Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 10 [8] July 2021 : 38-47

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

REVIEW ARTICLE **OPEN ACCESS**

Impact of Corona Virus Epidemic on Solid Waste Management: Challenges, Opportunities, and Progress

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ABSTRACT
Waste management is critical to human development and health outcomes, especially during the COVID-19 pandemic, as masks, gloves, and PPEs are essential to human life and have added more solid waste. Right now, the whole world has been trying to cope with this deadly virus ever since it was discovered, and for that, several lockdowns and curfews are imposed at various places. People are encouraged to stay home and keep working indoors, which has increased online purchasing of food, medicines, cosmetics, and various other kinds of stuff. The present paper examined existing solid waste management (SWM) processes, emphasizing SWM treatment and disposal facilities during COVID 19 pandemic. The data and information used in this paper are collected from various e-resources, including multiple scientific research studies from different domains, publications from multilateral and governments agencies, and media reports. Despite limited literature on solid waste management during such outbreaks, this article presents a global backdrop and examines various aspects of SWM. In addition, the impact of COVID-19 on global solid waste management strategy has also been introduced in the study, focusing particularly upon challenges, opportunities, and progress related to the Indian solid waste management system and types of solid wastes produced from different places and commodities.
Key Word: COVID-19 epidemic, Bio-medical Waste, Solid Waste Management (SWM), waste reusing Solid Waste (SW)
Received 29.06.2021 Revised 06.07.2021 Accepted 15.07.2021

INTRODUCTION

Solid waste management (SWM) has emerged as a matter of gigantic concern globally and subsequently in the Indian subcontinent. Various studies show that waste removal creates hazardous gases and leachates because of microbial disintegration, environmental conditions, and landfilling activities. As indicated by the twelfth"Schedule" of"the"74th Constitution Amendment Act of 1992", the nearby urban local metropolitan bodies (ULBs) are liable for cleaning the urban areas and towns. In any case, most ULBs need sufficient funds and face many challenges like poor institutional limits, monetary limitations, and an absence of a political will [1]. India has effectively depleted all accessible landfill destinations, and the concerned ULBs do not have the assets to obtain new land. Different enactments have been passed for managing the way of garbage removal. The Ministry of Environment, Forest and Climate Change (MoEFCC) and the Ministry of Housing and Urban Affairs (MoHUA) carried out strategies and projects to resolve these issues. In any case, the greater parts of these have neglected to accomplish their targets because of an absence of lucidity and mindfulness among the partners and helpless authorization by the controllers [2]. Because of the aggregation of waste or waterlogging, the danger related to the pervasiveness of microbes in the supplied water and contamination removal may enhance numerous folds [3]. Sweepers, rag pickers, and medical care staff are straight forwardly presented to such waste and may become tainted, at last hindering the region's neatness.

Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) is the term related to the current COVID-19 illness, which is identical to two earlier epidemics, severe acute respiratory syndrome coronavirus (SARS-CoV) and middle east respiratory syndrome coronavirus (MERS-CoV)[4]. The COVID-19 pandemic exemplifies this era's main worldwide health issue, as it claimed the lives of 2.45 million inhabitants;

nevertheless, 62.3 million individuals recovered. There are 111 million individuals affected in all. COVID-19 is highly contagious and has spread rapidly worldwide; transmission occurs mainly via direct touch or by droplets emitted by an infected person while coughing or sneezing. However, in some situations, it appears to be asymptomatic [5].

This epidemic, especially worldwide, has affected different areas that brought about financial breakdowns [6]. Spit or moisture contained in the cough, sneeze, or breath of an infected person is one of the primary sources of virus infection. However, optional origins are aberrant connections, for example, transfer of disease from an inactive surface of metals contacted by a contaminated individual. SARS-CoV-2 has tainted an immense populace and prompted bounteous fatalities across the world. The burial ground and incineration focus have noticed an unexpected increase in the surge of dead bodies that prepared staff appropriately outfitted with PPE must be taken care of. The ICRC (International Committee of the Red Cross) has offered rules to deal with the dead by keeping up with staff security, and the nobility of the expired Could not understand. During this COVID-19 era, PPE kits, masks, and sanitizers are essential for everyday routine, and more burden has been added to SWM because of the addition of these wastes. As lockdown and several restrictions are imposed, and people are encouraged to work from home, therefore, production of waste is more, and its management is a bit more difficult [7].

In order to maximise old systems to satisfy the urgent situation, several technological processing, separation, transportation, collection, and effective waste management innovations are needed [8]. Patients, health care professionals, and waste collectors may be exposed to wounds, illnesses, harmful effects, and air quality due to improper healthcare waste management [9]. Many kinds of wastes have been created, such as biological waste, radioactive material, clinical waste, contagious waste, industrial waste, lethal waste, needles and syringes, and pharmacological waste [10].

A BRIEF OVERVIEW OF DIFFERENT MEDICAL WASTE DANGERS

All trash created by medical institutions, clinical labs, and biologic testing institutions and by small or dispersed sources is categorized as medical waste. Although clinics create the majority of medical waste in terms of quantity, they account for just a tiny portion of the overall variety of origins. The following standard categories can be used to categorize medical waste:

(The following is almost the repetition of wastes that have already been described above)

a. Sharps waste
b. Pathological waste
c. Other infectious waste
d. Pharmaceutical waste, including cytotoxic waste
e. Hazardous chemical waste
f. Radioactive waste
g. General (non-risk) waste

Clinical waste contains microorganisms (disease-causing bacteria, viruses, parasites, or fungus) in high quantities or volumes to induce sickness in intermediate hosts. Cause of infectious material interactions among garbage pickers, trash professionals, health professionals, clinicians, and the general public where garbage is illegally discarded, inappropriate handling and removal of biomedical waste offer severe risks of subsequent transmission of infection. Waste disposal employees and the surrounding neighborhood are exposed to hazardous pollutants in air and ash from combustion and incinerator without proper reducing pollution.

WASTE GENERATION SCENARIO DURING THE COVID – 19 PANDEMIC

Because of the COVID – 19 epidemic, there is an enormous change in the outlook of waste produced (e.g., a rapid expansion in quantity and compute of different types of plastic burns utilized in various food bundles or single-use items such as PPE, masks, gloves, respirators, syringe, and so forth [11]. The decrease in petroleum product cost and doubt over the immaculateness of recyclables are different components answerable for the dive being used for plastics that are only used once. Presently, the interest for PPE has arrived at emergency mode, and reusable stuff is being avoided because of the great odds of viral infection. To forestall the airborne transmission of the infection, everyone needs to wear a mask or facial shield that has added a lot to the solid waste [12]. To limit the spread of the infection, cafés and bistros are utilizing one-time-use bundling materials [13]. Then again, during the lockdown, because of limited travel, telecommuting, expanded e-marketing, the homebound higher food utilization has contributed enormously to the waste. Interestingly, the waste produced from a few mass get-togethers is forestalled [14]. In Italy, Politecnico di Torino has anticipated that during stage 2, while the people movements continue, the month-to-month interest for covers and gloves will increase to over 1 billion.

A few associations such as"Operation" Mer"Propre" (France)," Thames21" (London), Oceans Asia (Hong Kong) have communicated worry regarding sloppy removal of covers and"PPE" that finish into the water bodies and have prompted contamination of plastic waste blast. The plastic-based shields, wipes, and utilized sanitizer plastic jugs add a burden to the landfills. The ill-advised removal additionally adds to rive downpour and marine contamination. Such pollutants meddle with the typical environment of the creatures and upset them [15]. The infection might be available outside the covers and come in the water bodies, undermining individuals in touch with it. Overall, Italy has expressed those 10 million shelters will be scattered in the climate within a month. If by some stroke of good luck, 1% of absolute covers are not discarded as expected, each veil gauging 4 g that will weigh up to nearly 40,000 kg plastic, representing an extremely horrible picture. Ill-advised removal of bio-medical waste is the reason for groundwater and soil defilement that unfavorably influences the biota [8].

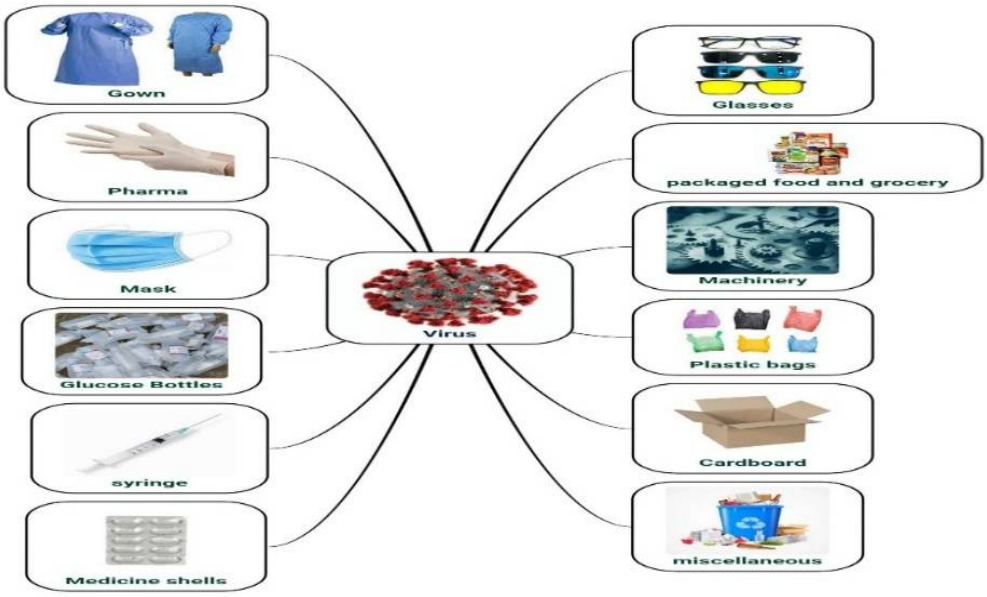

Fig 1. Types of waste produced during the pandemic

Because of the diverse SW rehearses, the agricultural countries face a more danger of tainting through waste and wastewater than advanced nations. The advanced nations have eco-friendly and safer strategies to deal with waste. Interestingly, in agricultural countries, the waste is, for the most part, dumped into hazardous landfills, and the rag pickers frequently visit unloading ground with no wellbeing gear. It might transmit the infection and make the situation more convoluted [8].

WHO has classified "medical care squander" into the following categories [16]

a) irresistible waste comprising of blood and body-liquids
b) infectious waste from patients
c) obsessive waste contains human tissues
d) sharp metallic garbage like careful edges, needles, and so on
e) compound waste comprises sanitizers, sterilant, mercury,etc
f) polluted medications
g) cytotoxic waste and their metabolites having genotoxic properties
h) Radioactive and general waste

As a general rule, bio-medical waste contains profoundly irresistible and risky things for the staff dealing with them. Throughout the epidemic, the number of infected people increased in the emergency clinics is significantly more than expected, so the medical clinic and lab wastes increased tremendously. The waste produced is hazardous because of the high risk of transmission and should be managed daily to forestall stacking [19].

Table 1. Country-wise guidelines for waste management (Source: Conservation & Recycling 162 (2020) 105052)

Country/Agency	Guidelines for waste management
China	The People's Republic of China's Ministry of Ecology and Environment released "COVID-19 Infected Pneumonia Medicine Waste Emergency Disposal Management and Technical Guide (Trial)," which states that harmful medical waste created during the anticipation and management of pneumonia epidemics are supposed to be adequately packed according to the requirements containers, unique packaging bags, and warning labels. The gathering and management of hazardous pharmaceutical waste produced during the management and cure of outbreaks must be prioritized by hazardous waste management units. Toxic waste burning plants, household waste incineration facilities, commercial burners, as well as other urgent removal operations for clinical waste must be carried out in line with the relevant health authorities' regulations. The methods for collecting, storing, transferring, and disposing of medical waste could improve staff hygiene protection [32].
EU	Tissues and masks utilized by the infected person should be quickly placed in the dustbin set in the patient's room. A subsequent sack should likewise be kept independently for putting away gloves and facemasks utilized by the caretakers. Without fail, the gathered bag should be kept congested and must not be moved into another pack. All such sacks should be picked and moved to a general trash container[33].
India	There should be a proper separate record of the virus-related waste stuff. The infected waste can be straightforwardly carried from the infected room into the CBWTF (Common bio-medical waste treatment and disposal facility) assortment van. The waste assortment sacks should be set apart as 'Coronavirus squander.' The naming is to guarantee the need for prompt management action and removal on being received at CBWTF. The management ought to promptly reach the sterilization staffs independently for bio-medical and general solid waste removal. This is to ensure the prompt removal of waste to the assigned waste storage area. They ought to guarantee that the disengagement wards utilize committed streetcars and assortment containers marked as 'Coronavirus waste. Aside from bio-medical waste, if any, it should be taken care of according to the current MSW law. Bio-medical waste should be gathered in a twofold layer of yellow-hued sacks, and canisters should be collected in twofold layers of yellow-hued packs and containers. Isolate camps/homecare offices should educate CBWTF administrators as and when the waste is created. Hence, the CBWTF guarantees opportune assortment and removal at their Urban local bodies (ULBs) ought to draw in CBWTF to get any bio-medical waste from homecare for individuals with symptoms. This can be straightforwardly from home or approved/recognized assortment focuses. CBWTFs should report the receipt of COVID-19 waste. They ought to guarantee standard sterilization of staff engaged with taking care of an assortment of COVID-19 waste. The team engaged with the assortment, movement, and treatment of COVID-19 waste should be given sufficient PPEs, including layers veils, nitrile gloves, gumboots, and wellbeing goggles. The assigned vehicle utilized for the assortment of COVID-19 waste should be appropriately labelled. It ought to be cleaned with sodium hypochlorite after every use. CBWTFs should guarantee that viral waste is arranged off promptly reaching the office while keeping up with its record [34].
USA	The Occupational Safety and Health Administration (OSHA) of the United States has asserted that disposal that's also presumed or believed to possess or be polluted with COVID-19 does not require additional safeguards further than those ~~is~~ designed to safeguard employees from the dangers they face in their daily work in household waste and sewage treatment. Furthermore, they have said that municipal solid trash with potential or known SARS-CoV-2 contamination should be managed similarly to non-contaminated solid wastes, with stringent operational and professional procedures, safe systems of work, and personal protective equipment (PPE), such as puncture-resistant hand gloves, and facial & safety glasses, in place to safeguard workers from being exposed to recyclable [35].

Italy	In Italy, the civil waste created by the families is classified into two categories :1.T1: Municipal waste produced by families with corona positive individuals in disconnection or individuals in compulsory isolate 2. T2: Municipal waste produced by average families' positive individuals in disengagement or individuals in mandatory isolate T1 type ought to be delegated irresistible clinical waste and overseen by following the rule for such waste sort. For the most part, not many organizations handle such waste, and they gather it utilizing normalized packs followed by disinfection. The rules for such waste underscore picking waste in a twofold layer sack and needs no source-isolated assortment as they are gathered as leftover waste. T2 squander type, then again, is gathered agreeing with the different assortment framework set up. Tissues, covers, and single-use gloves should be remembered for the leftover waste stream, which must be conveyed through 2 fixed packs. The staff associated with taking care of such waste ought to be furnished with PPE. The rules express that the older individuals ought not to manage T1 squander type in any case; by playing it safe, they can manage T2 squander type [36].
WHO	The WHO focused on that all the medical services waste created during the consideration of COVID 19 patients ought to be gathered securely in assigned compartments and sacks, treated and then discarded. It can also be treated and discarded ideally on location. With legitimate offices, the treatment and removal of waste can be managed well. It has also focused on all staff associated with medical care waste. The executives must put on suitable PPE (boots, cover, fully covered outfit, gloves, mask, or ~~a~~ face shield) and clean hands after accomplishing the work [37] .

CURRENT INDIAN WASTE MANAGEMENT SYSTEM

The concepts of "sustainable development," precaution," and "polluter pays" regulate waste management in India. These principles require towns and businesses to operate ecologically responsible and accountable, restoring equilibrium whenever their actions disturb it. Therefore, the rise in garbage creation as a result of economic growth, numerous subordinate legislation governing the disposal and treatment of produced garbage have been enacted under the umbrella law of the Environment Protection Act of 1986. (EPA). Different kinds of garbage are subjected to different standards and need other activities in accordance, primarily in authorizations, record-keeping, and proper disposal systems. The country is experiencing a significant waste management issue as a result of growing urbanization. Over 377 million people reside in 7,935 cities, producing 62 million tonnes of municipal solid garbage each year. Only 43 million tonnes of trash are recovered, 11.9 million tonnes are processed, and 31 million tonnes are deposited in landfills. Solid Waste Management (SWM) is one of the most important services offered by local governments in the country in order to maintain metropolitan areas clean. On the other hand, almost all municipal authorities carelessly dispose of solid trash to a dump yard inside or outside the city. According to experts, India's garbage disposal and management system are faulty [17].

Although India is battling the coronavirus, there is another issue that requires our consideration: for example, biological waste created by hospitals and laboratories, not all of it is dangerous, but even a tiny bit can spread the virus and make our fight against corona more difficult. Many studies are now being conducted in order to learn more about the virus. Recent studies have revealed that the virus may remain active on plastic surfaces, cardboard, and even in the air for various periods of time. In its active state, this survival feature makes it much more dangerous, and it may spread an outbreak through biomedical waste discarded by hospitals after treating ~~a~~ coronavirus patient. As a result, biological waste must be handled with extreme caution and appropriately managed so that it does not come into contact with anybody before being treated or stored in a secure location until the virus has been neutralized. In addition, before being disposed of, different wastes must be processed or disinfected. The difficulty in India is not limited to trash processing or disposal; some obstacles must be overcome in order to make the entire process smoother and faster. The challenges include adequate waste segregation, which is not widely done in India, knowledge of garbage management at the staff level, proper waste disinfection, and a shortage of PPEs for collection workers, among others [18].

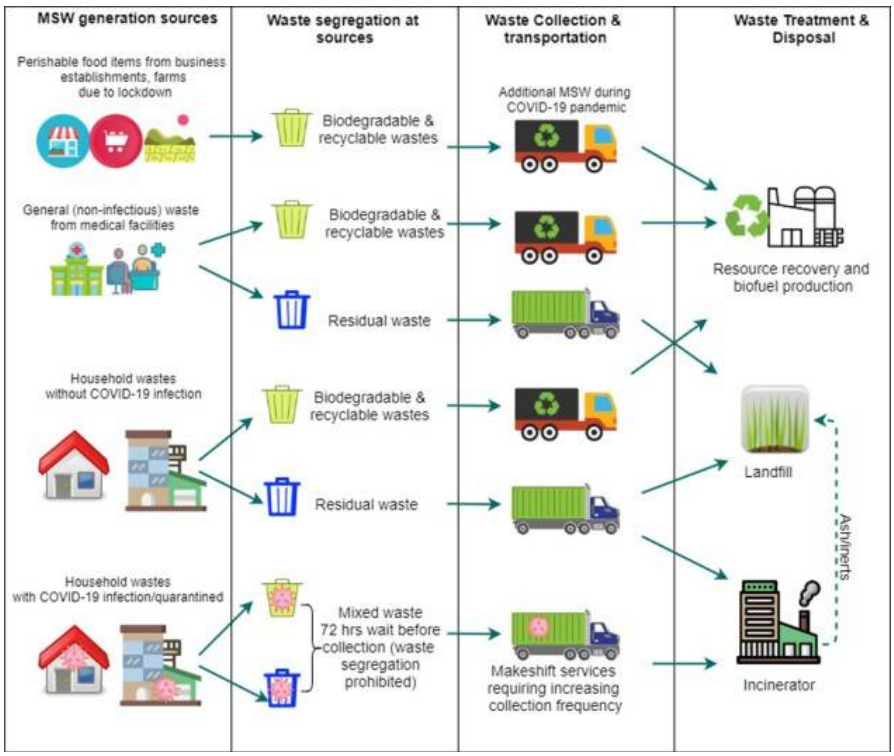

Fig 2. Solid Waste Management process of COVID-19 wastes disposal (Source: Kulkarni and Anantharama, 2020)

Table 2. Hierarchy of integrated solid waste management

Mode	Description
At Source Reduction & Reuse	At Source Reduction and Reuse Waste minimization and supportable use/multi utilization of items (for example, reuse of conveying sacks/bundling containers)
Recycling	Preparing non-biodegradable waste to recuperate monetarily essential materials.
Compositing	Processing natural waste to recuperate manure (for example, windrow treating the soil, in-vessel treating the soil, vermicomposting)
Waste to energy	Recuperating energy before conclusive removal of waste (for example, RDF(Refuse Derived Fuel), biomethanation, co-handling of energy flammable non-biodegradable dry part of MSW, cremation)
Landfills	Safe removal of dormant leftover waste at sterile landfills

GLOBAL CONCERNS AND CHALLENGES SWM DURING COVID-19

Several groups, including Operation Mer Propre (France), Thames21 (London), and Oceans Asia (Hong Kong), have shown concern about the disorganized dumping of masks and personal protective equipment (PPE) that ends up in rivers, explosion hazard of plastic pollution contamination. Polypropylene (PP) is utilized as the hydrophobic protective coating on the masks to avoid bodily fluid droplets, whereas other more costly masks use polyurethane (PUR) or polyacrylonitrile (PAN). Plastic-based masks, surgical masks, tissue sheets, and spent sanitizing plastic bottles contribute to landfill burden. In addition, poor waste disposal leads to the river and marine contamination. Contaminants like this disrupt the natural environment of animals. The virus might be present on the masks' surface and infiltrate water bodies, posing a hazard to people who come into touch with it. According to the World-Wide Fund for Nature (WWF) Italy, 10 million masks will be distributed in the environment within a month. If only 1% of total masks are not properly disposed of, each mask weighing 4 g will weigh up to 40,000 kg plastic, resulting in a horrifying sight. The quantity of masks used across the world is summarized by the amount of biomedical waste that is improperly disposed of, which causes soil and groundwater contamination and has a negative impact on the biota [8].

Developing countries are at a larger risk of pollution from waste and wastewater than industrialized ones due to differing waste management techniques. The industrialized countries are environmental friendly with secure garbage management systems. In contrast, garbage is typically disposed of in hazardous landfills in underdeveloped nations, which are frequently visited by ragpickers wearing no protective clothing. This has the potential to propagate the infection and make contact tracking more difficult [20].
Various kinds of waste produced from different sources make the task of solid waste management very challenging. For example, Infectious waste, which includes blood, body fluids, and contagious waste from patients; pathological waste, which includes human tissues, body parts, and sharp metallic debris such as surgical blades and needles; chemical waste, which includes disinfectants, sterilant, and mercury; and pharmaceutical waste, which includes expired and contagious pharmaceuticals. Biomedical waste, in general, contains materials that are extremely infectious and dangerous to those who handle it. The number of patients admitted to hospitals during the pandemic is significantly more than usual, and COVID-19 testing kits, among other things, has increased hospital and lab waste by a factor of ten (Table 3). Due to the great transmissivity of the waste produced, it must be removed on a regular basis to avoid piling.

Table 3 - The Estimated quantity of masks to be used during a pandemic (Nzediegwu and Chang, 2020).

Continents	Total Daily facemask (million)	Weight of total daily facemask used (tonnes)
Asia	3716.20	1486.48
Africa	922.22	368.89
Europe	884.71	353.88
North America	489.05	195.62
Oceania	45.43	18.17
South America	544.39	217.75

Note: (i) Total daily facemasks = (#population ∗ #urban population (%) ∗ ##facemask acceptance rate (%) ∗ ##average daily facemasks per capita)/10,000 [21] (ii) # Data extracted from https://www.worldometers.info/coronavirus/on Aug, 16 2020. (iii) ## values for facemask acceptance rate and average daily face mask per capita is assumed 80% and 2, respectively. (iv) Weight of masks (tonnes) is calculated based on each mask weighing 4 g [13].

GOVERNMENT RESPONSE TOWARDS MUNICIPAL SOLID WASTE (MSW) MANAGEMENT

During the epidemic phase, government officials in many nations understood the need of classifying distinct MSW executives and took various ways to deal with the growing problems. To avoid problems with municipal trash management, residents in Austria were asked to reduce waste for their own safety. Before embarking on this enterprise, residents were given guidelines to follow for trash reduction and appropriate segregation, but no consideration was given to the inhabitants' safety and well-being. Because of an increase in the number of people eating and drinking at home, Tokyo's family unit ignitable trash has increased by 3.10 percent. The Government of India has highlighted the procedure of composting in COVID-free home garbage to reduce the load of MSW creation. The British government has distributed COVID-19 monitoring statements for local enterprises and trash hoarders. These proclamations focus on waste stream priority, temporary waste storage capacity development, waste segregation, the use of an MSW incinerator to remediate COVID-19 infectious material. To clarify, 74% of MSW produced in Japan is burnt, 17.00 percent is repurposed, and 3.00 percent is disposed of in landfills [22]. Several countries, such as Sweden, Denmark, Finland, and Norway, use an energy recovery framework to burn over 50% of their MSW. Austria manages its MSW via composting (32.00 percent of trash generated), incineration with adequate energy recovery (40.00 percent), and landfilling (less than 9.00 percent of waste) [23]. In 2018, 45.00 percent of household trash was recycled in the UK, whereas 20.00 percent of biodegradable MSW was disposed off in landfills. Landfilling accounts for a large portion of the MSW produced in Indonesia, Brazil, China, and India. According to research on ozone-harming material emissions from MSW in Indonesia, 60–70%of the trash is disposed off in landfills, while the remaining 30.00–40.00 percent is disposed off in waterways or overseen by management authorities [24]. According to similar research on the energy and cost elements of producing electrical energy from solid trash in Brazil, 58.7% of the urban solid garbage is disposed of in the landfill sites [25]. According to previous research, 70 percent of India's urban solid waste is disposed of on land, posing a major danger to the country's long-term sustainability.

POLICY RESPONSE AND IMPLICATION

Due to the enormous amount of garbage generated during the shutdown, the Irish government allocated a million euros cash to combat the degree of unlawful disposal related to the COVID-19 (DCCAE 2020).
Due to COVID-19 precaution policies, garbage collectors whose lives depend on garbage collection may no longer be valued and forced to trade as normal. Waste pickers, for instance, assist in collecting reusable or recyclable discharged solid waste, which is crucial to economic inclusion [26]. As a result, garbage pickers are critical to creating a circular economy, particularly in emerging nations. As part of COVID-19 containment measures in Turkey, approximately 8,000 garbage pickers were prohibited; nevertheless, food aid and municipal shelters were given [27]. Garbage pickers are an occupational risk category that is more susceptible to health problems [28]. Hence, the Turkish government's prohibition saved many rag pickers from being exposed to COVID-19 secondary transmission.
The COVID-19 epidemic has prompted the EU to adopt a zero-waste policy that compels EU members to recycle 70–80% of their trash while reducing GHG (Greenhouse gases) emissions caused by toxic waste disposal and incineration practices [29]. The Zero Waste approach suggests that "The conservation of all resources via responsible production, consumption, reuse, and recovery of goods, packaging, and materials without burning, and with no discharges to land, water, or air that endanger the environment or human health". The post-crisis period has shown us that waste management prior to the COVID-19 epidemic cannot be carried on as usual but rather necessitates fundamental changes, emphasizing the necessity of shifting from a linear to a circular economy. This effectively navigates towards a zero-waste, zero-carbon, waste-free economic development with minimal waste management costs. Within the COVID-19 pandemic, proper waste management ensures the continuity and functionality of waste services and workers, as well as the safety of waste service workers and the adaptation of recycling services to include safety measures that contain the spread in the collection, disposal, and treatment of medical waste [30] .

CONCLUSION AND FUTURE PERSPECTIVE

According to the existing circumstances, the epidemic is likely to last until 2025 [8], necessitating the development of a long-term solid waste management plan. Reusable masks can be sanitized and used instead of single-use masks. Staff can be rotated through the trash recycling plant to operate at 50 percent capacity at any one moment [31.38,39]. It should, however, be used on a regular basis to minimize trash accumulation. The most important necessity is for citizens to be informed of how to properly deal with the current circumstance. The COVID-19 epidemic struck millions of people as an unexpected event. Several nations implemented lockdowns and interruptions of international travel to keep an eye on the number of patients. The virus's strong transmissivity resulted in an extraordinary surge in the number of cases. The unexpected cessation of industrial and everyday operations impacted product manufacture, resulting in the layoff of numerous people, and shifted trash creation and collection trends. Patients are overcrowding isolation units and hospitals, resulting in a significant volume of infectious trash. From health care to home levels, the demand for PPE kits, masks, hand sanitizers, gloves, and other items has increased at an unanticipated rate, resulting in massive waste creation. Several governments have taken precautions to prevent the virus from spreading[40, 41, 42]. The study concludes that:

- The most important aspect to remember is that trash management is not just the duty of the collector; residents must also be concerned about the safety of frontline workers. As a result, the instructions to reduce waste creation, such as allowing the trash to rest for at least 72 hours before ultimate disposal, disinfecting the disposal bag, and so on, should be followed [43].
- We must ensure that discarded PPE is adequately managed at the point of disposal and does not contribute to riparian contamination. Energy recovery from plastic trash, on the other hand, can help to minimize plastic waste footprints [44].
- Using bioplastics instead of fossil-fuel-based plastic can be a long-term solution, despite the extra expenses [45].
- As the environment has affected trash collection and disposal, countries have established strict and adaptable waste disposal regulations to avoid viral transmission through solid waste produced by homes, self-isolated COVID sufferers, and clinics [46].

REFERENCES

1. Gupta, N., & Gupta, R. (2015). Solid waste management and sustainable cities in India: The case of Chandigarh. Environment and Urbanization, 27(2), 573-588. doi:10.1177/0956247815581747
2. Mani, S., & Singh, S. (2016). Sustainable Municipal Solid Waste Management in India: A Policy Agenda. Procedia Environmental Sciences, 35, 150-157. doi:10.1016/j.proenv.2016.07.064

3. Songsore, J. (2017). The complex interplay between everyday risks and Disaster risks: The case of the 2014 cholera pandemic and 2015 flood disaster in Accra, Ghana. International Journal of Disaster Risk Reduction, 26, 43-50. doi:10.1016/j.ijdrr.2017.09.043
4. Perlman S (2020) Another decade, another coronavirus. N Engl J Med 382(8):760–762. https://doi.org/10.1056/NEJMe2001126
5. Rothan HA, Byrareddy SN (2020) The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. J Autoimmun 109:102433. https://doi.org/10.1016/j.jaut.2020.102433
6. Nghiem, L. D., Morgan, B., Donner, E., & Short, M. D. (2020). The COVID-19 PANDEMIC: Considerations for the waste and wastewater services sector. Case Studies in Chemical and Environmental Engineering, 1, 100006. doi:10.1016/j.cscee.2020.100006
7. Klemeš, J. J., Fan, Y. V., Tan, R. R., & Jiang, P. (2020). Minimizing the present and FUTURE plastic Waste, energy, and environmental FOOTPRINTS related to covid-19. Renewable and Sustainable Energy Reviews, 127, 109883. doi:10.1016/j.rser.2020.109883
8. Sharma, H. B., Vanapalli, K. R., Cheela, V. S., Ranjan, V. P., Jaglan, A. K., Dubey, B., Bhattacharya, J. (2020). Challenges, opportunities, and innovations for EFFECTIVE solid waste management during and post COVID-19 pandemic. Resources, Conservation and Recycling, 162, 105052. doi:10.1016/j.resconrec.2020.105052.
9. Mihai, F.-C. (2020). Assessment of COVID-19 waste flows during the emergency state in Romania and related public health and environmental concerns. International Journal of Environmental Research and Public Health, 17(15), 5439.
10. WHO. (2018). Health-care waste. Retrieved from https://buff.ly/2XXnz1f.
11. Patrício Silva, A. L., Prata, J. C., Walker, T. R., Campos, D., Duarte, A. C., Soares, A. M., . . . Rocha-Santos, T. (2020). Rethinking and optimizing plastic waste management UNDER Covid-19 PANDEMIC: Policy solutions based on redesign and reduction of Single-use plastics and personal protective equipment. Science of The Total Environment, 742, 140565. doi:10.1016/j.scitotenv.2020.140565.
12. Bauchner, H., Fontanarosa, P. B., & Livingston, E. H. (2020). Conserving supply of personal Protective equipment—a call for ideas. JAMA, 323(19), 1911. doi:10.1001/jama.2020.4770.
13. Naughton, C. (2020). Will the COVID-19 Pandemic change waste generation AND COMPOSITION? The need for more real-time waste management data and systems thinking. Resources, Conservation and Recycling, 162, 105050. doi:10.1016/j.resconrec.2020.105050.
14. Nzeadibe, T. C., & Ejike-Alieji, A. U. (2020). Solid waste management During Covid-19 PANDEMIC: Policy gaps and prospects for Inclusive waste governance in Nigeria. Local Environment, 25(7), 527-535. doi:10.1080/13549839.2020.1782357
15. Saadat, S., Rawtani, D., & Hussain, C. M. (2020). The environmental perspective of covid-19. Science of The Total Environment, 728, 138870. doi:10.1016/j.scitotenv.2020.138870
16. WHO (2020). Health-care Waste. https://www.who.int/news-room/fact-sheets/detail/health-care-waste.
17. Samar Lahiry, (2017). India's challenges in waste management. Down to Earth Magazine. https://www.downtoearth.org.in/blog/waste/india-s-challenges-in-waste-management-56753
18. Mohd. Faizan (2021). Solid Waste Management in India Under Covid-19 Pandemic: Challenges and Solutions. International Journal of Waste Resources. Vol.11 Iss.4 No:408, Pages 1-4
19. Aneja, D., Rana, A., Kumari, A., & Gour, A. A. (2021). The scenario of Bio-medical waste management During the Covid-19 pandemic in Delhi, India. Journal of the University of Shanghai for Science and Technology, 23(06), 271-293. doi:10.51201/jusst/21/05266
20. Nzediegwu C., Chang S.X. (2020). Improper solid waste management increases the potential for COVID-19 spread in developing countries. Resour. Conserv. Recycle. Oct.;161:104947.
21. Tripathi, A., Tyagi, V. K., Vivekanand, V., Bose, P., & Suthar, S. (2020). Challenges, opportunities and progress in solid waste management during COVID-19 pandemic. Case Studies in Chemical and Environmental Engineering, 2, 100060. doi:10.1016/j.cscee.2020.100060
22. MollicaG.J.G., Balestieri J.A.P. (2020). Is it worth generating energy with garbage? Defining a carbon tax to encourage waste-to-energy cycles, Appl. Therm. Eng., 173, p. 115195.
23. KyriakisE., PsomopoulosC., Kalkanis K. (2019). Investigating the correlation of purchase power parity with the adopted waste management method in EU28. J. Soc. Sci., 8, p. 162
24. Kristanto G.A. and Koven W. (2019). Estimating greenhouse gas emissions from municipal solid waste management in Depok, Indonesia. City and Environment Interactions, 4, p. 100027.
25. Santos R.E.D. , Santos I.F.S.D. , Barros R.M. , Bernal A.P. , Filho G.L.T. , Silva F.D.G.B. (2019). Generating electrical energy through urban solid waste in Brazil: an economic and energy comparative analysis. J. Environ. Manag., 231, pp. 198-206
26. Moreno-SÁNchez RDELP, Maldonado JH. Surviving from garbage: the role of informal waste-pickers in a dynamic model of solid-waste management in developing countries. Environment and Development Economics. 2006;11(3):371–391.
27. Hikmet, A. (2020). Waste pickers: We cannot make ends meet only with food aid.
28. Cruvinel VRN, Marques CP, Cardoso V, Novaes MRCG, Araújo WN, Angulo-Tuesta A, Escalda PMF, Galato D, Brito P, da Silva EN (2019). Health conditions and occupational risks in a novel group: waste pickers in the largest open garbage dump in Latin America.
29. Zero Waste. (2020). Zero waste Europe statement on waste management in the context of COVID-19ZWIA. (2018). Zero waste definition.

30. Finegan, O., Fonseca, S., Guyomarc'h, P., Morcillo Mendez, M. D., Rodriguez Gonzalez, J., Tidball-Binz, M., ; Winter, K. A. (2020). International Committee of the Red Cross (ICRC): General guidance for the management of the dead related To covid-19. Forensic Science International: Synergy, 2, 129-137. doi:10.1016/j.fsisyn. 2020.03.007
31. French nonprofit warns 'COVID waste' could harm the environment. https://www.pri.org/stories/2020-05-29/french-nonprofit-warns-covid-waste-could-harm-environment, 2020.
32. Annepu, R. K. (2012). Sustainable solid waste management in India. Columbia University, New York, 2(01).
33. Bhada-Tata, P., & Hoornweg, D. (2016). Solid Waste and Climate Change. State of the World, 239-255. doi:10.5822/978-1-61091-756-8_20
34. Banerjee, S., &Sarkhel, P. (2020). Municipal solid waste management, household and local government participation: a cross country analysis. Journal of environmental planning and management, 63(2), 210-235.
35. BMC Public Health. ;19(1):581.DCCAE. (2020). Funding Ring Fenced to tackle Illegal Dumping During Covid-19
36. Carol Konyn (2020), Another side effect of COVID-19: the surge in plastic pollution | Earth.Org - past present future [Online]. Available, https://earth.org/covid-19-surge-in-plastic-pollution/, 2020. (Accessed 29 July 2020).
37. Chavan, B. L., &Zambare, N. S. (2013). A case study on Municipal Solid Waste management in Solapur city, Maharashtra, India. International Journal of Research in Civil Engineering, Architecture & Design, 1(2), 46-53.
38. Coronavirus plastic pollution: What we can do about it - Thames21 (2020), from Coronavirus plastic phttps://www.thames21.org.uk/2020/06/coronavirus-plastic-pollution-what-we-can-do-about-it/, 2020.
39. Istrate I.-R. , Iribarren D. , Galvez-Martos J.-L. , Dufour J. (2020). Review of life-cycle environmental consequences of waste-to-energy solutions on the municipal solid waste management system. Resour. Conserv. Recycle., 157, p. 104778 ISWA. (2020). Waste management during the COVID-19 pandemic.
40. Hyun, M.C., 2020, April, April. Korea sees a steep rise in online shopping during COVID-19pandemic. ZD Net URL. https://www.zdnet.com/article/korea-sees-steep-rise-in-online-shopping-during-covid-19-pandemic/ accessed 5.19.20.
41. Health-care waste. (2020). Retrieved July 18, 2021, from https://www.who.int/news-room/fact-sheets/detail/health-care-wastely.
42. Mathur, S. (2017). Public-private partnership for municipal water supply in developing countries: Lessons from Karnataka, INDIA, urban water supply improvement project. Cities, 68, 56-62. doi:10.1016/j.cities.2017.05.007
43. Mohanta, T., & Goel, S. (2021). Mechanical-Biological treatment of MIXED Municipal Solid Waste: Two plants in Bengaluru, India. Asian Journal of Water, Environment and Pollution, 18(2), 9-17. doi:10.3233/ajw210014
44. Prioritization of waste and recycling collection services: Coronavirus (COVID-19) |GOV.WALES, Gov.Wales (2020) [Online]. Available, https://gov.wales/prioritisati/coronavirus-covid-19.
45. Scudellari, M. (2020). How the pandemic might play out in 2021 and beyond. Nature, 584(7819), 22-25. doi:10.1038/d41586-020-02278-5.
46. Van Doremalen, N., Bushmaker, T., Morris, D. H., Holbrook, M. G., Gamble, A., Williamson, B. N., . . . Munster, V. J. (2020). Aerosol and surface stability Of HCoV-19 (sars-cov-2) compared to SARS-CoV-1. doi:10.1101/2020.03.09.20033217.

CITATION OF THIS ARTICLE

P Khaneja, R Singh, N Sakhuja, A Singh, K Mandal & A Gupta· Impact of Corona Virus Epidemic on Solid Waste Management: Challenges, Opportunities, and Progress. Bull. Env. Pharmacol. Life Sci., Vol10[8] July 2021 : 38-47