Waste Management Survey of Bangalore City

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Abstract: The things that are thrown away and is unnecessary to the human beings is generally referred to as waste. These wastes can be recycled and reused. Solid waste is considered to be the third most pollution causing factor in the world. Managing of the solid wastes from the generation at the source through the recovery processes to disposal is called the solid waste management. Waste comes in different forms and they are categorized into different categories like, biomedical waste, biodegradable waste, bulky waste and municipal waste, e-waste etc..According to the survey conducted and discussed in this paper, people have a lack of segregation knowledge and are not aware about how the wastes are being managed currently. This tells about the people's cognition about waste management in Bangalore. This survey targets all the age groups for the development and the improvisations that can be done in a better manner. Based upon the Waste to Energy (WTE) techniques, which sheds light upon converting wastes to the useful resources, Bangalore can be a much cleaner city.

*Index terms:* Garbage, Municipal solid waste, Segregation, Waste management, WTE.

# Introduction

Bangalore, India's silicon city has been recognized as one of the leading global hubs of technological innovation. With the growing population of 11.5 million people, making it the most populated city in India. Working on Bangalore’s garbage has been a massive task for the BBMP with the common people and bureaucrats and private contractors.

The source segregation is one of the major concerns in the solid waste management. The awareness about this is provided by the BBMP through rallies, skits, pamphlets, and many more, since the segregation at the source is the efficient process to use the wastes as a resource[2]. Knowledge about the Recycle, Reuse and Reduce (3Rs) is essential for the people to know about on how the wastes are processed and the revenue, they might be able to obtain by the effective processing.

BBMP's contribution plays a major role in cleaning the city. Waste generation and recycling of the wastes is carried out by the Municipal Solid Waste Management Authority[1]. The authority have to be updated with an efficient methodology for the waste management. The current technique they are using is the compactors that replaced the trucks. These impacts came from the Swacch Bharat campaign, started in 2014. Gradually, this changed the people's perspective on segregation, recycling and waste knowledge. This also enhanced people to use the recycled products and this was a step towards greener city[1]. The people also had their contributions in starting up small organizations where initiatives are being taken to make the city cleaner and healthier.

Our survey was conducted to know about the people's awareness on the segregation, management and processing of the wastes that they have been doing it in their day to day life. The targeted group mainly ranges from the 21-30 years, where each individual take up initiatives in forming the small NGO's with their unique ideologies which creates a great impact on the society[10]. This paper also provides the information on the Waste to Energy programs that are presently happening in Bangalore.

# Motivation

Garbage is not a trash, it is a treasure. Managing them is not a simple task. There has always been a heated argument about how to increase recycling participation and moving everyone to recycle consistently. This led us to do a little research about the waste management, which let us know about the waste to energy technologies and the techniques that are currently implemented in India[9]. The waste to energy techniques that are being used in India are: a)Incineration b)Gasification c)Thermal depolymerization d)Pyrolysis e)Plasma gasification and f)Anaerobic digestion[3].

a) Incineration: This techniques embraces the waste management by the combustion of organic substances contained in waste materials. This is also one of the energy recovery technology that are been followed. The place in India where the technique is used, Timarpur-Okhla Waste to Energy Plant, New Delhi[4].

b) Gasification: In this process its likewise, converts the organic or fossil fuel based carbonaceous materials into CO2, CO and H. From this technique we can produce synthetic fuels, combustible gas and H. It is used in Pallavaram, Tambaram and Venkatamangalam municipalities.

c) Thermal depolymerization: This process involves hydrous pyrolysis for depolymerization, which helps in reduction complex organic materials into light crude oil. The demonstration plant were constructed in Carthage, Missouri.

d) Pyrolysis: The organic materials are decomposed using thermochemical decomposition method which is inflated at a high temperature int the absence of oxygen. It is used in most of the states like Andhra Pradesh, Assam, Bihar, Chattisgarh, Delhi, Haryana, Madhya Pradesh, Maharashtra, Rajasthan Tamil Nadu and Uttar Pradesh.

e) Plasma gasification: The technique coverts the organ matter into synthetic gas, slag, electricity using plasma. This technique is used in Pune and Maharashtra.

f) Anaerobic digestion: It is a breakdown of microorganisms into biodegradable material in the absence of oxygen. This type of process is used for industrial and domestic purposes, such that waste is managed efficiently to produce fuels. It's used in Nashik Municipality in India.

Each technique has its own advantages and drawbacks. Overview of these techniques and technologies speaks about the segregation levels that are being carried on in most of the cities. To know the people's contributions to the segregation, recycling methods and to analyze the impact of the WTE on people by conducted this survey[Appendix-A].

# Field Study

Bangalore is one of the those cities that is growing fast in terms of technology environment, cleaning and infrastructure. Waste management plays one of the important roles. People's contribution towards the environment is very vital as they produce approximately 0.5 kg of garbage per day. The garbage is directly proportional to the population. Increase in the urbanization increases the waste and management of the wastes[5]. In the waste management the two main roles that has to be considered, a) waste segregation and b)conversion of waste to energy.

a) Waste segregation is means of classification if the waste into mainly dry and wet waste. dry waste include wood, metals, glasses, plastics etc. Whereas, wet waste include organic waste normally generated in kitchens, hotels, restaurants that compose at faster rate. Based on the waste segregation it can be grouped into bio-degradable and non-bio-degradable wastes.

b) Conversion of waste to energy creates a vital role on the environment therefore the conversion from waste to energy has to be done in an efficient manner. Wet waste are used in biomethanation plants to convert into electricity, manure. Dry waste such as plastic, metals are used for recycling and plastic is used in asphalting(plastic road). The other waste can also be segregated and recycled and used in different fields.

Bangalore has been generating 4000 tones of Municipal wastes each day[2].To know about how these wastes are being processed and the kinds of techniques are being used, a field survey was conducted and the information obtained from these plants are being enlisted in this paper.

NIMHANS- National Institute of Mental Health and Neuro Sciences, Koramangala, Bangalorehas acquired a machine to convert organic waste generated on the premises into compost. All the biodegradable waste, including dry leaves, paper and food waste generated on the hospital’s premises, kitchen and hostels, would be turned into compost. The remaining biomedical waste, apart from glass and metal pieces and plastic, is being disposed as per the norms. The need for an organic waste converter required such that large quantity of biodeg- radable waste is processed effectively. It is probably the first hospital in the city to go completely zero waste. Over 300kgs of green waste is collected in NIMHANS on a daily basis. Organic waste converter will convert the waste into powder within 10 minutes. Water is then percolated through this powder to turn it into compost. The compost can be used to nurture the trees and plants in their campus, increasing the soil fertility. If there is a surplus, it will be sold to small scale farmers. The converter has the capacity to process 1kg of these green wastes and convert them into manure within 10-12 days[6].

Saahas Zero Waste Management, Koramanagala, Bangalore- whether it's near a mall or a casual hangout, one cannot miss the large garbage heaps scattered around. But it looks like there's a seeming appealing solution for the problem. Bio methanation plant has been set up in K. R. Market, Yelahanka, Koramangala, Kuvempunagar, Jayanagar. The plant segregates waste and sends it to separate chamber for processing and mixing. The bio-degradable waste is converted into organic manure and electricity. Making use of aerobic and anaerobic digestion, methane gas is also produced. The gas can be used for cooking and as fuel in vehicles. This implementation is more Eco friendly, it produces less carbon dioxide for each unit released. In Koramangala, the methane gas produced is converted into electricity that can lighten up around 25-40 street lights[7].

KCDC- The Karnataka Compost Development Co-operation, Kudlu, Bangalore is involved in Eco-friendly treatment of city's garbage and agriculture wastes through production of compost based organic manure and vermi-compost. This plant is presently receiving 200 tonnes of garbage which is aimed at receiving 700 tonnes each day. The unit has received about 1.15 lakhs tonnes garbage in 2014 of which 50,000 tonnes where processed and composed using organic waste converter and other waste management techniques,the remaining 65,000 of garbage remained as a landfill[12]. The dumped garbage is further been covered with 1 inch of soil. The mixed garbage latter begins to release,reset and likely to effect groundwater table. This is mainly due to segregation at source is not fully effective otherwise the plant are successfully generating organic manures, it is packed and sold to the needy farmers[5].

IV Survey Results and Discussions

In India, the technology has made a greater impact to the people, which in either way have increased the economy and in other have demolished thoughts of the people. The rapid growth in technology from the year 2000 has provided numerous changes in all the fields like e-commerce, online shopping, maps, etc. These technologies have grown up mainly to serve for the needs of various human cognitive thinking's and to satisfy their requirements. The success ratio of these technologies is directly proportional to the awareness about how much it has created the awareness in the market. This success ratio is dependent on the use of technology by the number of people.

The purpose of this survey is to know about the people's mentality which gives us why the various technologies that are being carried out by various organizations, either government or private organizations, their technologies of waste to energy are failing in the present society, in India. The waste segregation at each level and its efficient collection makes an important role in waste recycle and conversion to other useful products and to different forms of energy helping the society to a bright future ahead. A survey conducted earlier shows the waste generated in the country based on their income the people living[8].

Table1: Waste generated data in countries depending on their income

|  |  |  |
| --- | --- | --- |
| **Country's Income** | **Per Capita Municipal waste(kg/day)** | |
| **Before [2000]** | **Predicted [2025]** |
| Low | 0.45 – 0.90 | 0.60 – 1.00 |
| Middle | 0.52 – 1.10 | 0.80 – 1.50 |
| High | 1.10 – 5.07 | 1.10 – 4.50 |

Table2: Different age groups participated in our survey

|  |  |
| --- | --- |
| **Age Groups** | **% of people participated** |
| 11-20 | 8.50 |
| 21-30 | 74.00 |
| 31-40 | 11.00 |
| 41 and above | 6.50 |

The survey conducted aims at the people of Bangalore including all the illiterate and educated, old and the young people in the society. The age kept as a main comparison factor among the outcomes of our survey. The considered age group are shown in Table2.

With the data analyzed based on the survey, 90.5% of participants have knowledge about waste segregation and 74% of people are segregating at source level, that is happening presently in Bangalore The remaining details are illustrated in Table3.

Table3: Knowledge about solid waste in all age groups

|  |  |
| --- | --- |
| **Questions** | **For 200 samples in percentage** |
| Percentage of people who are aware about segregation | 90.5 |
| Percentage of who are segregating | 74 |
| Percentage of people comfortable using recycled products | 68.5 |
| Percentage of people knows about the waste after they give it away | 32 |
| Percentage of people who are aware about the WTE and waste processing plants | 37.5 |

The values helps in defining the hypothesis and finding the p-value for the defined hypothesis using the Z-score With the p-value it is able prove the objective of the survey with statistical analysis. With the result set provided in the Table3, the percentage of people aware about waste segregation is found between 87.08 to 93.92% as shown below using confidence interval based of sample Size [11].

Confidence Level considered is 90%.

The percentage of people aware about segregation from 200 sample size=90.5%

SE==0.02073

The 90% Confidence Interval estimate is 1.65\*(0.02073) =0.0342 i.e., Confidence Interval=3.42%

With Confidence Interval,it[population parameter] incurred about 87.08% to 93.92% of people are aware of segregation.

Hypothesis Testing:

Test1:

H0: The Awareness about waste segregation is found less than Po<87.08% or 0.8708.

HA: The value of alternative hypothesis is, Po >= 0.8708

The significance level of the null hypothesis, α=0.1

Table4: Binomial Distribution Parameters to calculate Z-value

|  |  |
| --- | --- |
| Statements | Values |
| Number of samples, n | 200 |
| Sample who said yes | 181 |
| Sample who said no | 19 |
| Probability of samples who said yes | 0.905 |
| Probability of samples said no | 0.095 |

The probability of people who said yes, pbr(yes) = 0.905 from Table4.

The standard deviation of the sampling distribution of a statistic, SE

SE == 0.020371 and Z value= = 1.684

p-value=0.046091 [using online Calculator].

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Age  Questionnaires | 11-20  (%) | 21-30  (%) | 31-40  (%) | 41+  (%) |
| Percentage of people who are aware about segregation | 94.12 | 91.87 | 86.36 | 92.31 |
| Percentage of who are segregating | 58.82 | 68.24 | 77.27 | 76.92 |
| Percentage of people comfortable using recycled products | 58.82 | 66.22 | 81.82 | 84.62 |
| Percentage of people, knows about the waste after they give it away | 70.59 | 29.73 | 13.64 | 38.46 |
| Percentage of people who are aware about the WTE and waste processing plants | 47.05 | 35.14 | 40.90 | 46.15 |

Test2:

Ho: The Awareness about waste segregation is greater than Po=93.92%

HA: The value of alternative hypothesis is, Po <= 93.92%.i.e, Po=0.9392

SE = =0.0168

Table5: Responses with each age group

and Z-value= = -2.0357

p-value=0.020925

The p-values is less than the significance level, i.e., α = 0.1

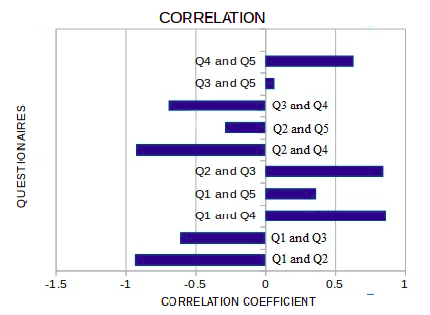
From the above two test the alternative hypothesis is stronger than the null hypothesis the awareness about waste segregation among the people of Bangalore is within the specified range. With the help of confidence interval it is estimated and concluded that the waste segregation practices is followed by about 68.9% to 79.1%. The Z-score[**1.59,-1.777**] also supports this result, with p-value(**0.0558,0.03778**) less than significance

Fig1: Correlation between the questions in the questionnaires

value(0.1).Similarly using Z-score, it states about 63.09% to 73.91% of people are comfortable using recycled product and also about 31.86% to 43.14% people are aware about the waste to energy technique and Waste processing plants in Bangalore.

The Confidence interval and Z-value(Z-score) helps us to conclude the aim of the survey, which are analyzing about the segregation and its awareness among the people of Bangalore. This survey tells the various waste to energy techniques that have reached out to the people, it also emphasizes the importance of segregation at source. The comfort level of the people for the use of recycled products are also being discussed.

In this paper, the questions in the questionnaires are correlated to know whether the outcomes have any relationship with each other. It is found that the results provide few variables with positive value which tells the results are correlated with other questions.

The questionnaire relationship value lies between -1 and +1. The values greater than zero indicate a relationship between a and b, as a increases, values for b also increase. And values less than zero indicates, as values a increases values for b decrease. The correlation value are showed in the figure 1.

From the Table5, With respect to Question 1 and Question 2, people who are aware about the segregation are not actually doing it. There's a depression to negative value. This indicates the segregation level happening. Similarly, the correlation between Question 2 and Question 3 says that people who are segregating are highly comfortable with using the recycled products. Thus, the correlation between each of the Questions have been found out and they are represented in the figure 1.

VI Conclusion

The survey lets us know about the people's contribution and their participation in the solid waste management. With the statistical figures provided, people are aware about the waste segregation but a step towards the segregation is not done from the source. It is very much required to do the segregation from the source so that the processing of the wastes are much more easier compared to the present scenario.

Bruhat Bangalore Mahanagara Palike, BBMP have been implementing various waste management techniques currently, but these are not efficiently followed by the people. Based on the analysis of survey results,our future work focuses on managing the wastes through a concept called shops, its efficient transportation from one point to another till it is being converted from waste to a useful resource or energy.

VIII Refereneces

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**APPENDIX A**

<http://goo.gl/forms/qkewJTfLJQ>