



CORONAVIRUS (COVID 19) PANDEMIC: EMERGING CHALLENGES AND STRATEGIES FOR WASTE MANAGEMENT IN INDIAN SCENARIO

Sonam Angmo¹. Shachi Shah². Yogita Kharayat³

¹Research Scholar, School of Interdisciplinary and Transdisciplinary Studies, IGNOU, New Delhi, India

²Professor School of Interdisciplinary and Transdisciplinary Studies, IGNOU, New Delhi, India

³Scientist C, Instrumentation Laboratory, Central Pollution Control Board, New Delhi, India

Received on: 25.11.2022

Revised on: 1.12.2022

Accepted on: 30.12.2022

Abstract

Generation and management of a huge quantity of waste and associated contamination risk during and post Coronavirus (COVID 19) pandemic is a potential global environmental problem. Like other countries of the world, India is also facing the challenges of proper segregation and disposal of the (COVID 19) waste generated from the last few months. Coronavirus (COVID19) waste like face masks, Personal protection equipment, sanitizer container, gloves, common packaging plastic waste generated from the hospital, household, restaurant and E-commercial sector, etc. are mostly made up of plastic and are associated with potential contamination risk. The world is already facing the problem of disposal and management of plastic pollution before the pandemic, COVID waste has posed an extra burden on the environment. Further, people who are engaged in the handling and disposal of COVID 19 waste could spread infection as they are working without proper personal protection equipment. Various government agencies in the world like WHO and CPCB in India have prepared the guideline for the management of COVID 19 waste i.e., biomedical, solid, and plastic generated during the pandemic. This paper highlights the urgent need for treatment of COVID 19 waste in fast track manner to avoid the transmission of the virus. The study highlights the Generation of COVID Waste during Pandemic, Rules and Guideline for waste management in India, Impact of COVID-19 waste on environment, and strategies for COVID Waste Management in Indian scenario.

Keywords

Covid-19, Waste, Management, Treatment, Pandemic, Guideline, Management.

1. INTRODUCTION

The pandemic known as Coronavirus also well known as Severe Acute respiratory syndrome coronavirus woke the world in late December 2019 [1]. Later on 11th February 2020 an International Committee on Taxonomy of Viruses declared coronavirus (SARS-CoV-2) as the name of the new infection [2]. COVID-19 outbreak as pandemic was exposed by WHO on March 2020 [3]. Developing countries like India are still fighting against the SARS-CoV-2 to survive by taking precaution like face masks, sanitizer, gloves, personal protective equipment, etc, which was later disposed off as waste. Waste is a serious environmental concern especially in developing countries and municipalities of both urban and rural areas put their best effort to successfully manage the large quantity. The problem of waste management has

become a serious concern during COVID 19 pandemic as new items of waste have started generating which are mostly non-biodegradable in nature. The pandemic has hindered the process of waste generation, making problems among decision-makers and workers working in sanitation [4]. Many types of waste including disposable face masks, gloves, and other personal protective equipment as well as the huge quantity of general solid waste of similar nature are produced during the pandemic[5]. With total lockdown, people started demanding food and groceries for home delivery services, because eating places around the world were closed finally led to excessive use and production of common packaging plastic waste like LDPE, HDPE etc[6]. As a result of the coronavirus pandemic there were reduction in the recycling activities of plastic, handling and

management have become a big question for the management business of waste[7,8] Huge production of infected face mask are source of environmental concerns because incineration and reclamation release harmful gases [9]. Abruptly rise in plastic waste due to the Coronavirus pandemic calls up for the critical need for plastic reduction policies and implementation at ground level without waiting and also to advances in innovation for sustainable solutions and to develop dynamic and reactive waste management systems instantly [10]. Therefore, to reduce the secondary effect on health and the environment authorities have counsel to treat waste management of biomedical, municipal solid waste or general waste, and other harmful waste as an important and necessary peoples service[5].

The pandemic Covid-19 has also immobilized the food network which is seen facing countless problems and caused alarm by countrywide lockdowns in many nations has resulted in the obstructive gathering of meal and other foodstuffs significant to break food waste creation active[11]. As a result of the emerging COVID-19, food manufacture and utilization systems have undergone notable changes, the food chain through a Material Flow Analysis, results reveal that first week of the COVID-19 lockdown [12]. The fast increase in waste quantity is probable to disturb systems that are planned for balanced conditions [13].

One of the grave problems during pandemic as far as waste is concerned is tremendous increase in plastic waste. If it is not managed properly it ended their life in the ocean which results in choking of aquatic fauna and if incinerated there is emission of toxic gases in the environment. Simultaneously, there is a possibility of transmission of the virus through the handling of COVID waste generated from the hospital, home isolation, quarantine, as virus life span is varied on different articles such metal, clothes, plastic etc. The cases are also increasing because of improper handling of COVID waste by waste pickers and rag pickers in the community. Till date, no study has been done on the transmission of the virus through waste in India. In this paper we have highlighted the generation of COVID Waste during Pandemic, rule and

guideline for waste management in India, Impact of COVID-19 waste on environment, and Strategies for management of COVID waste in Indian scenario. In this paper we have dwelled upon the generation of COVID Waste during coronavirus pandemic, rules and guideline for waste management in India, environmental impact of COVID-19 waste and emerging issues and strategies for Management of COVID Waste in Indian scenario.

2. CORONAVIRUS Pandemic (Covid-19)

Situation in India

The first case of positive coronavirus in India was announced on 30th January a student from Kerala returned from China[14]. In India as the number of positive cases of corona has increased on twenty fourth of March 2020 Prime minister declared a total lockdown of twenty one days for the whole country, which was again extended for nineteen days on fourteen of April 2020 in II phase followed till Phase IV. Various restrictions were imposed on various anthropogenic activities other common transportation activities. In addition to these directorial plan such as reduction on social gathering events, limitation on travel, corona suspects isolations and treatment were also imposed. However, the COVID-19 has created a crisis like condition for all and it would have a negative effect economy also [15].

The coronavirus has seriously impacted the second most populous country in the world. In India on September 14, 2020 there were 986598 active cases with 79722 death cases and further increasing new cases along with 3780107 discharged or recovered from the disease. More than 70% cases due to co-morbidities [16].As far as vaccine trials for coronavirus in India are concerned, as per to the Indian Council of Medical Research), Bharat Biotech and Serum Institute of India engaged in vaccine manufacture and DNA vaccine of Zydus Cadila have completed phase one and will begin phase two clinical trials, Oxford vaccine got approval for phase 2 and 3 clinical trials which are being manufactured by Serum Institute of India [17] . Fig. one shows the Continues decline in Active cases in India from July to December, 2020.

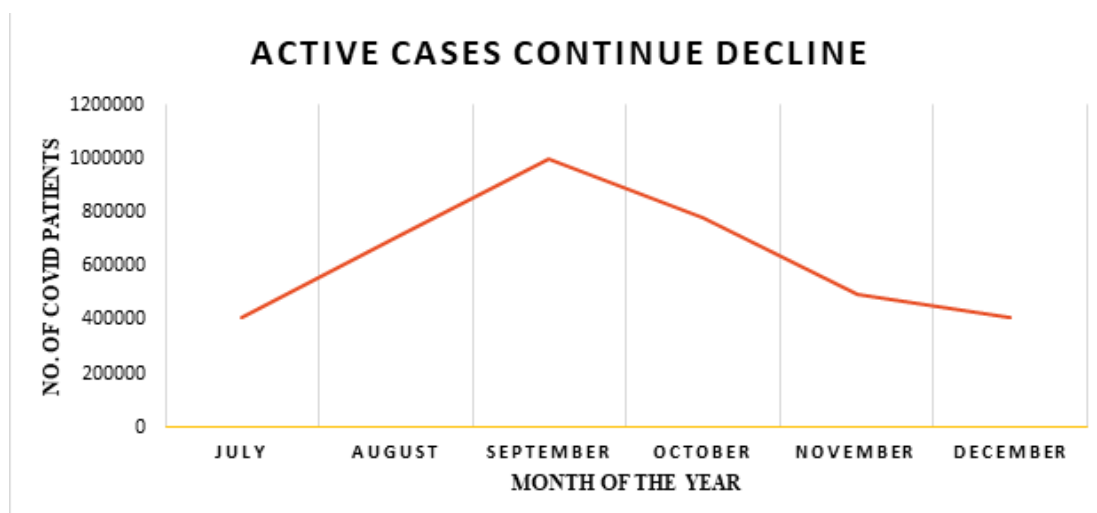


Fig 1: Showing the Continues decline in Active cases in India from July to December, 2020. Source:-pib.gov.in, 2020.

In India there was much decline in Covid case in Jan to mid-March but after amid of March month 2021 second wave of Covid started and highest number of Covid cases was on April 09 that was 144,829 found in India and India is 3rd leading country based on the USA and Brazil cases¹⁸. Some state of India such as Kerala, West Bengal, Tamil Nadu,

Andhra Pradesh, Maharashtra, Delhi, Karnataka, and Uttar Pradesh in which higher number of Covid cases were found. Table 1 illustrates about the status of various medical facilities, availability of vaccines etc. between the first wave of Covid and second wave in India [19].

Table 1: Comparison between Covid First Wave and Second Wave in India.

	First wave of Covid	Second wave of Covid
Causative organism	Severe Acute Respiratory Syndrome –Coronavirus-2 (SAR-CoV-2)	Variant of first wave Coronavirus
Symptoms	Respiratory	Respiratory, Gastrointestinal, Joint pain etc.
Presentations	More severe	Less intense
Age profiles of patients	Older peoples	Youngers
Comorbidities	Observed more in comorbidities	Less
Availability of medicines	Shortage of medicines	Medicines are available from various pharmacies and hospitals
Health care staff/worker	Less trained and also fear of infection as they were not vaccinated at that time.	Trained and less risk of infection as they were vaccinated
No. of beds	Limited no. of beds were available	Enhanced the availability of beds in hospitals
Personal Protection Equipments (PPE's)	Shortage of PPE's	Millions of PPE's (personal protection equipment) manufactured.
Age profile of the patients	Old age	Younger
Vaccines availability	No vaccines were available	Three approved vaccine are available
Beds having ventilators	Less	High
Death rate	Higher	Lower
Plasma therapy	Less	High
Positivity case rate	Lower	Much higher
Mechanical ventilations facilities	Less facilities of mechanical ventilations.	More

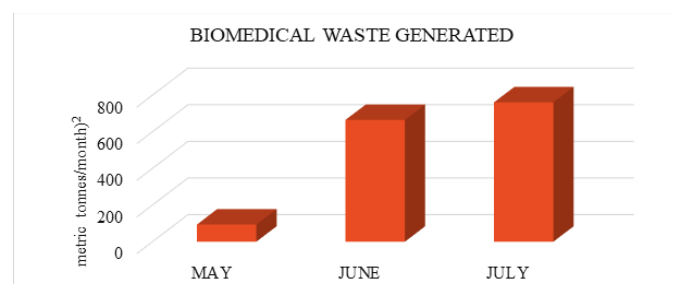
Source: Jain *et al.* 2021

In the second wave young people and children are infected in addition to older people [18]. Most of the symptoms observed are dry cough, breathing problem, joint pain, headache, Gastrointestinal or adding etc.

3. Generation of Covid 19 Waste During Pandemic

Waste was already a serious environmental issue before the pandemic as far as India is concerned, but the pandemic and

post-pandemic waste generation have imposed huge concern for safe disposal and management of waste. In developing countries, waste recycling is managed by both authorized and private sectors during pandemic [20]. The best management practices plan put into effect for waste handling and cleanliness is important and should be given careful thinking toward workers exposure [2].



Source: EPCA, 2020

Fig 2: Showing the generation of biomedical waste during the month of May, June and July from NCR State.

Table 2: Generation and Disposal of Biomedical Waste During Covid-19.

S. No	Name of State	No. of covid waste generator month of May) Ton/Day	Covid-19 Biomedical Waste In June) Ton/Day)	Covid-19 Biomedical waste In June) Ton/Day	Covid-19 Biomedical Waste	No. of CBWTF involved	Capacity of Incinerator for 16 hours operation in tons/day
1	Delhi	15	25.18	372.47	349.006	2	74
2	Up	45	14.5	137	247.32	4	9.4
3	Haryana	160	54.1	155.89	162.3	7	55.2
4	Rajasthan	11	Data Not Available	Data Not Available	3.27	1	2.4

(Source: EPCA report 2020)

According to (EPCA) Environment Pollution Control Authority report, 2020 As compared to May month Delhi produced fourteen times more biomedical waste because of Covid 19 in July. In addition, Environment pollution control authority (EPCA), 2020 as shown in fig. two and table two report mentioned that in National Capital Region (NCR) six district namely as Baghpat, Meerut, Muzaffarnagar, Gautam Buddha Nagar, Hapur, Ghaziabad of Uttar Pradesh in combined generated one hundred and thirty seven tonnes daily in month of June and 14.5 tonnes per day in month of May and which was increase to total of 247.32 tonnes COVID-19 hospital waste per day in the month of July. On other side, Gurgaon, Panipat, Karnal, Sonipat, and Faridabad, etc. thirteen (13) districts of Haryana in NCR, sum up generated 54.1 tonnes per day ,155.89 tonnes per day and 162.23 tonnes COVID-19 hospital waste daily in May, June and July month [21].

According to (MPCB) Maharashtra pollution control board state biomedical production has been increased from a mean of 62,000kg/ day before Covid and over 90,000 kg daily in lockdown [22] . Coronavirus focal point Wuhan witness a six times rise in hospital Waste during the maximum of its pandemic [23] . In India metro cities (Gurugram) of India is one of the most affected and in Ahmedabad city, the normal hospital waste generated around 550–600 kg/day and now during the first phase of lockdown which was increased to 1000 kg/day which will again rise up to 3000 daily as very fast use of face masks and collection of waste from quarantine places. It showed that biomedical waste has risen 40 times in the last couple of months [24]. Now, India has finite potential to handle hospital waste, around one hundred and ninety eight (CBMWTF) common bio-medical waste treatment facilities and two hundred and twenty five captive incinerators are working in the country [25]. It has been a major issues to the municipal official to control the unexpected increase in the generation of Biomedical Waste quantities from the COVID-19 upsurged. Various types of waste are brought out during covid-19 are discussed below:

3.1 Plastic waste: During Pandemic (Coronavirus) time most of the countries made it mandatory to use masks, gloves, protective gowns, etc. which minimizes the infection of virus [26,27, 28, 3] . Both masks and hand sanitizer producer has use of plastic-like polypropylene which is due to the

microfibers' water repelling characteristic and also polyurethane and polyacrylonitrile for expensive protective cover[29] . On one side over need for Personal Protection Equipment result in the rapid production of plastic wastes [8, 30, 31, 32, 33] . Unfortunately, suitable disposal place for Personal Protection Equipment has not been gained due to a number of reasons [34]. Various polymers and metallic compounds are used for the manufacture of personal protection equipment. Besides all recycling is the best method for treatment of Personal Protection Equipment, such activities are not easily realized due to problems in proper segregation [35].

The energy and environmental footprints of plastic product systems have rapidly in response to the rush in the COVID-19 number cases globally. The idea of Plastic Waste Footprint (PWF) is suggested to trap the environmental footprint of a plastic material's entire life cycle. Due to increasing concerns of cleanliness, specifically from materials used for personal protection and health protection purposes the usage of single use plastic is set to come back [36] . A rush in single-use plastic utilization found that people are demanding food at a rate more than twice as high as last year as a group surveyed over 2000 participants in early April, indicating most probably due to social distancing measures. [26]

3.2 Solid waste: The situation tackle by the waste management zones during the covid-19 has been a big source of concern during this emergency. Further, in absence of public involvement and support, blending virus infected on hospital waste with the general solid waste stream show notable impact on health and safety matter to waste handler and workers [37,38] . Suggested alternatives proposal for Municipal Solid Waste management and indicate the upcoming opportunity of work to gain post pandemics in sustainable waste management

3.3 Biomedical waste: Generation of hospital waste is increase during coronavirus emergencies rapidly, as well as the discard of infected disposable masks and personal protection equipment has disturbed the current waste management systems. As health care has expanded to temporary isolation centers facilities like camps, home-care etc. following guidelines or rules related to waste segregation and storage. Disposal of general solid waste from the hospital

are managed according to solid waste management rule[39]. In India guidelines issued for the management of hospital waste during pandemic also the disposal of general solid waste generated from both medical facilities and households covid patient should follow solid waste management rule 2016 [40].

3.4 Food waste: Ability to make healthy food production and supply systems are key to fighting hunger and fight against diseases challenges wherever they appear in humans, animals, plants or the environment [41].The Pandemic Coronavirus Disease is a global issue which is already influencing the food and agriculture sector [42]. A guidelines has been issued by United State Environmental Protection Agency for solution for food waste management in a sustainable way during pandemic COVID-19 public health crisis, in addition guidelines also direct food waste management at different levels i.e. households, institutions and businesses[43].

In India, diversity of agriculture and horticulture product i.e., seasonal crops, vegetables and fruits were ripened or mature and wheat, paddy and barley crops were got ready for harvesting. Due to the sudden lockdown in the country, maximum of the food product was wasted, in addition, the government of India (GOI) also cooperate in the management of perishable products and supplies disbursal of food items to affected people. Most importantly, food delivery through technology applications support the government to reach the specific and remote individuals received food management and reduced the food loss [38].

However, in many place there is a probability of rise in meal waste from the supply chains such as edible food items

getting stuck on the road due to lockdown, shortage of labour in the depot for handling the food stuff, in future localized strong supply chains to counter such circumstances during pandemics [34].

4. RULE AND GUIDELINE FOR WASTE MANAGEMENT IN INDIA

In India there are separate rule for each type of waste i.e Solid waste, Biomedical waste, Plastic waste, C&D waste (Construction and Demolition), Hazardous waste and E-waste under (EPA) environmental protection act 1986. And these rule are amended according to need of improvement by invite suggestion from public .All these rule are amended in year 2016. Which are appended on CPCB websites. Here we discussed on different waste management Rule 2016.

4.1 Biomedical waste management rule in India:- The handling and management of Biomedical waste rule come in 1998 in which waste were categories into ten categories on the basis of waste item generated in health institution during diagnosis, treatment etc. Later in 2016 this rule was amended and named as Biomedical waste management rule 2016 where term handling was omitted in this rule there were four categories on the basis color of bins and treatment required i.e., Red, Blue, Yellow and White in which waste item were dump. Black bin which are also in health institution for dispose of food waste are considered under general waste not in biomedical waste. Fig. three shows type of colors bin use for segregation of biomedical waste in hospital of India are yellow bin are for segregation of soiled waste, blue bin is for glass waste like vials etc., red bin is for segregation of Plastic waste like glucose bottles etc. and white puncture proof container for sharps like needle and blade etc.



Fig 3: Showing different color code bin use for segregation of Biomedical waste in hospital.

In 2020, due to break of pandemic like Coronavirus government agencies has given a new guideline for management of biomedical waste these were World health organization, International solid waste association, Occupational safety and health administration, Centers for disease control and prevention. Such guideline main purpose

was for overall safety protection and welfare of sanitary worker and waste collector while stockpile COVID-19 waste. In India Central pollution control board given new guideline with revised version time to time according to need of public well-being [44].

4.2 Guideline for handling of Covid waste i.e., Biomedical and Solid waste: -In India CPCB has given a guideline for waste generated during from Covid patients and which were revised time to time and 4th revised was on 17 July 2020 and appended on CPCB central pollution control board website Delhi. This guideline in addition with Biomedical waste management rule 2016 is applicable ULBs and CBWTF (i.e. Urban local bodies, Common biomedical waste treatment and disposal facilities), Laboratories, quarantine centres, and Isolation wards. The 1st guideline for handling of biomedical waste on 22 April 2020, 2nd revised guideline on 30 April 2020 and 3rd revision guideline in June and last guideline i.e. 4th revised guideline on 17 July 2020 is for guide segregation of biomedical waste and solid waste generated by Covid patient during treatment and also mention disposal of personal protection equipment. According to guidelines, proper label and yellow bins with double layer and leakage proof should place in isolation wards for management of hospital waste generated by Covid patients. So, it could be easy for waste collector to direct transfer to CBWTF (Common biomedical waste treatment and disposal facilities) to handle the waste. All the plastic waste such as PPEs (personal protection equipment) are dump into red bag and wet waste should put in compostable bags. Other waste like non-plastic or semi-plastic, tissues and toiletries, of covid patient segregated in yellow bag[45].

4.3 Solid waste management in isolation ward: -Earlier solid waste management rule was name as municipal solid waste management and handling rule 2000 which only cover area under municipal but in 2016 this rule has been amended and term municipal has omitted and new named solid waste management rule 2016 which covered area extension of municipal like religious place, airport, harbor, defense area etc.[43]. During pandemic (Covid -19) revised guideline-4 of CPCB (central pollution control board) mentioned that general solid waste generated by Covid patient in isolation ward should collect and manage according to SWM rule 2016. In order to reduced waste generation, plastic items must

be used for serving food are should be manage with disinfected as per given guidelines by Central Pollution Control Board. The wet and dry solid waste bags should kept carefully in non-leak-bags, disinfected with chemical such as sodium hypo-chlorite solution and finally give to waste picker authorized i.e., Urban Local Bodies on daily basis. General solid waste should not be kept in Yellow colored bags [46].

4.4 Biomedical and solid waste management in Camp, Home-Care, Quarantine center facilities. According to guideline revised-4 issued by CPCB state that biomedical waste generated by Covid patient should be segregated in yellow bag or bins finally handover to authorized Urban Local Bodies, Waste collector or Common Biomedical Waste Treatment Facilities. Solid waste or general waste generated by Covid -19 patient or quarantine persons generated from patients quarantine in different facilities such as camps and home quarantine should be segregated and collected in bags, properly sealed and gave to waste collector authorized by Urban Local Bodies for final disposal. Also ensure not to let of mixed of general waste with covid waste generated from quarantine center [37]. Fig. four shows flow chart for management of Covid waste generated by patients.

In Delhi The two municipalities bodies i.e. SDMC and NDMC i.e South and North Delhi Municipal Corporation accountable for transported Covid waste produced by covid positive patients undergoing home care isolation and finally transport to (Wte) waste-to-energy plants such as Timarpur-Okhla waste treatment plant, Narela-Bawana and Ghazipur. Environment Pollution Control Authority (EPCA) Suggested waste can send to (CBWTF) common biomedical waste treatment facilities, because present (WtEs) Waste to energy plant are designed to incinerate municipal solid waste. For treatment of biomedical waste incineration having double chamber and guideline for storage and emission control are needed [18].

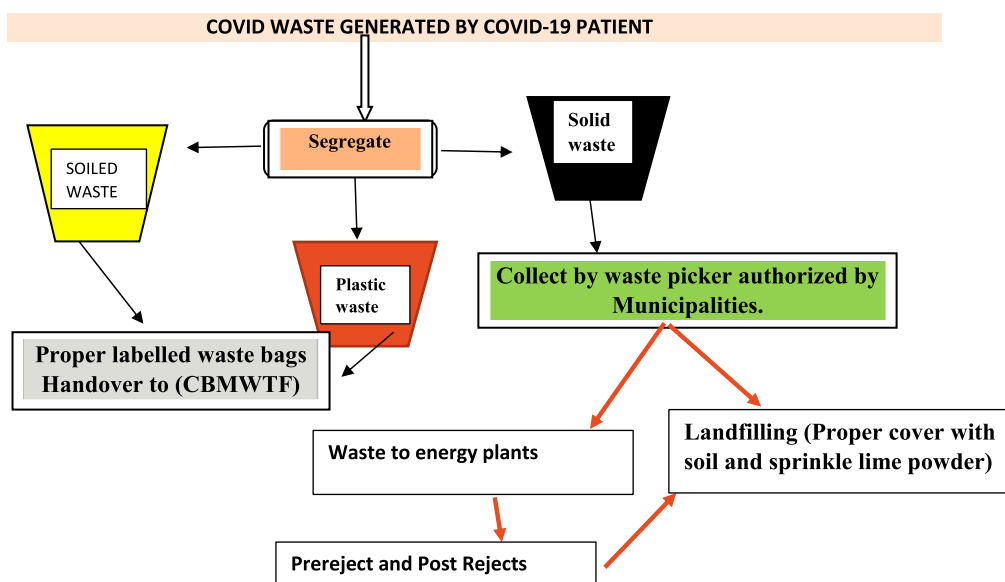


Fig 4: Showing flowchart for management of waste generated by a Covid patient in India.

5. ENVIRONMENTAL IMPACT OF COVID-19 WASTE

Before Covid -19 pandemics, waste has been one of the main environmental issue and discussion took place at various platform and aware the peoples about negative impact of unplanned disposal of waste in environment. Currently, at time of pandemic people maintain social distancing by avoiding entertainment and recreation areas which result in decreased in waste in people place and cities [47]. Due to stay-at-home guideline by government, many people have enhanced their single-use packaging for delivered food item from food corner. Many municipalities had their recycling activities of local waste because of the risk of transmission of virus in recycling [48].

Likewise economic impact, GHG emissions and the nutritional content (+11%), (+10%), (-8%) complete the multifaceted impact form that the COVID-19 epidemic had on FLW production and management [27]. On the other hands domestic waste, food delivery boxes have notoriously increased in quantity. Some nations have ceased their recycling to minimize virus infection happened and protect labours [44]. Recently National Green Tribunal (NGT) directed the (CPCB) central pollution to recover fee from E-commerce like Amazon and Flipkart as they used excessive plastic packaging for their sale product and may violate the environmental norm. Amazon, Flipkart and other e retailers used plastic packaging beyond the size of the product inside the packet which later break into microplastic and become a major threat to aquatic and terrestrial environment [49].

Biomedical waste represents a potential threat as many disposable items, such as gloves, facial masks, and shoes, are not easily degraded in nature and we can face its collection in our environment which can be again harmful to all environmental components[50]. COVID-19 epidemic increases the menace of plastic pollution which was already worsened the terrestrial and aquatic environment both[26]. Chemicals like Hydroxychloroquine and chloroquine are some of the drugs that have been used to treat COVID-19 which are persistent, bioaccumulative, and harmful to aquatic life and act as pollutants[51,52,53]. Many diagnostic laboratories usually use disposable supplies, produce huge quantities of plastics and chemicals that degrade soil and water[54]. Maximum of personal protective materials, such as masks and containers, made up of plastic [55].

In the public places object that are placed close to containment area to control people enter mostly manufactured of methacrylate (source of plastic material, Resistance) which later ending their products durability and dumped in landfill. It has been also reported disposable mask and gloves also found in coastal area and seafloor Asian countries [56]. Animal of both terrestrial and aquatic were entangled or eaten this waste as food and finally end their life [57,58].

General waste containing viable coronavirus are probably produced at the residential level from COVID-19 positive

person may be cause of infection for people involve in waste collection [2]. In that regard,[59] report that proliferation of the SARS-CoV-2 may be rise by lack of proper handling and management of waste especially in developing countries having insufficient waste management rule. It has been reported in Nepal that lot of people are asymptomatic, may effect in infection to ragpickers of solid waste and collector and then reinfection back to the groups, In addition few of the product from waste are purchased by poor people, and again increase the cause of infection[60]. Likewise In Nigeria, Poorly disposal of solid wastes in dumpsites which are collected for recyclable and mistaken eaten by animal as their food and result in increased risk of infection in the community[61]. On other the hand in developed countries over generation of plastic mask and gloves from residential areas showed threat of transmission and degrade the environment[2,62]. Severe Respiratory Syndrome-Coronavirus-2 which was settle more imbalance on copper and cardboard than plastic and stainless steel and also known to stable on mask and gloves generated from households. Much of the information on Severe Respiratory Syndrome-Coronavirus -2 persistence on solid surfaces is work out from preceding coronavirus studies [63]. Two very toxic carcinogenic gases—Dioxin and Furan large number of people living around these incinerators and might end up having cancer and other diseases in the years to come (tribune) Covid waste new kind of pollutant which add up on current existing environmental issues [26].

PPE (Personal protective equipment) play a vital role during pandemic crises which need to be changed three or four time in a days for health worker which are gradually rise in quantities and threat to the environment. According to the CPCB (Central Pollution Control Board) report said that 30 per cent of waste still not treated and incinerator treat only 70 per cent of this waste. Even PPEs, Mask, Gloves have been found dumped outside the hospitals or even on the roads. Also waste segregation have not occurred at source of generation and waste collector have to segregate it, which may risk of infection as they reside in overpopulated place[64]. Many waste collector was got infected because of mishandling of biomedical waste and healthcare workers and public were also suffered as waste was not properly managed[65].

6. Strategies and Technology for Covid Waste Management

People of different countries already fighting against single-use plastics which is non biodegradables, Currently the world is facing a new challenge in disposing masks, gloves and personal protective equipment amid the COVID-19 crisis. It is time for government needs to act quickly respond, install toxic gas absorbing filters and take all necessary steps for safe disposal of the huge amounts of biomedical waste being generated. It is imperative for the country to step up efforts to sensitize regarding proper handling of biomedical waste to protect the environment and reduce the threat of Covid-19[66]. For food packaging breadbox is highly safer than polythene bag in terms of sterility, and that food corner should offer discount to customers that bring their own food

vessel. The best solution would be to make healthy food at home [26]. Environment Pollution Control Authority EPCA has suggested to the SC (Supreme Court) that all municipalities and SPCB (State Pollution Control Boards) be rule to use the mobile applications started by the CPCB (Central Pollution Control Board) name as COVID19BMW to follow biomedical waste management [19]. Some of the sanitization plan at national level used for hospital liquid waste sterilization during corona for biomedical waste and some common disinfection are incineration, chemical and physical disinfection were used in hospital [67].

Incorporation of the different proposals for (SWM) solid waste management improve the present systems and execute new waste management systems for solid waste and can minimize the environmental impacts from (GHG's) greenhouse gas emission [68]. Best management waste practices should be applied to avoid the workers vulnerable to potentially contaminated waste². According to [69] Mask which is made of various compounds and difficult to be recycled, suggests an environmentally at the same time gaining the generation of useful fuels from the face mask it is done by method such as Carbon dioxide-assisted thermochemical process was performed and these conversion of discarded face mask and Carbon dioxide could be an eco-friendly way to reduce Covid waste and production of energy.

In India discarded (PPE) personal protection equipment should be shredded and transport to plastic waste recyclers which are authorized by state pollution control board, or may be used plastic waste in generation of energy i.e., Waste to Energy (WtEs) plant and into refuse derived fuel (RDF) or for road construction [37]. Treatment of biomedical waste can be done by autoclaving technique called as hydrothermal carbonization (mostly non-infectious plastic fraction) carbonization [70]. In china biomedical waste treated by adopting of these technologies depend on budget and flexibility, to assess potentiality, value and correlated degradation of environment [64].

According to central pollution control board plastic waste which are generated from residential households must first store in paper bag for at least for seventy-two hours then discard of the similar as dry general solid waste [37]. Personal protection equipment (PPE) which get rid of from materialistic set up, shopping malls, institutions, offices, etc. must put waste in segregated form in different bin for 3 days, afterwards do cutting and finally discard in general solid waste [42]. Some Practices which may include if collection of infected household would have delaying waste collection later than (72 h) then direct transportation of waste to waste to energy or dumpsites without waste segregation at MRF (Material Recovery Facilities) [2]. [71] Claims that the technologies like (WtEs) waste to energy are hardly employ in developing nation concentrate on waste type, treatment may demand high level plant arrangement, and major capital costs.

CONCLUSIONS

The Pandemic coronavirus affect all the countries of the world in term of life, environment and economy but peoples

try to cope up with serious situation and support their Government in tackling the situation. As number of cases increasing is directly related to increasing in biomedical waste such as PPE, mask, glove and other plastic waste etc. which required at time of treatment and risk for transmission is also there as people may contact with covid-19 positive patient. Rule and guideline are also made by government agencies to manage the waste generate from hospital and temporary isolation or quarantine place for patient there are need of awareness on segregation waste from household to not to mix biomedical with general waste but still there lack of implementation of guideline at ground level. Most of countries including India still fighting against pandemic and various vaccine has been developed by different countries researcher and in second wave three vaccine are approved in India and which were in different phase of human trial during first wave but in second wave vaccination against covid has been started for two age group i.e. 45+ and 18+. In future, people may tackle the third wave in better way as presently there are enough facilities and also people experienced already first and second wave of covid. It is duty of government to provide health and food security for waste collector and rag picker at time of these pandemic situation as they put their life at risk while handling of waste. For treatment of waste there are need to improvement in technology at waste to energy plant and also enhance the intake capacity of waste at plant. It would be better if maximum waste can be recycle and find out value added product from these waste in ecofriendly way than incineration.

Acknowledgement: NA

Funding: The author received no financial support for the research, authorship and publication of this research.

Conflict of Interest: The authors do not have any conflict of interest.

REFERENCES

1. **Ramteke, S., and Sahu, B.L** Novel coronavirus disease 2019 (COVID-19) pandemic: considerations for the biomedical waste sector in India. *Case Studies in Chemical and Environmental Engineering*. 2020. <https://doi.org/10.1016/j.csee.2020.100029>
2. **Nghiem, L.D., B. Morgan, E. Donner, and M.D.** The COVID-19 pandemic: considerations for the waste and wastewater services sector. *Case Studies in Chemical and Environmental Engineering*, 2020, 100006.
3. **WHO.** Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020.
4. **Mallapur, C.** Sanitation Workers At Risk From Discarded Medical Waste Related To COVID-19. India Spend. 2020
5. **UNEP . BASEL:** Waste management an essential public service in the fight to beat Covid -19. The United Nations Environment Programme (UNEP) and The Basel Convention. 2020.

6. **Tenenbaum, L.** The amount of plastic waste is surging because of the coronavirus pandemic Forbes (2020).
7. **Ferronato, N., Torretta, V.** Waste mismanagement in developing countries: a review of global issues. *International Journal Environment. Research Public Health* 2019,16 (6), 1060.
8. **Kaufman, L., Chasan, E.** Cities Wonder Whether Recycling Counts As Essential During the Virus. Bloomberg Green,2020. <https://www.bloomberg.com/news/articles/2020-03-27/cities-wonder-whether-recycling-counts-as-essential-during-the-virus>
9. **Jung,S., Lee,S., Dou, X., Kwon,E.E.** Valorization of Disposable COVID-19 Mask through the Thermo-Chemical Process. *Chemical Engineering Journal*.2020
10. **Silva A.L.P., Prata, J.C.,Walker,TR., Campos,D., Duarte,AC., Soares,AMVM., Rocha- Santos,T.** Rethinking and optimising plastic waste management under COVID-19: Policy solutions based on redesign and reduction of single-useplastics and personal protective equipment *Science of the Total Environment* 2020, 742
11. **Neel, K.** Punjab farmers start dumping vegetables due to curfew. Chandigarh News (Times of India). 2020.
12. **Aldaco, R., Hoehn, D., Laso, J., Margallo, M., Ruiz-Salmón, J., Cristobal, J., Kahhat, R., Villanueva-Rey, P., Bala, A., Batlle-Bayer, L., Fullana-i-Palmer, P., Irabien, A., Vazquez-Rowe, I** .Food waste management during the COVID-19 outbreak: a holistic climate, economic and nutritional approach. *Science of the Total Environment* .2020,742
13. **Klimes, J.J., Fan,Y.V., Tan, R.R., Jiang, P** .Minimizing the present and future plastic waste, energy and environmental footprints related to COVID-19, *Renewable and Sustainable Energy Reviews* 2020, 127 :109883.
14. **India Today(2020)** Coronavirus in India: Tracking Country's First 50 COVID-19 Cases; what Numbers Tell. Retrieved from: www.indiatoday.in/india/story/coronavirus-in-india-tracking-country-s-first-50-covid-19-cases-what-numbers-tell-1654468-2020-03-12.
15. **The Economic Times, (2020).** World's Biggest Lockdown May Have Cost Rs 7-8 Lakh Crore to Indian Economy. Retrieved from: www.economictimes.indiatimes.com/news/economy/finance/worlds-biggest-lockdown-may-have-cost-rs-7-8-lakh-crore-to-indian-conomy/articleshow/75123004.cms?from=mdr.2020.
16. **MoHFW (Ministry of Health and Family Welfare) – Government of India (GOI), 2020.** Retrieved from: www.mohfw.gov.in/.
17. **ICMR Covid-19 latest updates: 3 Indian vaccines under trial, Russia to allow civilian use this week.** (hindustantimes.com.) 11.August 2020.
18. **Worldometer.** COVID-19 coronavirus pandemic. 2021; published online
19. **Jain,V.K Iyengar,K.P.,Vaishya,R.** Differences between First wave and Second wave of COVID-19 in India. *Diabetes Metab Syndr.* 2021 15(3): 1047–1048. doi: [10.1016/j.dsx.2021.05.009](https://doi.org/10.1016/j.dsx.2021.05.009)
20. **World Bank.** Waste workers are protecting our communities during COVID-19.202. <https://blogs.worldbank.org/sustainablecities/waste-workers-are-protecting-our-communities-during-covid-19>). 2020.
21. **EPCA .**Delhi generated 14 times more COVID-19 biomedical waste in July compared to May: EPCA report. 2020 ([www.financial](http://www.financialexpress.com) express.com)
22. **Time of India** Pollution report shows massive rise of Covid waste in state.19 Sept 2020a) http://timesofindia.indiatimes.com/articleshow/78195365.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
23. **SCMP (South China Morning Post), (2020).** Coronavirus leaves China with mountains of medical waste.<https://www.scmp.com/news/china/society/article/3074722/coronavirus-leaves-china-mountains-medical-waste.2020>.
24. **Times of India.** 350 tonnes of trash disappear from streets of Ahmedabad. 8 April. http://timesofindia.indiatimes.com/articleshow/75039037.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.2020b
25. **Datta, P., Mohi, G.K., Chander, J (2018) Biomedical waste management in India: critical appraisal.** *Journal of laboratory physicians*, 2018, 10 (1)
26. **CDC.** Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed Coronavirus Disease 2019 (COVID-19) in Healthcare Settings (Centers for Disease Control and Prevention: CDC), 2020.
27. **PHAC.** Coronavirus disease (COVID-19): For health professionals (Public Health Agency of Canada: PHAC), 2020.
28. **ECDC.** Guidance for wearing and removing personal protective equipment in healthcare settings for the care of patients with suspected or confirmed COVID-19 (European Center for Disease Prevention and Control: ECDC), 2020.
29. **Earth.org.** Another Side Effect of COVID-19: The Surge in Plastic pollution ,2020 (www.Earth.org.in).
30. **Aldaco, R., Hoehn ,D., Laso,J., Margallo,M., Ruiz-Salmón,J.,Cristobal,J., Kahhat ,R., Villanueva-Rey,P.,Bala,A., Batlle-Bayer ,L., Fullana-i-Palmer,P., Irabien,A., Vazquez-Rowe,I.** Food waste management during the COVID-19 outbreak: a holistic climate, economic and nutritional approach. *Science of the Total Environment*.2020, 742.

31. **Jolanki,R ., Aalto-Korte,K., Ackermann, L., Henriks-Eckerman, M.L., Välimaa, J., Reinikka-Railo., H., Leppanen, E.** 1,2-Benzisothiazolin-3-one in disposable polyvinyl chloride gloves for medical use, *Contact Dermatitis* 57 (2007) 365-370.
32. **Lee, S., Cho, A.R., Park, D., Kim, J.K., Han, K.S., Yoon, I.J., Lee, M.H., Nah, J .** Reusable Polybenzimidazole Nanofiber Membrane Filter for Highly Breathable PM 2.5 Dust Proof Mask, *ACS Applied Materials and Interfaces*.2019, 11 :2750-2757.
33. **Aslan,S., Kaplan,S., Çetin, C.** An investigation about comfort and protection performances of disposable and reusable surgical gowns by objective and subjective measurements, *Journal of the Textile Institute* 2013,104:870-882.
34. **Bdour, A., Altrabsheh, B., Hadadin, N., Al-Shareif, M .** Assessment of medical wastes management practice: A case study of the northern part of Jordan, *Waste Management*.2007, 27 :746-759.
35. **Anuar S.D., Abnisa, S.F., Wan Daud,W.M.A., Aroua,M.K.** A review on pyrolysis of plastic.2020
36. **Vanapalli, K.R., Sharma, .B., Ranjan, V. P., Samal, B., Bhattacharya, J., Dubey, B.K., Goel,S .** Challenges and strategies for effective plastic waste management during and post COVID-19 pandemic. *Science of the Total Environment*. 2020. <https://doi.org/10.1016/j.scitotenv.2020.141514>
37. **Dubey,B., Sharma, H.B., Kumar,R.V., Cheelaa,V.R.S., Ranjana,V.P., Kumar,A., Goela,S., Bhattacharya,J .** Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic. *Resources, Conservation & Recycling*. 2020, 162:
38. **Kulkarni B.N., Anantharama,V .** Repercussions of COVID-19 pandemic on municipal solid waste management: Challenges and opportunities .*Science of the Total Environment*.2020, 743 140693
39. **WHO..** Report on health-care waste management (HCWM) status in Countries of the South-East Asia Region (SEA-EH-593). The World Health Organization.2017.
40. **CPCB.** Guidelines for Handling, Treatment and Disposal of Waste Generated during treatment/Diagnosis/ Quarantine of COVID-19 Patients. Central Pollution Control Board, India.2020
41. **FAO.** Questions and answers. COVID-19 pandemic - impact on food and agriculture. 2019 .<http://www.fao.org/2019-ncov/q-and-a/en/>.
42. **FAO (2019)** Novel coronavirus food and Agriculture.2019
43. **US EPA.** Recycling and sustainable management of food during COVID-19 public health emergency.2020 <https://www.epa.gov/coronavirus/recycling-and-sustainable-management-food-during-covid-19-public-health-emergency>
44. **Somani, M., Srivastava ,A.** Indirect implications of COVID-19 towards sustainable environment: An investigation in Indian context . [Bioresource Technology Reports](https://www.biorxiv.org/content/10.1101/2020.06.11.20111111v1).2020, 11
45. **CPCB, Revision-4 (2020)** Guidelines for Handling, Treatment and Disposal of Waste Generated during treatment/ Diagnosis/ Quarantine of COVID-19 Patients. Revision -4, 2020.
46. **MOEFCC.** Salient features of Solid waste managements, 2016, Govt of India. http://cpcb.nic.in/uploads/hwmd/Salient_features_SW_M_Rules.pdf.2016.
47. **Zambrano-Monserrate, M.A., Ruano, M.A., Sanchez-Alcalde, A., (2020).** Indirect effects of COVID-19 on the environment. *Science Total Environment*.2020, 728, 138813.
48. **UNCTAD.** Environmental impacts of coronavirus crisis, challenges ahead .20 April 2020.
49. **NGT.** NGT Directed CPCB for recover fee from Amazon and Flipkart for excessive used of Plastic. ([www.Hindustantime.com](http://www.hindustantime.com)) on 13 Sept 2020.
50. **Arab State .** COVID-19 and the Environment: Impact and Response.17 may 2020.
51. **Liu, J., Yao, J., Zhang, X.** Impact of Meteorological Factors on the COVID-19 Transmission: A Multi-city Study in China. *Science of The Total Environ*.2020, 726, 1–8.
52. **Ramesh, M., Anitha, S., Poopal, R.K., Shobana, C.** Evaluation of acute and sublethal effects of chloroquine (C18H26ClN3) on certain enzymological and histo pathological biomarker responses of a freshwater fish *Cyprinus carpio*. *Toxicology*. Rep.2018, 5, 18–27.
53. **Daughton, C.G .** The Matthew effect and widely prescribed pharmaceuticals lacking environmental monitoring: case study of an exposure-assessment vulnerability. *Science of The Total Environment*. 2014, 466, 315–325.
54. **Corman, V.M., Land, O., Kaiser, M.** Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. *Euro surveillance*, 2020, 25 (3), 2000045.
55. **Das, O., Neisiany, R.E., Capezza, A.J.** The need for fully bio-based facemasks to counter coronavirus outbreaks: a perspective. *Science of The Total Environment*.2020, 736, 139611.
56. **CNN.** Conservationists warn Covid waste may result in more masks than jellyfish' in the sea.2020. <https://edition.cnn.com/2020/06/24/us/plastic-pollution-ocean-covidwaste->
57. **Sigler, M.** The effects of plastic pollution on aquatic wildlife: current situations and future solutions. *Water Air Soil Pollut*.2014, 225 (11), 2184.

58. **Vegter, A.C., Barletta, M., Beck, C.** Global research priorities to mitigate plastic pollution impacts on marine wildlife. *Endanger. Species Res.* 2014, 25 (3), 225–247.
59. **Mol, M.P.G., Caldas, S.** Can the Human Coronavirus Epidemic also Spread Through Solid Waste? *Waste Management . Research.* 2020, 38, 485–486.
60. **Kharel, T.P.** Risk of COVID-19 for household waste workers in Nepal. *International Journal of Multidisciplinary Sciences and Advanced Technology.* 2020, 1, 116–123.
61. **Nzediegwu, C and Chang, S.X.** Improper solid waste management increases potential for COVID-19 spread in developing countries. [Resource Conservation and Recycling](#). 2020, 161: 104947.
62. **Aboubakr, H., Sharafeldin, T.A., Goyal, S.M.** **Stability of SARS-CoV2 and other coronaviruses in the environment and on common touch surfaces** OSF Preprints (2020), [10.31219/osf.io/y2rth](https://doi.org/10.31219/osf.io/y2rth)
63. **Kampf, G., Todt, D., Pfaender, S., Steinmann, E.** Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *Journal Hospital Infection.* 2020, 104, 246–251.
64. **Swati, S.** PPE, Masks, Gloves: Rising environment problem due to slowly piling COVID-19 waste. 4 July 2020. (www.Expressnewservices)
65. **Time of India.** Disposal of PPE kit, other biomedical waste challenges during covid-19 pandemic: Government. 20 Sept. 2020c
66. **Sharma, V.** COVID biomedical waste poses environmental challenge. (July 2020)
67. **Wang, J., Shen, J., Ye, D., Yan, X., Zhang, Y., Yang, W., Li, X., Wang, J., Zhang, L., Pan, L.** Disinfection technology of hospital wastes and wastewater: suggestions for disinfection strategy during coronavirus disease 2019 (COVID-19) pandemic in China. *Environ. Pollut.* 262, 114665. <https://doi.org/10.1016/j.envpol.2020.114665>.
68. **Ramachandra, T.V., Bharath, H.A., Kulkarni, G., Han, S.S.** Municipal Solid Waste: Generation, Composition and GHG Emissions in Bangalore, India. *Renewable. Sustainable. Energy. Reviw.* 82, 1122–1136.
69. **Jung, S., Lee, S., Dou, X., Kwon, E.E.** (2020) Valorization of Disposable COVID-19 Mask through the Thermo-Chemical Process. *Chemical Engineering Journal*, 2020, <https://doi.org/10.1016/j.cej.2020.12665>.
70. **Yafei, S., Shili, Yu., Shun, Ge., Xingming, C., Xinlei, Ge., Mindong, C.** Hydrothermal carbonization of medical wastes and lignocellulosic biomass for solid fuel production from lab-scale to pilot-scale. *Energy*, 2017, 118, 312–323.
71. **Mayer, F., Bhandari, R., Gath, S.** Critical Review on Life Cycle Assessment of Conventional and Innovative Waste-to-Energy Technologies. *Science of The. Total Environ.* 2019, 672, 708–721.