



Are the Residents of Varanasi City Practicing Enough to Manage their Kitchen Waste?

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Abstract

Kitchens are the foremost areas to generate large quantity of wastes and the moisture-loaded wastes are generally dumped in open to putrefy rapidly, to emit foul odour and to invite disease vectors. The article investigates existing policy measures and current kitchen waste management (KWM) practices to portray the waste management scenario in Varanasi City. It also emphasizes to elicit lacuna from municipal authorities' part and residents' role in KWM. The work embraced quantitative and qualitative methods along with descriptive and case study research designs to sail the research work smoothly. Residents from Varanasi city have been recruited by using snowball-sampling technique. Non-participatory direct observation accompanied by self-administered schedule have been incorporated in the process of data collection. Results exhibit that the assigned municipal personal do not execute municipal solid waste management guidelines. Open dumping is the most common way for the disposal of kitchen waste. Education of the respondents is the key factors, which creates the difference in their behaviour and attitude towards waste management. Mixing different waste altogether intensifies the complexity of the issue. Therefore, awareness creation among the residents and candid implementation of the rules are pivotal to set up sustainable and healthy living conditions in the city.

Keywords: Solid Waste Management; Moisture-Loaded; Kitchen Waste; Snowball Sampling

Introduction

Municipal solid waste (MSW) generation is an inevitable part of anthropogenic activities and it is widely accepted that the composition of generated waste varies country to country based on the consumption pattern of the society. It is also loud and clear that the developing countries generate solid waste which contain huge moisture in comparison to the waste generated by the developed nations. The constituents of waste explicit that organic fraction is to be the highest in low as well as middle income countries, whereas in high-income nations the percentage of organic waste is significantly less [1]. The total amount of organic waste may reach

to new heights with the exponential growth of population and urbanisation paired with the enhancement of living standard. The increase in waste amount would create extra burden on the existing urban services and resources provided by the city authorities.

Table 1 elucidates that low and middle-income countries generate organic waste more than fifty per cent (54 to 64%), which is considerably high in comparison to the waste generated by high-income countries (28%). The estimate by 2025 imparts the figure that although the amount of organic waste has come down in low and middle-income countries yet it is larger than high-income nations.

Current Estimates						
Income Level	Organic (%)	Paper (%)	Plastic (%)	Glass (%)	Metal (%)	Other (%)
Low Income	64	5	8	3	3	17
Lower Middle Income	59	9	12	3	2	15
Upper Middle Income	54	14	11	5	3	13
High Income	28	31	11	7	6	17
2025 Estimates						
Income Level	Organic (%)	Paper (%)	Plastic (%)	Glass (%)	Metal (%)	Other (%)
Low Income	62	6	9	3	3	17
Lower Middle Income	55	10	13	4	3	15
Upper Middle Income	50	15	12	4	4	15
High Income	28	30	11	7	6	18

Table 1: Types of Waste Composition by Income Level.

Source: What a waste: A global review of Solid Waste Management-2012, pp-19.

Organic fraction of domestic waste containing remains of vegetables, fruits, plants and garden waste, food remains from restaurants, hospitals etc. (Mebrate Taffese Tanto and William L. Magette, originally taken from Petersen., *et al.* 2003; Moss., *et al.* 2002). In India, moisture laden kitchen waste composes the maximum part of the organic waste. Table 2 explains the composition of MSW in India. It declares that urban India generates compostable waste more than fifty per cent (51%), whereas recyclables are 17.48% and the contribution of inert waste is 31.21%. The average calorific

value of urban MSW is 7.3 MJ/kg (1,751 Kcal/kg) and the average moisture content is 47% (Annepu, 2012).

Fruit and vegetable peels, residues of fruits, vegetable and food grains, and leftover foods are collectively designated as food waste. According to the Food and Agricultural Organisation (FAO, UN), 'Food that was originally meant to human consumption but which fortuity gets out the human food chain is considered as food loss or waste even if it is then directed to a non-food use' [2]. FAO further

Region/City	MSW (TPD)	Compostable (%)	Recyclables (%)	Inert (%)	Moisture (%)	C.V. (MJ/kg)	C.V. (kcal/kg)
Metros	51,402	50.89	16.28	32.82	46	6.4	1,523
Other Cities	2,723	51.91	19.23	28.86	49	8.7	2,084
North India	380	50.41	21.44	28.15	46	9.8	2,341
East India	6,835	52.38	16.78	30.85	49	6.8	1,623
South India	2,343	53.41	17.02	29.57	51	7.6	1,827
West India	380	50.41	21.44	28.15	46	9.8	2,341
Overall Urban India	1,30,000	51.30	17.48	31.21	47	7.3	1,751

Table 2: Composition of MSW in India and Regional Variation (Annepu, 2012).

Sustainable Solid Waste Management in India, 2012 pp. 34.

explains that food loss and food waste refer to the decrease of food in subsequent stages of the food supply chain intended for human consumption. Food is lost or wasted throughout the supply chain, from initial production down to final household consumption [3].

During the desktop literature research, it was found that most of the related literatures were concentrated around the food waste only. Some texts were including pre and post-harvest wastage, commercial food wastage, wastage from poultry farm, household, restaurants, hotels, marriage parties and other occasions as food waste. Nevertheless, the researcher has engaged the term ‘Kitchen Waste (KW)’ instead of ‘Food Waste, which is a broader concept. It includes polythene bags, wrappers of the products, plastic bottles, and other articles along with the food waste, which are commonly generated in the kitchen. The researcher has excluded hotel and restaurant waste and the work is stuck to the kitchen waste only, generated from the kitchen in the residential area of Varanasi City.

Waste management practices in the study area give the impression of improved condition and it emerges that stuffs related to waste management are under control. However, the ground reality is astonishing and harsh. Once the waste is generated, it is discarded under the open sky, which putrefy rapidly, emit foul odour and become a heavenly shelter for the rodents, cattle and other disease vectors. Consequently, the present study is an attempt to explore current waste management systems with the special emphasis on kitchen waste management practices in the temple city Varanasi.

Study area

The ‘Varanasi Urban Agglomeration (VUA)’, an agglomeration of 20 urban constituents [4], covers an area of 112.26 km². It lies between 82° 56’ East – 83° 03’ East longitude and 25° 14’ North - 25° 23’ 30’’ North latitude in the middle Ganga valley in the state of Uttar Pradesh along the left crescent-shaped bank of the south to north flowing river Ganges at the elevation of 80.71 meters from mean sea level.

The work has been conducted in Varanasi City, which is delimited by the revenue boundary of the Varanasi municipal corporation. Administratively, Varanasi city is divided into five zones- Varunapar zone, Adampur zone, Kotwali zone, Dashashwamegh zone, Bhelupur zone, and 90 municipal wards. The wards have been further

grouped into 16 sanitary wards for the convenience of the services. The area of the city is 81.02 km² with the population of 12, 01,185.

Methodology

Before executing the fieldwork, a desktop literature review was carried out to comprehend the severity of the research problem and to figure out the possibilities to tackle it. To navigate the research work in a productive direction and to obtain genuine as well as appropriate data related to KWM, descriptive and case study research designs have been recruited. Semi-structured schedule-based interview with the competent authorities of Varanasi Municipal Corporation (VMC), who are dealing with municipal solid waste management (MSWM), have been employed to acquire information to strengthen the research work. To construct the validity of the present work, one hundred fifty respondents (thirty from different wards of each zone) have been selected using snowball sampling technique. Since, kitchen and household works are generally executed by the female members of the family; hence, only females have been interviewed to get the information. The average age of the respondents was under 40 years and most of them were homemakers. Before the main survey, a pilot study was also exercised to check the wordings and suitability of questions of the schedule and to evaluate the appropriateness of the answering options.

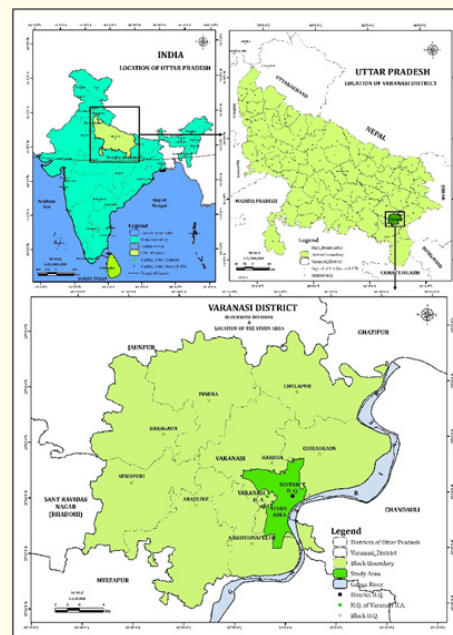


Figure a: Location Map of the Study Area.

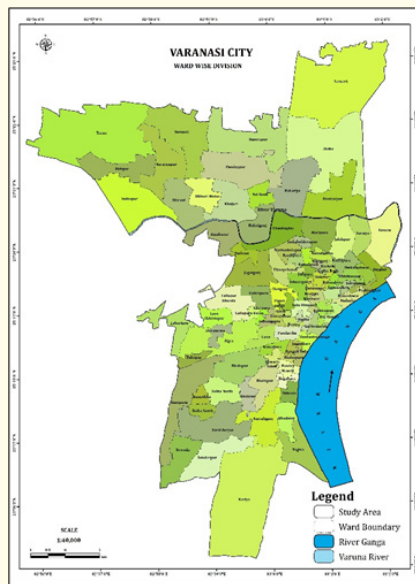


Figure b: Ward Wise Map of the Study Area.

The schedule was intended to quantify the amount of total waste and kitchen waste generated daily, to examine the composition of kitchen waste, to check the awareness level regarding source segregation and willingness to pay for door-to-door waste collection. It also aims to know the relation between education and awareness level among the respondents. ‘How much (quantity) total waste and kitchen waste do you generate daily?’, ‘What is the composition of the kitchen waste, you generate?’, ‘Are you familiar with the term Source Segregation?’ and ‘Do you use separate bins for kitchen waste?’ are the some questions listed in the schedule to figure out the reality. Demographic statistics was compiled from the respondents, such as age, religion, education, occupation, type of family- joint or nuclear, size of the family, and monthly budget of the kitchen.

Objectives

The study is aimed to explore the potential of kitchen waste utilisation and to develop the ideas to maximise the efficient management of kitchen waste in the study area and for that the objectives are:

- To study the present status of SWM and KWM practices in Varanasi city.
- To recognise the methods to reduce kitchen waste.
- To identify the concepts for kitchen waste management in the home and in the premises of residential areas.
- To search the food waste collection options and its implementation possibilities.
- To come up with the concept for the optimum use of kitchen waste.

Results and Discussion

Why is kitchen waste harmful?

Every day, most of us deliberately or unintentionally, contribute to generate kitchen waste along with the food waste. Meals left on platter, edible items passed its expiry or looked, smelt or tasted bad, went mouldy, left over from cooking are the thrust activities, which are responsible for the generation of kitchen waste [5].

Kitchen waste especially food waste is a growing area of concern with many costs to our community in terms of waste collection, disposal and greenhouse gases [6]. When the food waste is discarded into the urban locality, it gets rotted and emits nasty odour, creates a filthy atmosphere. Decaying food waste ends up in the landfills, and produces methane a powerful greenhouse gas, that is contributing significantly to damage the environment. Besides it, food waste depletes precious resources too, i.e. water, energy resources, which are used to produce food grains, and consumed to process, store, refrigerate, transport and cook foods. Polythene bags, wrappers, plastic bottles have been a headache for the human being and for the nature as well. That is why; there is an immediate need to manage the kitchen waste and to reduce the wastage of valued resources.

Present status of solid waste management in the Varanasi city

After the 74th amendment of the Indian Constitution, Schedule XII lays down the liabilities of the urban local bodies (ULBs). Article 243W narrates that the ULBs will take care of public health, sani-

tation conservancy and solid waste management [7]. Hence, the Health Department of Varanasi City holds the duty for the proper and efficient MSWM.

In 2010, VMC had apportioned A2Z, a Gurugram (Haryana) based company, for the collection, handling, and final disposal of MSW. The contract between VMC and the company was signed for the next 30 years by 2040, but owing to some disputes with the corporation, the contract was terminated in the mid-way and the company was fired out in 2013. After the incident, for two years the entire waste (650 metric tons) including kitchen waste, was dumped in mixed form at the Raman dumping ground or near the inhabited areas and used for insanitary landfilling.

After introducing 'Swachh Bharat Mission (Clean India Mission), steps have been taken in 2015 to resume the suspended SWM project to cope with the challenges of solid waste in the city. A tie up with National Thermal Power Corporation (NTPC), a Maharatna Company, has been done to restart the SWM project in 2016. At present, Karsada waste treatment plant is being governed by NTPC to produce compost from dumped waste [8].

Chemical properties of municipal waste in Varanasi City

Geographical components such as, location, climate along with cultural aspects i.e. socio-economic settings, dietary practices, and education of a specific population, are the key factors to decide the quality as well as quantity of waste being generated. The chemical properties of the municipal waste are the important characteristics in the analysis of discarding approach of the refused. It plays a crucial role to decide the destiny of the waste, whether it would be composted or incinerated.

Table 3 and figure 2 depict the chemical properties of the municipal waste in the study area.

George B. Willson describes that if the initial mixture of materials has a C/N ratio of 15 to 40, a moisture content of 40%-60%, a pH of 5 to 12 (optimum is in the range of 6.5 to 8.5) and greater than 30% free air space, it will usually be possible to operate an effective composting process [10]. Therefore, analysis of the above data shows that 63.28% moisture having pH of 6.62 is ideal for

Sr. no.	Parameters	Generalized values of all the wards*
1.	Moisture	63.28
2.	pH	6.62
3.	Carbon	26.37
4.	Nitrogen (N)	0.76
5.	Phosphorus (P ₂ O ₅)	0.58
6.	Potassium (K20)	0.93
7.	C/N Ratio	29.53

Table 3: Chemical Properties of the municipal waste in Varanasi City.

[9] Source: Varanasi Municipal Corporation, 2015 (Banerjee, Smita).

* All values except moisture have been calculated on dry weight basis.

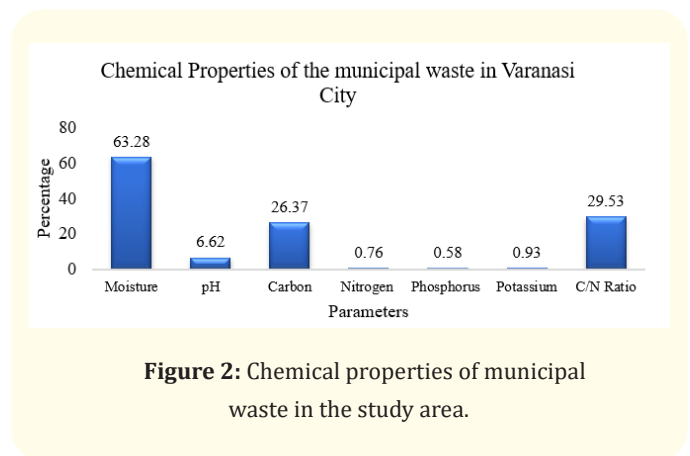


Figure 2: Chemical properties of municipal waste in the study area.

composting as it assists in the growth of microorganisms. So, the food waste and other organic items from kitchen can be composted to prepare rich manure.

Nitrogen (N), Phosphorus (P, usually expressed as P₂O₅), and Potassium (K, usually expressed as K20) values are important parameters considered for composting [11]. In compost, nutrient content may be expressed on a dry or wet weight (as received) basis. The nitrogen (0.76%), phosphorous (0.58%) and potassium (0.93%) values of the city's waste are apposite for composting.

Current scenario of Kitchen waste management in the city

Proper handling and management of waste is still a challenge for the city authorities. Since, separate data related to kitchen waste was unavailable, therefore a semi-structured schedule-based interview, with the municipal personnel and with one hundred fifty female residents from the different localities, was organised to avail relevant information. Based on their responses, it was found that 83.33% families generate approximately 2 kg. KW, 13.33% generate up to 3 kg. KW and only 3.34% families produce kitchen waste more than 4 kg. Collectively more than 80% respondents were graduate, post graduate, doctorate or having technical or professional knowledge, yet only 46.67% out of them were familiar with the term ‘source segregation’ and rest 53.33% did not have any acquaintance with it.

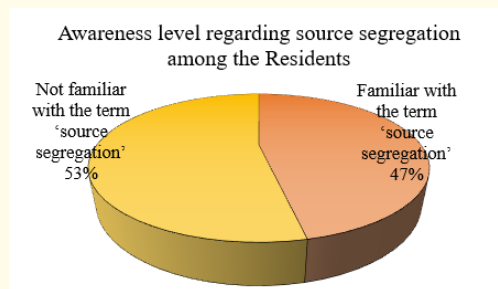


Figure 3: Level of awareness among the residents.

Surprisingly, the figure got reversed when they were asked about the use of separate bins and 53.33% answered that they were putting their kitchen waste into a different bin, whereas 46.67% families were using a single bin to collect the waste. This is because of the initiatives taken by VMC. In few wards, VMC has distributed two bins (green for wet waste and blue for dry waste) with written cautions on it that is why people are using it to put the waste separately.

Door-to-door waste collection is also being exercised in some parts that is why 53.33% families give their waste to the waste collectors, 16.67% throw in dustbins placed near to their localities, 23.34% residents throw their waste in open and only 6.66%

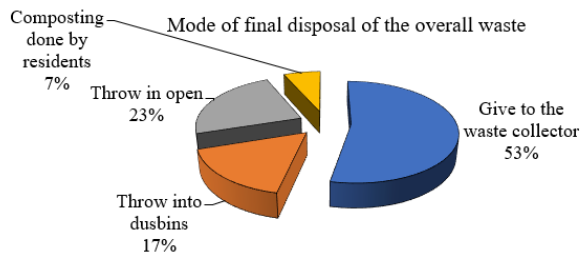


Figure 4: Different ways of disposing the daily waste.

Education Level	Percentage of respondents
Matriculation	6.0
Higher Secondary	10.67
Graduate	30.67
Post-graduate	25.33
Professional	14.67
Technical	10.0
Doctorate	2.66
Total	100

Table 4: Education level of the respondents.

Source: Field survey.

respondents are practicing to compost their waste. Absence of composting pits, in and around the housing areas, is the primary reason behind the low participation. Asking about the knowledge of ‘kitchen waste composting’ 53.33% families came with positive answer, while 46.67% respondents replied in no.

To know the composition of kitchen waste in the study area, four families from each zone (total twenty families) were selected randomly and asked for the kitchen waste twice in a week, overall eight times in a month. The total waste was collected in polybags. The collected waste was then segregated and measured. The data regarding the waste composition in the study area has been presented in the table 5 and it has been further depicted by the pie chart.

Item	Percentage
Peels of vegetables and fruits	47.7
Leftover or cooked food waste	36.3
Uncooked vegetables, fruits, and food grains	9.4
Polythene bags, wrappers, and plastic bottles	4.6
Restaurant waste	2
Total	100

Table 5: Composition of kitchen waste in the study area.

Source: Field survey.

The table exhibits that compositely vegetable and fruit peels along with leftover or cooked food waste contribute 84% of the total kitchen waste. Uncooked vegetables, fruits and food grains are also the part of the kitchen waste. These all wastes consume a large part of the valuable resources and end up in the dumping grounds, where it gets rotted and emits harmful methane gas. Polythene bags, wrappers and plastic bottles are creating an acute pressure to get handled, but unable to manage.

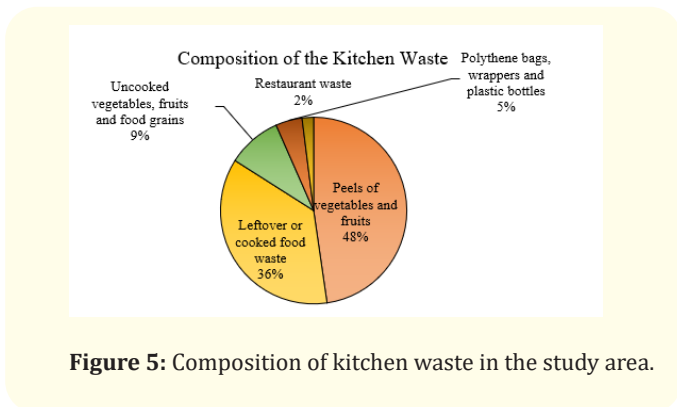


Figure 5: Composition of kitchen waste in the study area.

Creation of awareness can improve the current scenario of kitchen waste management practices in the study area. Therefore, to know the best medium to establish sentience a question was asked and the responses have been compiled in the following table.

Different variables, used in the study, have been presented in the table seven, where in column of variable description, 1, 2, 3, 4... so on numbers demonstrate nominal scale, and it has been used for coding and decoding purposes not for any statistical use.

Medium	Percentage of respondents
Newspaper	7.29
Street plays	8.67
NGOs	6.61
School & Colleges	15.68
Local TV & Radio channels	31.92
Social Media	29.83
Total	100

Table 6: Best medium to create awareness.

Source: Field Survey.

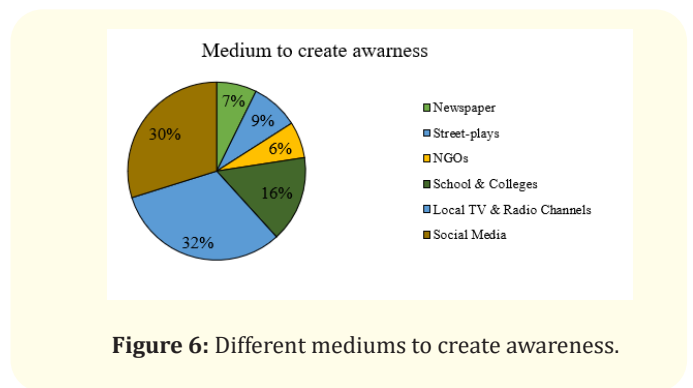


Figure 6: Different mediums to create awareness.

As it has been discussed earlier that source segregation and door-to-door collection are being practiced in the study area, but waste collected from the households are finally dumped in mixed form at the waste collection points, which is ultimately carried to the Karsana treatment plant, where the plant is still not functioning properly.

The above images, which have been taken by the author during the fieldwork, explicit the severity of the problem. Food waste, which becomes toxic once it gets putrefied, entices disease vectors, loses its value and it becomes no more part of food chain. The waste dunes, around the urbanized areas, are the open invitations to the cattle, swine, stray dogs and other animals. These all eventually lead to the wastage of various resources. Hence, proper management of kitchen waste needs immediate attention to protect further resource loss.

Variables	Variable description	Percentage of respondents
Kitchen waste	Daily kitchen waste generation [Less than 1kg = 1, 1-2kg = 2, 3-4 kg = 3, above 4 kg = 4]	1-2kg: 83.33% 3-4 kg: 13.33% above 4 kg 3.34%
Composition	Composition of the kitchen waste [Peels of vegetables and fruits = 1, Leftover or cooked food waste = 2, Uncooked vegetables, fruits, and food grains = 3, Polythene bags and wrappers = 4, Restaurant waste = 5, All the above = 6]	Detail depicted in Table 5
Familiarity with Segregation	Familiar with the term 'Source Segregation' [No = 1, Yes = 2]	No- 53.33%, Yes- 46.67%
Segregate	Segregate waste [No = 1, Yes = 2]	No- 46.67%, Yes- 53.33%
Approach	Waste segregation is required [No = 1, Yes =2, Do not know = 3]	No- 10.11%, Yes- 82.67% Do not know- 7.22%
Mode of disposal	Current method of waste disposal [Throw in open = 1, Give to the waste collector = 2, Throw into the dustbin = 3, Compost it = 4]	Waste Collector- 53.33% Throw into dustbin- 16.67% Throw in open- 23.34%, Compost- 6.66%
Collection	Door-to-door collection is done in your locality [No = 1, Yes = 2, Do not know = 3]	No- 10.11%, Yes- 82.67% Do not know- 7.22%
Awareness	Best medium to create awareness [Newspaper = 1, Street plays = 2, NGOs =3, Schools and Colleges = 4, Local TV and Radio Channels = 5, Social Media = 6]	Detail depicted in Table 6
Budget	Budget of the kitchen [Less than ₹1000 = 1, ₹ 1000-2000 = 2, ₹ 3000-4000 = 3, above ₹ 4000 = 4]	₹ 3000-4000: 67.41% Above ₹ 4000: 32.59%
Knowledge	Knowledge among respondents regarding Kitchen waste composting [No = 1, Yes = 2]	No- 41.67%, Yes- 58.33%
Education	Education level of the respondents [Illiterate = 1, Primary = 2, Middle = 3, Matriculation = 4, Higher Secondary = 5, Graduation = 6, Post-Graduation = 7, Professional = 8, Technical = 9, Doctorate = 10]	Detail depicted in Table 4
Family	Type of the Family [Nuclear = 1, Joint = 2]	Nuclear- 43.28, Joint- 56.72%

Table 7: Summary of the variables used to assess kitchen waste management practices in Varanasi city.



Figure 7: Food waste thrown on the roadside and stray dogs searching for food from the heap of garbage.

Encountered problems in the study area

Some problems, which were noticed during the study, are being discussed here:

- Dwellers do not cooperate fully to the responsible authorities.
- Municipal personnel are not aware of the waste management guidelines issued by the government.
- Unavailability of kitchen waste statistics.
- Lack of updating the data hinders the way of proper planning.
- According to the authorities, insufficient funding is also an issue.
- Inadequate number of dustbins for storage of wet and dry wastes.
- Open dumping on the roadside and around the inhabited areas are the major concerns.
- No separate collection of kitchen waste.
- There is no provision of food waste composting.
- Wastes are being dumped altogether in the mixed form.
- Lack of accountability and will power among staffs.
- Absence of strong and punishable enforcement of laws.

Suggestions to solve the problem

After the above discussion, now attention is required to explore policy measures and consolidated plans, which can mitigate food wastage, can reduce the quantity of kitchen waste and can further exploit the potential of optimum use of kitchen waste. Since, the nature of the problem is extremely complicated, henceforth a single strategy may not alleviate the issue. A bunch of action plans would be necessitated here. Some crucial approaches with institutional transformation are being narrated below, which may improve the scenario:

- The possibility of the success of any proposal or scheme is determined by the support of the beneficiaries, for whom it is being implemented. So at the very first, local authorities need to instruct and inform to the residents about the ideas of kitchen waste minimisation (KWM). Various concepts in this regard can be broadcasted on local TV and radio channels and can be published in newspapers.
- Screening of short documentary movies related to smart purchasing, shopping habits, food storage method, use of leftovers and composting food scraps may be an important tool to educate the people. Such short videos can be publicised through social networking sites and TV channels. VMC can also take assistance from non-governmental organisations (NGOs) in this regard.
- Large quantity of poly bags, packets and packaging items can be reduced, avoided or recycled, if we inculcate some habits. We can refuse extra packaging, if possible avoid pre-packed fruit and vegetables, plastic take-away containers from restaurants can be reused for storage purpose. We must take bags when go for shopping [12]. These all habits may lead to reduce a huge amount of polythene and plastic.
- Decision makers need sound analyses of economic and environmental impacts of options for managing household food waste [13]. Preparation of data concerned to the total food waste from households, commercial and industrial sectors, cost of wasted food, environmental cost due to the overuse of natural resources and greenhouse gas emissions can be helpful for policy makers to make the plans or to redesign them.
- Publications of the above-discussed data in nonprofessional's language can kindle the civic sense of the common person. It may work to check the wastage of food waste and depletion of the valuable resources.
- Composting the food and other waste can decrease the amount of organic waste that is dumped into the landfills and releases methane. Manure prepared from the composting may be used to enrich soil fertility to promote organic as well as rooftop farming. Consequently, the use of toxic chemical fertiliser can be reduced.

- VMC can appoint experts in the premises of housing societies and communities with the aim of composting. Ready-made composting bins are sold in the market. One, who wishes to prepare compost at home, can purchase the bins. The size of bins may be chosen according to available space.
- Worm farms is also an option. It is an innovative way of turning organic kitchen waste into nutrient-rich manure for the plants and soils. Worms eat organic waste and turn it into liquid fertilizer and worm castings (the organic material that has been digested by the worms). Both of these products can be used in garden and into the pot plants to keep them thriving [14]. Some practical aspect of the method may be a matter of debate, but once worm farms are installed, it may be an incredible way to minimise food waste. Readymade worm farms of different sizes are sold in the market, which can be set up in the balcony or on the rooftop.
- Keeping chickens in the backyard or in the premises of societies can assist to reduce food waste. Chickens eat the leftover food and spawn eggs and besides it chicken meat can also be obtained. However, some provisions must be taken care of i.e. permission from the local council, selection of right chicken breed, care of the chicken from disease etc. [15].
- VMC can introduce some toll-free numbers to avoid wastage of food from the parties, marriage functions and households. By making call on that number, leftover food can be collected and distributed among the needy. It may be extremely beneficial during wedding season.
- Plastic bottles, boxes, polybags, wrappers, small boxes of cardboard are the materials that can be reused and recycled. If the government launches buy-back offer and discount scheme at the time of return of used items, mentioned earlier, it can save the resources and large quantity of waste can be diminished.
- Besides it, some institutional changes, i.e. regular training of the staffs, sufficient budget allocation, updating the data in time, creating accountability and authority to enforce the rules strictly, must be embraced to execute the course of action discussed previously.

Conclusion

Nature has squandered its treasure to beautify the earth and there are ample amount of resources to meet the need, but not the greed. When we try to accumulate and consume more and more, it leads to the wastage of goods. Therefore, as a consumer, it is our onus to use the resources as much as it is required.

It is the responsibility of all the nations of the world including India to redefine their policy, because the problem of kitchen waste and municipal solid waste management is exceptionally severe and complicated and no single idea can be panacea. Hence, an integrated approach of kitchen waste management must be implemented to cope with the catastrophe. If a candid implementation of the above approaches is achieved by VMC, it may facilitate a society where no food would be thrown into the garbage, resources may be proved more than sufficient, and no one will sleep with hunger and everyone could say 'Love food, hate waste'.

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