Urban Household Kitchen Waste Management: Compost Quality and Shredding in Automatic Compost Machine

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***Abstract*—Solid waste management is one of the most essential services for maintaining the quality of life of the people in the urban areas and protecting our environment. Composting is a process of controlled decomposition of the organic waste, typically in aerobic conditions, resulting in the production of stable humus like product called compost. Considering the typical composition of wastes and the climate conditions, composting is highly recommended after segregation of wet fraction of waste. Various composting machine are available in the market which help in fast composting. They have an inbuilt shredder where all hard and soft organic material is mixed and once the material is shredded the same goes into another chamber for further composting process. shredding cuts all waste into small pieces that help in faster composting process.**

The study is particularly interested in the socio-demographic, cultural and environmental features in high-rise residential buildings household waste treatment. The study identified key areas in waste management systems in high-rise residential buildings which is the avenue for future studies for integrating waste management strategies in high density residential development in Mumbai. Further a survey of resident's high-rise residential buildings in Mumbai suggest how aware they are about composting process. Based on the findings, the study recommends that shredding happen to degrade the quality of compost and all plastics material gets broken into small pieces and is difficult to separate from the readymade compost, thus degrades the quality of compost. It suggests alternative ways to dispose waste so that quality of compost would be better and will lead to non-contamination of agriculture soil.

Keywords—Urban household kitchen waste; Shreddi;, Compostin;, Quality; Solid waste management; Compost machine;.

I. INTRODUCTION

Urban India is facing an increasing challenge to provide for the incremental infrastructural needs of the growing urban population [1]. According to the 2011 census, the population of India was 1.21 billion, of this 31% lives in cities. As per Central Pollution Control Board (CPCB) report (2014-15) on state wise municipal solid waste generation data, Maharashtra generates 22,570 Tons per day (TPD) including Mumbai out of which about 5,927 TPD (26%) of waste is treated as per the requirement of MSW Rules 2000. Per capita MSW generation in various towns of the state ranges from 100 to 600 gram per person per day [1]. It is further projected that by 2050 half of India's population will live in cities and solid waste management is one of the most essential services for maintaining the quality of life of the people in the urban areas for protecting our environment. Releasing the findings of the survey, BCIL Chief Executive Officer Chandrashekar Hariharan said the kitchen waste of a family of four would provide rich nutrient fertilizer that can serve a full acre of plants and trees every two months.

Composting is a process that progresses in stages and at each stage, certain types of microbes enter the pile and break down the organic waste without intervention in 60 days. [6]

Mixed waste composting, with effective and appropriate pre-treatment of feedstock may be considered an interim solution; in such cases stringent monitoring of the compost quality is essential. The decomposition process takes place in the presence of air and results in increase in temperatures, the production of carbon dioxide, water and stabilized residue, known as humus. A high degree of stabilization can generally be achieved in 3-6 weeks, however 'curing' of the humus is normally carried out. For composting to occur in the best way five key factors are to be controlled; temperature, moisture, oxygen, material porosity and Carbon: Nitrogen ratio. Compost, the final product, because of its high organic content, makes a valuable soil conditioner and is used to provide nutrients for plants. When mixed with soil, compost promotes proper balance between air and water in the resulting mixture, which further helps reduce soil erosion, and serves as a slow-release fertilizer.

The composting machines claim to break down waste into compost in 10 days [7] and some claim to break it in 24 hours. It has an inbuilt shredder where all hard and soft organic material is mixed with 3:1 ratio of bulking material which helps in balancing the carbon and Nitrogen ratio once the material is shredded the same goes into another chamber called Blender where the waste is sprayed with bio enzymes and artificial aeration is provided for the degradation process to happen. The blended waste is pushed into a rotating in-vessel which is

designed to hold waste for 10 days, after 10 days the matured compost automatically comes out of the machine and the same can be used for agriculture purposes. Ananth and Shum (1976) studied fine shredding of municipal solid waste (MSW). They reported overview of equipment used for municipal solid waste size reduction and discussed their performance and cost aspects of the basic types of equipment used for shredding waste. The 11 basic types of equipment used for shredding MSW, only hammer mills and grinders found wide application [3].

The in-vessel composting process is a closed reactor process with aeration and automated process flow. In-vessel composting is a completely enclosed and odor-controlled system with continuous loading facility and is available in customizable capacity. The waste can be loaded and discharged either by an automated mechanical system or by simply using a front loader. For loading, a tunnel loading machine, or a system of conveyor belts can be used. The most

common discharging method is either by a pushing floor system or front loader. The technology is a continuously loading, fully enclosed, flow-through process that transforms food and other organic material into compost with a 14-28-day retention period. The process output is a soil conditioner suitable for agricultural and horticultural purposes. The composting vessel can be custom designed to handle a range of capacities. The composting vessel is a double-walled tunnel (stainless steel interior, burnished steel exterior) insulated to control the heat produced when organic materials decompose. Temperature and moisture levels inside the vessel's air zones are monitored constantly, and airflow is independently controlled in the composting zones to assure optimum composting conditions. The mixing zones (between each composting zone) assure proper mixing and aeration for bacterial growth. As the waste travels inside the vessel, it passes through composting zones and mixing zones.

Some machines have sophisticated temperature display panels, sensors and the rest were basic. The shapes and sizes varied, too. But all of them seemed to consume power and let out CO2 intensely. Community composting machine vendor made different claims although all of them ran on similar technology. The kitchen waste will need to be shredded before the breaking down process starts. This step is important because the smaller the size of the waste, the faster the composting process. Fitzgerald et al., (2009) studied the technical and economic analysis of preceding municipal solid wastes prior to disposal. They did research on how size reduction and homogenization of the raw MSW stream would potentially improve operating characteristics decreasing capital investments. The most important criterion in the adoption of pre-shredding [2]

Compost samples can be tested in labs. The compost quality is not good as the shredder happens to shred the small plastics waste that unintentionally accompanied the organic waste as the awareness levels of individuals is low and they have less time to take out small pieces of plastics waste like tomato sauce sachets etc. that are quite common on a urban households.

When I cross-checked all these findings with an expert, he said that “what comes out of these machines is not compost but burnt carbon”. Since he has also been promoting his own composting system, he didn’t want to be quoted for obvious reasons. However, he regretted how government authorities are falling for these claims and letting such machines hit the market without due diligence. More importantly, we are concerned about the wrecked-up electrical conductivity of such ‘compost’ which can damage the soil composition and kill the plants. The only way to prevent more vendors from jumping on to this ‘24-hour compost’ bandwagon is to reject quick-fixes and look for sustainable composting options.

Storage of waste at source is the first essential step of Solid Waste Management. Every household, shop and establishment generate solid waste on day to day basis. Waste should be stored at the source of waste generation till it is collected for disposal by ULB staff or appointed contractors. It is essential to segregate wastes into wet waste and dry waste. Segregation of municipal solid waste needs to be linked to primary collection of waste from the door step and given high priority by the ULBs; unless door to door collection of segregated waste is practiced by the ULBs, source segregation by waste generators will remain a meaningless exercise.

The study is particularly interested in the socio-demographic, cultural and environmental features in high-rise residential buildings household waste treatment. The study identified key areas in waste management systems in high-rise residential buildings which is the avenue for future studies for integrating waste management strategies in high density residential development in Mumbai. Further a survey of resident’s high-rise residential buildings in Mumbai suggest how aware they are about composting process. Based on the findings, the study recommends that shredding happen to degrade the quality of compost and all plastics material gets broken into small pieces and is difficult to separate from the readymade compost, thus degrades the quality of compost. It suggests alternative ways to dispose waste so that quality of compost would be better and will lead to non-contamination of agriculture soil.

II. RESEARCH METHODOLOGY

The assessment had two components: Study of garbage disposal methods by housing society members and composting machines that include shredding. A questionnaire about individual’s evaluations of their garbage disposal methods and analysis of demographic data was carried out through a survey that was administered online.

A. Survey

Releasing the findings of the survey, BCIL Chief Executive Officer Chandrashekar Hariharan said the kitchen waste of a family of four would provide rich nutrient fertilizer that can serve a full acre of plants and trees every two months.

This motivation is enough for us to conduct this survey to assess the awareness levels of residents of building societies in Mumbai. But the compost generated should be free from plastics waste that unintentionally accompanies the wet waste.

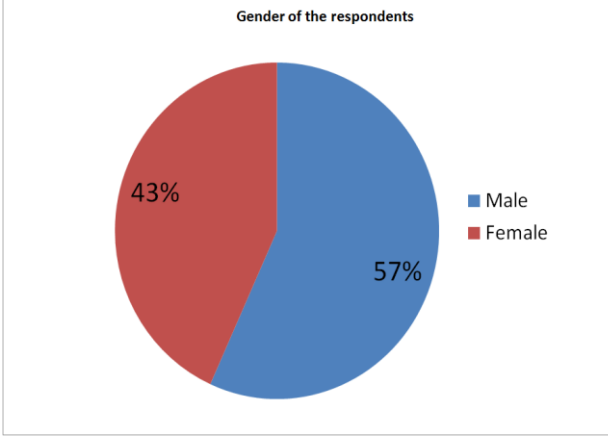
How many of us are willing to keep the waste generated in our homes and treat it? With nearly 70 per cent of the 3,500 tons of waste generated in the city daily being wet waste, local composting and segregation would cut costs in transportation of waste. But most people are not interested in using the generated waste at home as in Mumbai each household lacks spaces for kitchen gardens as small galleries are also a luxury in this city.

According to the survey, 50 percent residents felt "the faster the waste left home, the better." "While 69 per cent do not use the generated waste at home, If your society were to create organic waste composting bins, will you support? 97 per cent of the respondents think they would support such an initiative.

Besides this, home composting would also reduce the burden and cut transportation costs by 70 per cent for the local civic body. While 50 per cent of the respondents are willing to keep the waste at home for a day or treat it, three out of four citizens are willing to pay a fee to get their waste disposed. [4]

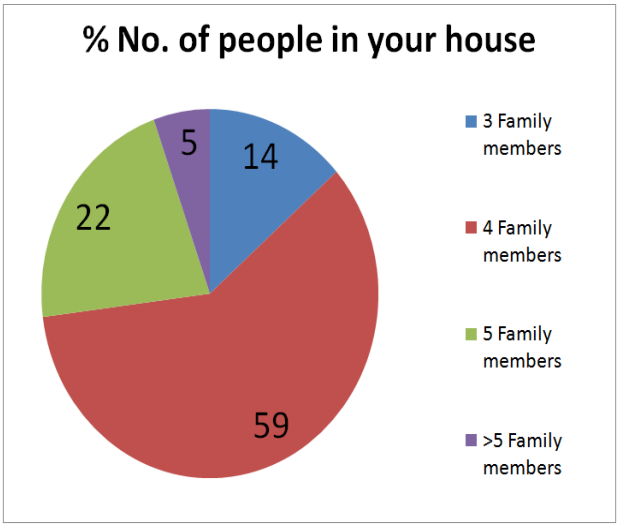
Most of the people have no clue as to where the waste generated in their homes was being dumped, only 25 per cent of the respondents said they segregated waste before disposing it. 59% throw all waste together without segregation.

B. Findings of the survey



There were 98 respondents from which 43% females and 57% male had responded to the questionnaire which was an online survey posted to them on Facebook or WhatsApp or SMS. Almost representative of the population as far as gender is concerned.

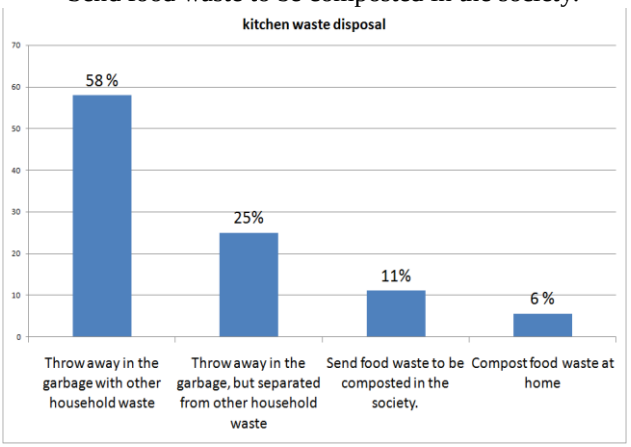
Q2. No. of people in your house



59 percent respondent have four-member families. Most of the respondents are having four members in their family.

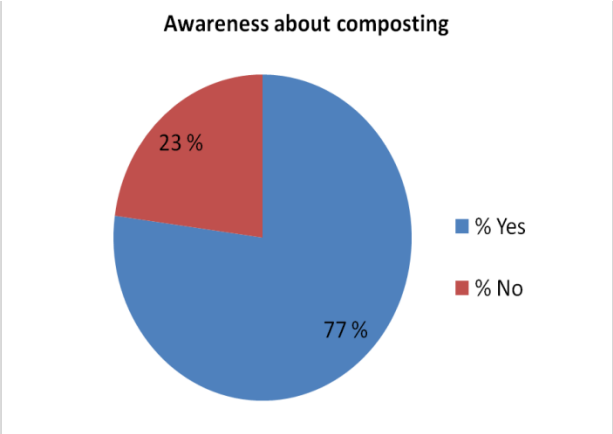
Q3. How do you dispose of organic waste e.g. fruit and vegetables scraps, peelings, teabags, tissues, paper hand towel, spoiled food, egg shells?

- Throw away in the garbage with another household waste
- Throw away in the garbage, but separated from another household waste
- Compost food waste at home
- Send food waste to be composted in the society.



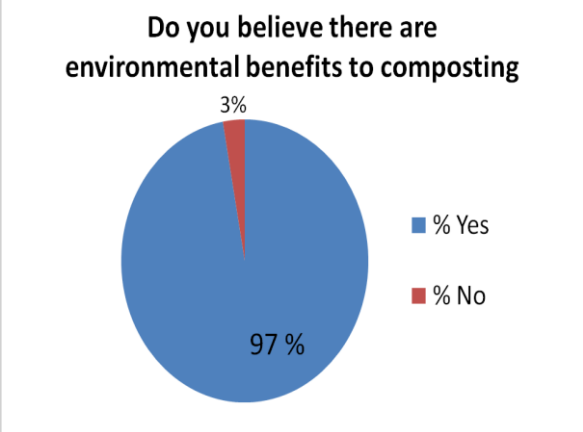
Most of the respondents happen to have less awareness about segregation of waste and survey shows that there are no composting methods employed in their societies. Only 11 percent respondents have composting facility in their societies.

Q4. Do you know about composting?



77 percent respondents are aware about the process of composting, but it seems lack of initiative from the society no composting process is in place. Moreover, they are not motivated enough to compost it at home themselves though they are aware about the process.

Q5. Do you believe there are environmental benefits to composting?



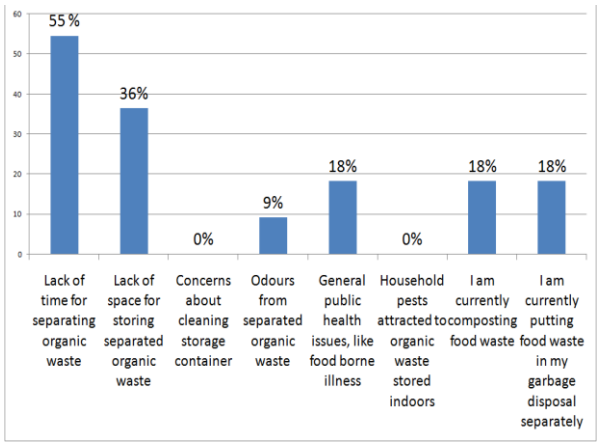
97 percent are aware about the environmental impact of solid waste management.

Q6. If the Society implemented a program for collecting organic waste separately for beneficial use, would you participate in the program?

100% respondents agree to participate actively in segregation of waste if their housing society has a plan in place for composting. That is they will be willing to segregate waste and contribute to this cause.

Q7. Please indicate your concerns for composting?

- Lack of time for separating organic waste
- Lack of space for storing separated organic waste
- Concerns about cleaning storage container
- Odors from separated organic waste
- General public health issues, like food borne illness
- Household pests attracted to organic waste stored indoors
- I am currently composting food waste
- I am currently putting food waste in my garbage disposal separately
- I do not see any benefits of separating organic waste

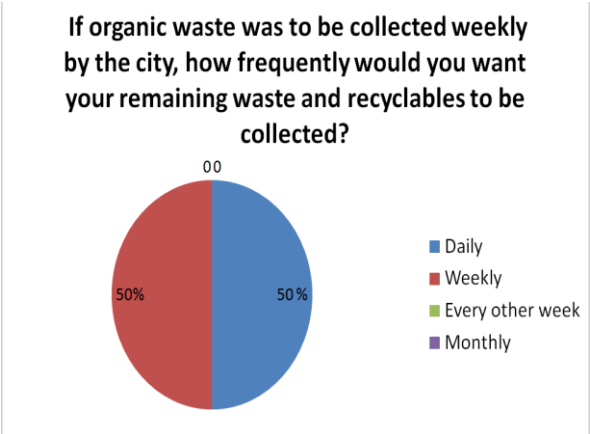


People think that it is not worth their time to separate organic waste which calls for awareness drives and campaigns to motivate the residents to segregate waste as well as incentivize the process. . Lack of space is a concern with 36 percent respondents. They are also concerns about health problems that may arise if they do composting at home.

Q7. If organic waste was to be collected weekly by the city, how frequently would you want your remaining waste and recyclables to be collected?

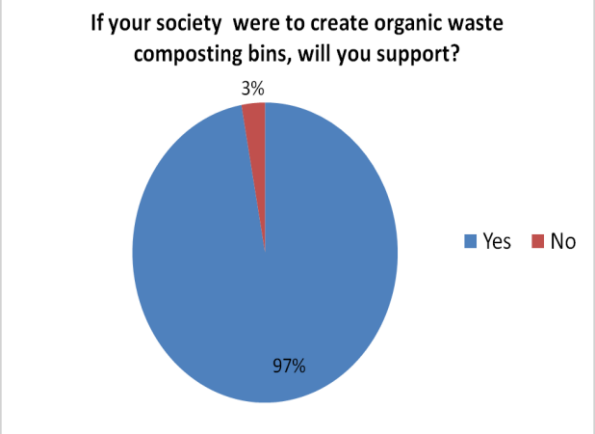
- Weekly
- Every other week
- Monthly
- Daily

According to the survey, 50 percent residents felt "the faster the waste left home, the better. "Other recyclable waste like paper, plastic can be stored and collected occasionally which would reduce transportation cycles that need to be made by collecting vehicles.



Q8.If your society were to create organic waste composting bins, will you support?

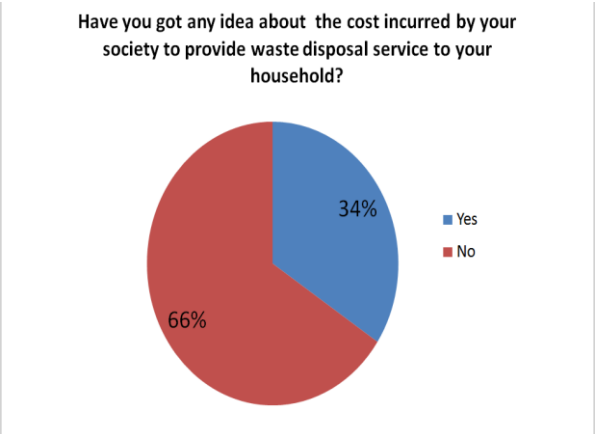
- Yes
- No



If society has a compost bins respondent are willing to support it. This may also mean they are fine with not using automatic machine for faster compost generation. If compost it degraded by natural process it will not need machines for shredding and compost quality would be high as plastic waste can be easily removed during the sieving process of the ready compost.

Q9. Have you got any idea about the cost incurred by your society to provide waste disposal service to your household?

- Yes
- No



66 percent respondents have no idea about the cost of the waste disposal service in place in their society and thus also may not have a clue of cost of composting machines and thus their working also. Society members involvement in this process is key sources to motivate them to dispose waste responsibly.

C. Study of Composting machines

There are dozens of compost turner machines which goes from small scale to large scale but most of the compost making machines are having shredders. we can broadly classify the compost making machine in 7 categories which are as follows:

- *Full Hydraulic Crawler Compost Turner*

It works on the principle of aerobic fermentation design, It effectively mixes and stirs organic raw materials and bacteria, like sludge garbage, straw, livestock and poultry manure. Under aerobic conditions of organic matter decomposition, the bacteria can fully play the role in organic fertilizer composting.

- *Semi Hydraulic Crawler Compost Turner*

It installs hydraulic push plate without turning composting manually. It is roller hydraulic lift and the cab is equipped with air conditioning. Owing to crawler design, it can work on rough ground.

- *Semi Hydraulic Wheel Compost Turner*

This machine is similar to hydraulic auxiliary crawler machine. The only difference is that it adopts wheel design.

This organic fertilizer composting making machine can be used for most of organic fertilizer fermentation before **organic fertilizer granulation process**.

- *Forklift Compost Turner*

Forklift Compost Turner Machine can raise the compost pile reaching a height of 2-3m, there being good air circulation in the turning process which greatly improves the composting efficiency.

Multi-functional forklift compost turner is specially designed and manufactured to satisfy the requirements of most bio organic fertilizer production lines. It has crushing function, mixing and turning functions, being an environmental-friendly "rising star" in Organic Waste Management Industry, so it saves energy.

- *Tow Behind Compost Turner*

These kinds of compost turners are designed to tow behind a tractor. They are widely used in farms to manage larger crop residues (e.g. corn stalks), animal manure (e.g. pig dung, horse waste), yard waste, newspaper, cardboard, etc. They lift and tumble compost materials, aerate each windrow with more oxygen for faster composting.

- *Groove Type Compost Turner*

Groove Type Compost Turner Machine is cost-effective and simple to deploy and maintain. It can be used in both industrial composting and household composting. Main raw materials are poultry & livestock manure. All those features help it become one of the most popular composting equipment in North America.

- *Self-Propelled Wheel Windrow Turner*

This windrow turner turns windrow piles periodically to improve porosity and oxygen content, mix in or remove moisture, and redistribute cooler and hotter portions of the pile, being an easy-operation composting equipment for outside fermentation. Organic materials are piled in long rows (windrows). Self-propelled compost windrow turner efficiently mixes materials with microbial preparation evenly to create a better aerobic environment. [5].

by and large these machines are used for different purpose and having different categories to prepare manure, but all this machine contain shredder or churner or mixer which churn or shred the material in small particles.

III. CONCLUSION

Most of the respondents happen to have less awareness about segregation of waste and survey shows that there are no composting methods employed in their societies. Respondents are aware about the process of composting, but it seems lack of initiative from the society no composting process is in place. Moreover, they are not motivated enough to compost it at home themselves though they are aware about the process. Nearly all are aware about the environmental impact of solid waste management and are willing to participate actively in segregation of waste if their housing society has a plan in place for composting. That is they are willing to segregate waste and contribute to this cause.

People think that it is not worth their time to separate organic waste which calls for awareness drives and campaigns to motivate the residents to segregate waste as well as incentivize the process. . Lack of space is a concern with some respondents. They are also concerns about health problems that may arise if they do composting at home.

According to the survey half of the percent residents felt "the faster the waste left home, the better. "Other recyclable waste like paper, plastic can be stored and collected occasionally which would reduce transportation cycles that need to be made by collecting vehicles but is awareness is not there among them.

If society has a compost bins respondent are willing to support, it. This may also mean they are fine with not using automatic machine for faster compost generation. If compost it degraded by natural process it will not need machines for shredding and compost quality would be high as plastic waste can be easily removed during the sieving process of the ready compost. Most respondents have no idea about the cost of the waste disposal service in place in their society and thus also may not have a clue of cost of composting machines and thus their working also. Society members involvement in this process is key sources to motivate them to dispose waste responsibly.

Shredder should not be employed to cut waste into too small pieces as the plastic or other inorganic waste that has accompanied the wet waste will be easily removed while sieving process after the compost is ready.

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