. The year 2021Print, online, and social media campaigns should be run to raise awareness about the need of not littering and of using the correct ways for dumping and sorting trash [Nahman and Godfrey, 2010]. The public must be educated about the significance of sorting trash at the source and given sorting bins in order to optimise subsequent SWM operations and reduce their negative impacts [Dangi et al., 2013]. When it comes to reducing trash, recycling more, and sorting and separating materials at the source, community groups and NGOs can also be powerful allies. A complete recycling programme is required by certain waste management techniques so that all materials can be utilised in the end. Among the most typical methods are these:

(1) For instance, Tsai et al. [2021] discovered that in Vietnam, for sustainable SWM to be achieved, it is essential for stakeholders to coordinate and for there to be suitable legislative and policy frameworks.

(2) On page two The necessity to modernise current facilities or utilise environmentally friendly technologies has been demonstrated during the last fifty years. Particularly for non-recyclable waste, some academics looked at why incineration is preferred over other approaches.

(3) As an example, Xin et al. [2020] discovered that solid waste in Beijing was able to reduce its greenhouse gas emissions by 70.82% through incineration, recycling, and composting.

(4) Part four The optimal scenario for lowering greenhouse gas emissions in Tehran city, Iran, was found by Maghmoumi et al. [2020] to involve incineration of 50% of the garbage, landfilling of 30%, and recycling of 20%.

(5) Composting and biogas production seem to be the preferred methods for organic waste, according to multiple research.

(6) It is important to control landfilling by implementing better methods for detecting leaks and collecting leachate and biogas, even though some researchers have called for a total ban on the practice [Deus, et al., 2020].

(7) A number of scholars have proposed combining biological and mechanical methods to remediate solid waste (BMT) [Hong, 2006].

(8) By 2035, the waste-to-biogas plan, landfill ban, and open burning measures in Kenya are projected to cut waste-related emissions of greenhouse gases and particulate matter 2.5 by more than 30%.

Therefore, it is clear that plants, animals, air, soil, and water (both surface and subsurface) are all helped by a well-planned landfill. For MSWM to be effective—and to create jobs, better health, and environmental protection—it must be able to extract and reuse materials, energy, and nutrients. To illustrate:

[i] According to Menikpura (2013), recycling 24% of MSW in Thailand reduced the harmful effects on health, society, the environment, and the economy caused by landfills. The SWM system should incorporate waste pickers, who are essential to waste circularity, and involve them in decision-making (Menikpura, 2013).

The people who collect trash also need to be better prepared to deal with dangerous materials. Furthermore, eco-friendly purchasing practices including bioplastics might contribute to lessening the detrimental effects of solid waste on the natural world.

In order for municipal solid waste management (MSWM) to be effective, local authorities need to take a holistic approach to resolving MSWM issues including inadequate planning, ineffective recycling and trash collection, underfunded budgets, a lack of trained waste management experts, and poor leadership. Only then can they integrate financial regulations to address MSWM. Additional variables that affect the efficacy of a SWM system include garbage production rate, population density, economic standing, degree of commercial activity, culture, and location/city/region. Thorough, end-to-end planning are necessary for an MSWM programme to be sustainable and to effectively safeguard both public health and the environment.

Vermi-Composting

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The term "vermi-composting" refers to a method where the organic matter in solid waste is turned into manure by using earthworms to break it down. The byproduct of vermicomposting is an excellent source of nutrients for crop fertilisation. In environments with temperatures ranging from 20 to 40 °C and humidity levels between 20 and 80 percent, you can find earthworm species such as Perionyx excavates sp., Eisenia sp., and Pheretima sp. It is often believed that modern-day city dwellers are to blame for the 50 MT of solid trash produced daily. Five times their own weight is consumed by waste by these worms.

The vermi-composting factory in Bangalore, India, has the biggest capacity at 100 MT/day. Established vermicomposting plants can be found in Hyderabad, Bangalore, Mumbai, and Faridabad. It takes a lot of space for land to compost, and there have to be precautions to make sure that hazardous elements in garbage don't kill the earthworms.

Thermal Treatments for MSWM

This technology's primary objective is to reduce the emission of harmful waste and treatment byproducts. Incineration, gasification, and pyrolysis are the main technologies.

Incineration

The incineration process involves burning solid trash at high temperatures as a means of removal. Incineration temperatures typically fall between 980 and 2000 °C. Due to the high temperature, the waste is reduced to ash and gaseous product gas is released as a byproduct. Both the recovery of energy and the removal of harmful substances are outcomes of this process.

Burning trash can reduce the volume of combustible waste by as much as 80 to 90%. At sufficiently high temperatures, this property can be developed, and its original volume can be reduced by up to 5%. More than that, it's a clean, odourless, and noiseless process. Due to the high expense of transportation, these thermal facilities should ideally be built closer to the waste's origin. These incineration procedures are often utilised in affluent countries like Japan that do not have enough space for landfills.

Incineration, on the other hand, has the ability to release pollutant likedioxins, furans, and PAHs into the air. With regard to these long-lasting chemical substances, mostly

[i] PCDDs, or polychlorinated dibenzoethanes
ii) PCDFs, or polychlorinated dibenzofurans
iii) PCBs, or polychlorinated biphenyls

As a result of incomplete combustion, PCDDs and PCDFs are the most common types of municipal, medical, and domestic waste. These processes also release SOx and NOx into the atmosphere. There is a high operational and maintenance cost associated with this approach type, which requires trained staff.

For a sum of Rs. 250 million, the Delhi Municipal Corporation had an incineration plant set up in 1987 in Timarpur, Delhi. This facility can generate 3.75 MW of electricity and can process 300 metric tonnes of waste each day. But its high maintenance cost and poor performance led to its forced shutdown. The majority of solid waste consists of organic matter, inert materials, water, and other forms of trash that contain water. The lack of widespread use of incineration in MSWM Indian approach is likely due to this same reason. In smaller towns, this method is mostly utilised by larger institutions and hospitals, such as BARC, which built a facility in Trombay, Mumbai, to handle their institutional garbage.

Pyrolysis

The steps in this process involve pyrolysis, which is the heat degradation of a chemical in the absence of oxygen. In pyrolysis, an external heat source must be maintained continually because the temperature ranges from 300 to 850°C. Pyrolysis is a waste management technique that produces synthetic gas and char. Char mostly consists of carbon and non-combustible elements, with a significant amount of syngas such as methane, carbon monoxide, and hydrogen. Not only may these gases be used to create fuel oil, but they can also be condensed to make wax and tar.

Gasification

The gasification process is a hybrid of combustion and pyrolysis that occurs when there is not enough oxygen to completely oxidise a substance. The normal operating temperatures for this exothermic process are greater than 650 °C. It is necessary to dry and sort garbage before application. Hydrogen, carbon monoxide, and methane make up the syngas that is produced during the process. This approach has the potential to recover energy and replace natural gas as fuel gas using this syngas instead.

Because there isn't enough oxygen, gasification doesn't release any harmful gases like SOx and NOx, unlike incineration. Because of the potential impact of waste's high moisture and inert content on efficiency, this procedure necessitates substantial funding and a reliable power source. Operations and transportation can both contribute to the production of materials with a high viscosity. Proper management and disposal are also required of the solid, non-combustible residue component following gasification. To create an inert residue (ash), plasma gasification technology applies intense heat (electric arc) to the waste material. As a result, the inert material vitrifies and the tar component cracks, allowing clean syngas to be released.

India started off with just two gasification facilities. Both are located on the Gaul Pahari campus in New Delhi and Nohar, Hanumangarh, Rajasthan, respectively, and are run by Narvreet Energy Research and Information (NERI). One gazification facility is operated by the Tata Energy Research Institute. It is possible to treat 50-150 kg of trash each hour with NERIFIER, which has an efficiency of 70-80%.

Conclusions

Most solid trash is burned in open areas, which contributes to pollution, and any leftover solid waste is thrown wherever, which increases the burden of certain diseases, according to solid waste management. Also, when it comes to managing liquid waste, the majority of it ends up in the open, where it contaminates surrounding water supplies and, in turn, spreads a host of dangerous diseases. The epidemiological data shows that diseases like scrub typhus, hepatitis, and diarrhoea are becoming more common in the region being studied.

The majority of homes were practicing proper personal hygiene, but they were not practicing safe water consumption, which was causing a rise in water-borne infections.

By consistently practicing proper sanitation and hygiene, we can reduce the prevalent pattern of disease burden. Consequently, the area's political and local bodies, in addition to more IEC/Awareness initiatives about "Swacchta," are required to achieve this goal.

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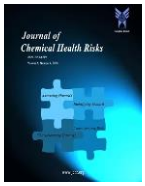

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