24 to 48 hour Composting Machines:
Do They Really Produce Compost as the Final Output and Their Viability for Community Composting in Indian Cities

Monika Khanna Gulati[1] and Shyamala K. Mani[2]

Abstract

This paper focuses on the city of Gurugram to evaluate the effectiveness of automatic composters (24-hour composting machines) as a part of decentralised waste management measures for the treatment of wet-waste. It compares the physical and chemical parameters of the output from these machines to the standards of quality compost and with compost produced using natural composting processes to find that the output does not conform to the standards. It highlights the kind and intensity of challenges cities will face in case these machines are employed by Bulk Waste Generators (BWGs). It emphasizes the need to employ source segregation of waste and natural composting methods for addressing meaningful municipal waste management and enhancing and protecting the soil quality. During the COVID-19 pandemic, one of the locations comprising 1000 households treated 183 tons of segregated wet waste in and generated 20 tons of stable compost which was used to nourish the soil of 16 parks in that area.

Keywords: Community Composting, Decentralised Waste Management, Soil Health, Gurugram

[1] Founder NCR Waste Matters, Member of Citizen's Monitoring Committee, Gurugram, Haryana. Email: ncrwastematters@gmail.com
[2] Senior Advisor, Centre for Environmental Health, Public Health Foundation of India, Gurugram, Haryana. Email: shyamala.mani@gmail.com

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Introduction

Municipal solid waste management is a major concern for rapidly urbanizing cities across India. Gaps in the existing practices and infrastructure have motivated citizens to actively participate in finding workable solutions.

Introduction to Gurugram, urbanization and waste-related issues

The city of Gurugram located in northern India, at a distance of about 30 kilometres from the country's capital is among the rapidly urbanizing cities in the country (Bansal et al., 2020). In recent years, it has witnessed a surge in economic activity, which has led to exponential population growth (primarily attributed to rural-urban migration), with a rate of increase of 283% between 2001 and 2011 (Census of India, 2011; Chatterji, 2013). As a result, its formal urban limits have also expanded six times (Chatterji, 2013). This growth is however marked by 'infrastructure deficiencies', 'disaggregated urban transformation' (Chatterji, 2013, p. 274, p.287; Gururani, 2013) and spatial heterogeneity.

Urbanization, coupled with economic growth has resulted in increased consumption rates, which has led to increasing volumes of waste production (KPMG India, 2020). The city of Gurugram, along with another major city in the state named Faridabad generate one-fourth of the total amount of the waste in the state on a per day basis (Haryana Pollution Control Board (HPSCB), 2019). The city currently generates 1000 Metric Tonnes (MT) per day and is projected to generate 2900 MT by 2041 (HPSCB, 2019).

As per HPSCB's annual report (2019), the city treats only 17.5% of its total waste, and the remaining is sent to the Bandhwari dumpsite, which is spread over an area of 30.5 acres. This dumpsite has received waste that is 166% of its capacity

(Chowdhury, 2013), resulting in 34,300 MT of waste being piled up (CPCB, 2020).

According to CSIR-National Environmental Engineering Research Institute (CSIR-NEERI, 2020) air pollutants released because of open decomposition of waste and its burning are detrimental to the health of the villagers residing in surrounding areas. The report further adds that the dumpsite releases carbon dioxide and methane as a result of open decomposition which are greenhouse gases (GHGs) contributing to climate change. It also states that the soil and water of the area have been contaminated because of the discharge of leachate from the landfill, posing a threat to the adjacent Aravalli range and its forest areas.

The study estimates a total incurred damage of about Indian Rupees (INR) 1.4 billion due to externalities from the Bandhwari dumpsite (this includes depreciation of land value). More importantly, leachate from the landfill has been contaminating groundwater, thereby impacting the health of villagers in surrounding areas (Desai, 2018), which makes this a pertinent social issue, having implications beyond the point of waste generation.

The paper evaluates the efficacy of 24-hour composting machines as a solution for waste (biodegradable/organic) management in (urban) India. While Section 1 covers introduction and current practices, Section 2, goals and objectives of the paper, Section 3, methodology, Section 4 gives results and analysis, Section 5 discussion, which includes an insight on the case study areas and an explanation on the importance of decentralised wet-waste management. This is then followed by an analysis of the technology in focus, i.e. 24-hour composting machines by an assessment of the quality of compost produced by these using technical parameters, followed by conclusion and recommendations in Section 6.

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Decentralised waste management

The ramifications of openly dumped waste in landfills, in terms of contributing to climate change at a global level and air, water and soil pollution at the local level, are well established. As biodegradable waste mixed with inorganic waste decomposes in the open, it releases methane, which has a Global Warming Potential (GWP) 28 times (for cumulative forcing over 100 years) that of carbon dioxide, making it a potent green-house gas (GHG) (IPCC, 2014).

In terms of local level concerns, lack of waste management has led to increased air and water pollution levels in cities across the globe including those in India (Ferronato and Torretta, 2019; Samal, Mani and Madguni, 2020). The immediacy to resolve the lack of waste management is reflected in a statement by the World Bank (Kaza et al., 2018), according to which waste generation will outpace global population growth by more than double by the year 2050 given the current trajectory. In this regard, decentralized waste management, driven by community participation is key. Cities across India have been witnessing an increased rate of community participation with regard to waste management, thereby facilitating decentralized waste management (Singh, 2012).

A decentralized system not only reduces the volume of waste being openly dumped in the city’s landfills, but also allows community integration through participation and ownership in waste management (Agarwal and Gupta, 2003). Additionally, alterations and improvements can be made with inputs from the community, which ensures sustained commitment (Agarwal and Gupta, 2003). Rathi (2006) also points out that community participation in decentralized waste management is the least cost option, as compared to processing by the municipality or private organizations.

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Stakeholders' actions

The Municipal Corporation of Gurugram (MCG) is the Urban Local Body (ULB) responsible for solid waste management in the city. In 2018, MCG released a notification according to which BWGs, which include Resident Welfare Associations (RWAs) needed to treat their wet-waste (biodegradable/organic waste) at source (Khera, 2020). The push for source segregation and on-site treatment of wet-waste was also brought forth by the Solid Waste Management (SWM) Rules, 2016.

As a result, residential colonies (comprising primarily gated communities) across the city have begun to shift their focus to decentralized waste management (Roychowdhury and Puri, 2017). The city is therefore undergoing an institutional, regulatory and civic transformation in its waste management activities, with a focus on decentralized wet-waste management.

In order to identify and adopt solutions at a decentralized level, citizens have organized platforms and forums to discuss and exchange experiences regarding various types of technologies available to process waste. Waste champions and citizen groups across the city have been evaluating and testing several composting methods and technologies for their efficacy at the community level. The traditional 30-day natural composting method has been adopted in majority of the residences across the city, and has been functioning successfully across the country (Mandpe et al., 2020). However, the emergence of 24-hour composting machines, as a short-term solution has become a cause of concern for citizens who understand that solutions for waste management need to be adopted considering long-term impact, in addition to efficacy.

In a recent case in the city of Pune in central India, these machines (24-48 hour composters) were employed for the treatment of wet-waste. However, it was found that the output produced did not conform to the standards under the SWM Rules,

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2016 (Chavan, 2017). In another case, in the city of NOIDA in northern India, citizens faced similar challenges when wet-waste composting machines (24-48 hour composters) remained defunct after an operating period of a few months and citizens reconsidered the adoption of natural composting methods (Sinha, 2021).

As per the manufacturers, the composting process in these machines is controlled automatically (temperature and moisture content control), and the content is processed within 24 to 72 hours. Manufacturers also claim that the end result from these composters is as functional as compost produced from the natural composting process. This technology is easily accessible in the market, at an affordable cost (for RWAs), and is being aggressively marketed across various platforms.

Formulation of CMC

In order to address concerns surrounding these technologies and machines, the citizens and MCG identified a need to formulate a Citizen's Monitoring Committee (CMC). This committee was constituted on 7 Feb 2018 by the then Commissioner of MCG, Uma Shankar to monitor Solid Waste Management and Street Sweeping in Gurgaon by M/S Ecogreen Energy Pvt. Ltd. Gurgaon/Faridabad. Shortly after, the mandate was expanded to include Construction and Demolition Waste Management by the next Commissioner Yashpal Yadav.[1]

The CMC (Citizen's Monitoring Committee) under the leadership of Yashpal Yadav decided to empanel vendors for community composting to the MCG to bring viable solutions to the city. It was important to empanel and bring a healthy mix of solutions which would match the different requirements of space, price and quantity of waste generated. Through this empanelment, the RWAs and citizen bodies could take informed decisions on the kind of technology to be adopted for their community to enable successful decentralized composting. Many solution providers came forward to be empanelled including companies providing 24-48 hour composting machines. Given the lack of reliable data on the efficacy of these machines, it was decided that MCG would conduct an experiment on these 24-48 hour composting machines over a duration of one month and then evaluate if they could be empanelled.

In December 2018, an Expert Panel comprising Dr Shyamala Mani, Dr Lakshmi Raghupathy, Sudhir Krishna, Smita Ahuja, Priya VK Singh, Keshav Jaini and Monika Khanna Gulati was set up to view the presentations made by 6 vendors of 24 - 48 hour composting machines, review the pilot processes and outcomes and present the findings to MCG with the assistance of Executive Engineer (EE) Pardeep Kumar, all of which process organic waste inside the machine run on electricity so as to shred it, remove excess moisture, and in some cases, subject it to enzymes. The output is claimed to be ready for application to plants/ addition to soil after 24-48 hours, or, in some cases, after 3, 7 or 10 days of curing.

Goal and Objectives

This paper focuses on the use and employability of this technology, with an aim to assess the viability of such 24-hour composting machines for BWGs in the urban Indian context. There are two concerns that push for such an assessment. The scale of waste-related issues in Gurugram and other cities across India demands all forms of interventions, including technological ones. However, stakeholders (which include decision-makers and citizens who are the most affected) also need to consider the viability and effectiveness of such interventions in India, which is overshadowed by varying dynamics such as a strong dependence on informal waste collectors working in precarious conditions in the absence of financial and social safety nets (Wilson et al.,

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2006). Secondly, although urban India is already burdened with several environmental problems, this is the opportunity to integrate existing availability of manpower and transition with technologies that are not further detrimental to the environment.

Therefore, the main objective of this paper is to test the viability of 24-48 hour composting machines, by testing if they produce compost as an output and if these are sustainable options for community composting.

The other specific objective of the paper is to highlight the effectiveness or otherwise of these 24-hour composting machines and identify specific reasons as to why they do or do not suit rapidly growing urban India's waste woes, which has been articulated in the discussion, conclusion, along with recommendations on solutions that will work in urban India.

Methodology

The experimental work was done as a pilot in Gurugram as part of city-wide empanelment with the help of MCG and CMC. Details with regard to the formulation of the CMC have been discussed in previous section, as specified in the structure of the paper.

Empirical data from Gurugram has been analysed for this assessment. Samples of treated biodegradable waste across five locations have been tested in laboratories, and are compared against national standards of compost. These samples have been assessed on the basis of

(i) Technical specifications
(ii) Output - quality of compost
(iii) Feasibility of adoption

These values are also compared with data from two locations that employ natural composting (as control) processes that have been explained. The purpose of the comparison is to

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substantiate the argument whether natural composting processes are best suited for decentralized waste management.

Data collection

The paper brings forth data collected as a part of experimental testing, conducted by citizen groups of Gurugram, primarily involved through the CMC with the MCG. This was more crucial after learning about experiences of citizens and Municipal Corporation of Pune, NOIDA and other places in regard to the inability of this technology to perform satisfactorily.

MCG provided the necessary logistics and support to facilitate the setting up of the required machinery, collection and testing of samples. Five locations were set up as a part of the experiment, where the MCG provided a sheltered space and dedicated power supply. Source segregated and collected wet-waste fed into these machines was provided to the machine operators by MCG. Each location had a 24-hour composting machine provided by five distinct manufacturers/sellers.

These machines across Locations 1-5 ranged from those that can process 50 kilogram (kg) of waste per day to those that can process 400 kg of waste per day. The temperature, air flow and moisture content can be manually controlled in these. One of these has the provision of controlling the percentage of bacteria added to the content, based on temperature changes during the process, and can vaporize the moisture present in the waste, which also reduces the volume of the output product.

Additionally, it claims that the control of air flow helps prevent odour, pests, any leakage of leachate or emission of harmful gases. The machine at one of the locations also has an in-built shredder and cylindrical container that can crush and mix the waste simultaneously to cut down the volume of waste and accelerate decomposition. The heating arrangement in this model

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is said to optimize the performance of microorganisms, again to accelerate the composting process.

The following natural composting processes were used in other two locations:

Location 6

The crushed food waste is put in five large 2000 litre rotary drums. To balance the high nitrogen content in the food waste, carbon in the form of dried shredded leaves is added in double proportion, according to volume. One gram of bio enzyme powder is also added to each kg of the food and horticulture waste mix to introduce microbes. Waste decomposer is also sprayed every alternate day for the introduction of enzymes and microbes. After six days, the semi-digested waste is moved to cover metal mesh bins. There is regular raking to aerate the piles and after a period of 8 to 10 weeks, the compost is ready for use. This process provides full-time employment to four workers.

Location 7

This location uses the Aaga composter that helps composting of wet waste in a decentralized manner. Two Aagas handle 18 kg of wet waste per day. During usage, one Aaga in the pair remains idle and the other one is loaded with wet waste, cocopeat and microbes daily until it fills up (takes 15 days). After that the process is repeated in the second Aaga and by the time the second Aaga is full, fresh compost is ready in the first Aaga.
Compost quality tests of ‘compost’/ product from all these locations have been tested in approved laboratories and discussed in the next section.

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Results

Test Results

Table 1: Properties of 24 hour composting machines

Source	Pilot period of machines in use	Time taken for processing, temperature, capacity of equipment used	Form of waste (shredded or hammered)	Inputs	Observations on appearance	Units of electricity consumed to process 1 kg of waste
Location 1: Sector 56 	19.1.19 to 20.2.19	24 hours 50°C 50 kg/day	Not shredded or hammered	Kitchen waste	Charred grey-black, Clumpy appearance. Burnt odour	0.16
Location 2: Sector 45 	03.1.19 to 20.2.19	24 hours 50-60°C 150 kg/day	-	Kitchen waste & bio enzyme @ 1 tsp/100 kg	Moist, powder, black, foul, acidic odour	1.67
Location 3: Beriwala Bagh 	01.02.19 to 20.2.19	24 hours 60-70°C 50 kg/day	-	Horticulture & kitchen waste + microbe powder	Dark & moist on Same day. Granular & brown after curing in baskets for 10 days	22.03
Location 4: Sector 15 	10.2.19 to 07.3.19	24 hours and 10 days of curing 50°C 400 kg/day	Shredded/ hammered	Uncontrolled proportions of kitchen & horticulture waste	Moist, clumpy & dark brown & appearance	2.22
Location 5: Nandi Dham Gaushala	29.1.19 to 20.2.19	24 hours 60-70°C 100 kg/day	-			

Source: On-site collection, February 2019

Table 1 provides the details of the total duration of usage, quantity of waste, time for processing, kind of inputs, observations of appearance and importantly, the units of electricity consumed to run each of these, at the five locations where 24-48 hour composting machines were kept.

Table 2: Physical and chemical properties of output product, ICAR review (location-wise) and comparison with FCI standards; Date of testing 22 February 2019 to 8 March 2019

Source	pH (1:5)	Conductivity (Ds/m) (1:5)	Moisture (% by weight)	Carbon (% by weight, min)	Nitrogen (% by weight, min)	Phosphorous (% by weight, min)	Potassium (% by weight, min)	ICAR review
FCI 2009 for Organic compost (as per SWM Rules 2016)	6.5-7.5	Not more than 4.0	*15-25*	*12.0*	*0.8*	*0.4*	*0.4-1.24*	-
Location 1: Sector 56	7.72	5.09	*29.8*	*28.8*	*2.29*	*0.25*	-	Saline
Location 2: Sector 45	4.96	8.89	*32.8*	*44.6*	*1.93*	*0.23*	*0.93*	Saline and acidic
Location 3: Beriwala Bagh	4.09	7.40	*60.0*	*39.4*	*1.98*	*0.37*	*1.33*	Saline and acidic
Location 4: Sector 15	7.70	3.91	*113*	*31.8*	*2.41*	*0.21*	*1.26*	Normal
Location 5: Nandi Dham Gaushala	6.54	7.56	*30.6*	*22.7*	*1.42*	*0.24*	*1.38*	Saline

Table 2 analyzes the output product from each of these variables such as pH, moisture content, conductivity, carbon content, nitrogen content, potassium content and phosphorous content, as is prescribed by the standards provided by Food Corporation of India (FCI) (as mentioned in Schedule (IV) clause 2 (h) and (q), Part A of SWM Rules, 2016) and Indian Council for Agricultural Research (ICAR) (for testing compost quality). To assess the quality of the output product, Table 2 compares the values with these standards.

Table 3: Physical and chemical properties of compost produced using natural processes.
Date of testing
Location 6 – 12 May 2017 to 27 May 2017
Location 7 – 31 January, 2019 to 06 February, 2019

Source	pH (1:5)	Conductivity (Ds/m) (1:5)	Moisture (% by weight)	Carbon (% by weight, min)	Nitrogen (% by weight, min)	Phosphorous (% by weight, min)	Potassium (% by weight, min)	ICAR review
FCI 2009 for Organic compost (as per SWM Rules 2016)	6.5-7.5	Not more than 4.0	*15-25*	*12.0*	*0.8*	*0.4*	*0.4-1.24*	-
Location 6 	8.26	2.58	*2.05*	*29.4*	*2.95*	*0.35*	*1.63*	"Manure sample is normal"
Location 7 	7.4	1.8	-	*14.10*	*0.80*	*1.60*	*0.65*	'The tested sample of Compost conforms to Specification as per FCO, 1985 w.r.t. above test.'

Source: On-site collection date for Location 6 – May 2017; date for Location 7 - January 2019

Analysis and Inference

Lack of conformity to standards: As observed in Table 2, the output produced from Locations 1-5 except Location 4, do not meet the necessary FCI standards across various properties. In the case of pH, samples from Locations 2 and 3 are acidic and saline in nature (as shown in ICAR's review). At least 4 out of 5 Locations also do not conform to the conductivity standards for compost, and none of the Locations meet the moisture requirements as specified in the standards. None of the samples meet the minimum phosphorous (percentage by weight) requirements, and only Location 2 meets the potassium requirement.

The samples were also tested on odour and particle size (minimum 90% should pass through a 4 millimeter (mm) sieve). Samples from Location 1 and 2 did not match the standard odour requirements and none of the samples matched the particle size requirement. In the case of the compost produced from natural composting processes, test reports explicitly identify the output to be compost that conforms to the required Fertiliser Control Order (FCO) standards, part of 1985 order.

In contrast to this, samples from sites Locations 6 and 7 that used natural processing methods were clearly identified as 'manure suitable for use'. This is attributed to the fact that since these methods do not employ heating of any form, they retain the microbial content, which enhances the quality of the compost produced. For instance, just Location 6 with 1000 households treated 183 tons of segregated wet waste in 2020-2021 and generated 20 tons of stable compost, which was used for parks and common green areas in the community itself.

Discussion

Wet-waste and its treatment

Wet-waste treatment, in the form of composting is an intrinsic part of decentralized waste management. According to Mandpe et al. (p. 42, 2020), composting can be defined as 'the process of the biodegradation of the mixture of organic substrate conducted by the populations of various microbial species in aerobic environments in the solid state'. In addition to reducing the waste that goes into landfills, compost produced from this method enhances the nutritional quality of soil (Thanh et al., 2015), promotes nutrient recycling, increases water retention and improves soil structure (Wei et al., 2017), all of which are important to maintain the ecological health of the soil in cities.

Additionally, this system also contributes in strengthening the waste management system, as it helps integrate local informal workforce (local waste collectors) in the waste management system thereby creating new economic opportunities in the process (Zurbrügg et al., 2004). Apart from these environmental and social benefits, this scale and method of managing biodegradable waste also has several financial benefits, in addition to reducing emissions caused due to transportation of waste to landfills.

Municipal Solid Waste (MSW) in India contains significant fractions of biodegradable waste (Ministry of Urban Development (MoUD), 2016)). As per MCG data (Roychowdhury and Puri, 2017), 50 to 52% of the waste in the city is biodegradable, implying that composting at local levels can prevent a significant proportion of current volume of waste from being dumped in the landfills.

Community composting in Indian cities

Communities across India have been successfully employing traditional composting methods (natural composting), thereby reducing the volume of waste collected by municipalities. Aich and Gosh, 2019) identify composting to be the most feasible and effective waste management technique in comparison to other techniques. The only caution here is to ensure that the quality of compost produced at this scale adheres to standards established for the usability of compost. According to Saha et al. (2010), segregated waste collection before composting plays a vital role in improving the quality of the compost and needs to be duly considered as a part of community composting measures.

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They also highlight that 'India has an estimated potential of producing about 43 million tons of compost each year containing about 45,000 tons of nitrogen, 11,000 tons of phosphorous, and 23,000 tons of potassium. Inappropriate solid waste management and production of poor quality composts are the main constraints in exploiting such large amounts of plant nutrients to increase crop productivity' (p. 200). The need of the hour is to integrate composting processes that help restore this nutritional value to increasingly degraded quality of soil, and in the process resolve the waste crisis, the city and country are currently engulfed in.

Concerns with 24 to 48 hour composting machines

Heating is detrimental

Although these machines recommend heating to reduce the volume of the waste, this is detrimental to the biological life (such as natural fungi, bacteria etc.), which are an intrinsic component of the composting process itself and enhances the nutritional quality of compost. The loss of microbial activity can also be attributed to the loss of moisture which takes place even as fresh wet waste is added, thereby completely prohibiting the proliferation of microbes, which is detrimental to soil quality in the long run as it impedes the natural nutrient decomposition cycle (Hiremath, 2018).

High power consumption

Power consumption ranged from 0.16 units (for processing 1 kg of wet waste) to 22 units. Out of all 5 samples, only the sample at Location 4 appears to conform to the standards to an extent. However, this location consumes the highest amount of electricity, i.e. 22 units. In comparison to natural composting, which uses electricity (based on the type of method used) to churn

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and mix the components, the power consumed by these 24-48 hour machines, is too high (given the high volume of waste it will process), and makes the financial sustainability of the solution questionable.

Market buy-back/financial viability to ensure sustenance

As mentioned in section 1.3, in the case of Pune, the output from the machines did not conform to the standards. (Chavan, 2017). The quality of compost largely influences its sale and determines its market value, and the lack of this is likely to weaken the already unstable compost market (Hettiarachchi et al., 2020). Lack of quality, therefore, has financial implications for neighbourhoods/RWAs and eco-entrepreneurs who wish to set up businesses and livelihoods that intend to sell the compost produced. Not only does this impact the financial sustenance of the process, but also increases the liability since the RWA would have to pay for the removal or dumping of this by-product.

Natural composting process

In another study by Kucbel et al. (2019), automatic composters were employed to produce compost from food waste in the city of Ostrava in Czech Republic. Two types of automatic composters were used that processed food waste in 7 days, and between 14 to 21 days, respectively. According to the study, ‘the utilization of automatic composters for household food waste processing produces a material which is not suitable immediately after the end of composting for direct gardening and agricultural applications.

The resulting product is not sufficiently humidified and stabilized’ (p. 664). It also found that compost prepared in these automatic composters from household food waste had low organic content, and therefore unfit for horticultural and

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agricultural practices. Given that these machines do not produce compost, the output material therefore forms to be an alternate form of waste, which is of a grave concern as it will only add to the ever expanding stratum of waste (O'Neil, 2019).

Another major concern that emerges from this study is that the machines that process wet-waste and have considerable desired standards, consume high amounts of electricity. This would add on to the expenses of the RWAs and citizens. Natural composting methods on the other hand do not depend on electricity for functioning, making them financially sustainable.

Furthermore, it is pertinent to look at the intensity of impact these machines would have if they were employed in RWAs across the country. Degraded nutritional quality would lead to open dumping of the processed output, which takes us back to our original problem. According to Wilson (2007), as a community we need to realise that we are in this situation because for years we have relied on landfilling, and dependence on these automatic composters is only going to exacerbate these challenges.

According to the Ellen MacArthur Foundation (2017), 'regenerating natural systems' is one of the principal objectives of a circular economy. By using compost made from natural processes, communities can truly transform into circular economies, as this compost would regenerate soil quality, and natural systems in the process.

Despite awareness efforts made by the government, segregation at source has been weak across the country (Pratap et al., 2020). An area of concern, which can also be taken up for further research is that as citizens discover that automatic composters are only adding to the existing waste crisis, it could potentially demotivate them and thwart current waste segregation practices.

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Conclusions and recommendations

The usage of automatic composters such as the 24-48 hour composters analysed in this study, have the advantage that large amounts of organic biodegradable waste of virtually any type (food scraps, meats, horticulture, etc.) can be shredded/macerated, mixed with bulk matter and inoculum under controlled environmental conditions using electricity. However, such processing of organic waste (whether for 1 or 2 or 3 days) is required to be followed by at least 30 days of aerobic composting and an additional two weeks of curing before the output becomes ready for use so that pathogens are completely destroyed and the exothermic decomposition of the processed organic waste has advanced well enough so that it does not pose a threat to plant health (MoUD, 2005). Since none of the automatic composting solutions presented to the Expert Panel satisfied this condition, their empanelment by MCG was not recommended.

The paper hence establishes that automatic composters bring with them heavy environmental social and economic costs as mentioned in 5.1. Environmental costs consist of soil degradation resulting from the disposal of the low-quality output and high-power consumption rates as compared to natural composting processes. ULBs dumping large volumes of the aforementioned unusable output, threatens the soil and water quality, thereby endangering the lives of citizens. On the other hand, natural composting processes preserve and protect the microbial content in the soil, which is vital for soil health.

Furthermore, employing full-time workers to run and maintain these natural composters, could also facilitate the integration of informal waste workers and increase sustainable livelihoods, thereby avoiding any social costs. In addition, during COVID-19 pandemic, when processing of wet-waste from COVID positive homes and centers proves a challenge, simple natural composters and decentralized composting using natural composting methods have not only addressed this challenge but also have helped in containing the transmission of infection, thus protecting the waste workers and general community from reinfection.

In terms of economic sustenance, the use of natural composters can avoid costs due to high power consumption by these machines, and ensure long-term feasibility since the output conforms to quality standards, and can be sold in the market.

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[1] Members of CMC, Gurugram (Instituted in February 2018): Sudhir Krishna, Former Secretary, Ministry of Urban Development (now Ministry of Housing and Urban Affairs); Dr Lakshmi Raghupathy, Former Director, Ministry of Environment and Forests (now Ministry of Environment, Forest and Climate Change); Monika Khanna Gulati, NCR Waste Matters; Sonia Garga, Sahaas, Gurgaon; Smita Ahuja, I am Gurgaon