



RESEARCH ARTICLE

REDUCTION OF CARBON FOOTPRINT THROUGH SUSTAINABLE PRACTICES- A CASE STUDY AT CHRIST UNIVERSITY CAMPUS, BANGALORE, INDIA

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ABSTRACT

This paper reports on institutional Solid Waste Management (SWM) in Christ University, Bangalore. Waste audit was conducted to understand the composition and generation of waste in the Institution. The paper has detailed investigation report on understanding the waste composition, impact on environment by methane emission and also for bringing awareness among students in Christ university campus. Also for encouraging other institutions to develop such sustainable model of SWM. The effectiveness of present waste management system in the institute has been assessed with respect to methane emission.

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INTRODUCTION

Solid waste is the garbage/refuses generated from residential, industrial and commercial activities in particular which together can be called as Municipal solid waste (MSW). It may be categorized based on its origin such as domestic, industrial, commercial, construction or institutional or based on its contents such as organic material, glass, metal etc. or based on its characteristics of hazard potential such as toxic, non-toxin, radioactive, infectious etc. (Javeriya Siddiqui et al., 2013 ; Ramachandra et al., 2006).

The institutional waste management system is necessary as there is number of wastes generated in large quantities. Educational institutes generate lot of food waste along with the containers of food which are made up of plastics, papers, aluminium foils etc. There is also large amount of papers wastes generated from books, magazines and newspapers. Hazardous wastes generated from the laboratories. (Vipin et al., 2012)

Carbon footprint in the study refers to the emission of methane during management and disposal of waste generated. Methane (CH₄) gas has short life span than carbon dioxide (CO₂) in the atmosphere but trapping of radiation is higher compared to CO₂. Thus CH₄ emissions contribute to climate change by causing global warming (Chanakya et al.,

2005; Houghton et al., 1997; Susan et al., 2002; Tomonori et al., 2008). Methane emissions can be reduced by following recycling, composting, anaerobic digestion and Mechanical biological treatments.

Study Area- Christ University

Christ University founded in 1969 is a premier leading educational institution in the city of Bangalore, India. It has a population of 15,000 students and close to 1000 staff members. Christ University is located in Koramangala locality of Bengaluru city. The coordinates for latitude and longitude is 12.9347° N, 77.6053° E.



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Image Google Maps

Objective

1. To understand the waste composition generated in the Institute.
2. To understand the treatment methods through 3 R's. (Reduce, Recycle and Reuse)
3. To study the impact on environment by Methane emission or Carbon emission by the solid waste generated in the campus.
4. To assess the efficiency of present SWM system in the campus.
5. To bring awareness among the students and encourage other intuitions to replicate such sustainable models.

METHODOLOGY

Christ university used to produce around 600 kgs of waste per day before 2008 which was either incinerated unscientifically or sent to open dumps. From 2008 as the student and faculty population increased, the amount of waste generated also increased significantly. To reduce the impact of waste on environment the institute executed waste management system in the campus. Students and faculty were educated on waste management practices and their impact through posters , streetplays and other campaigns which is reinforced every year . A Waste processing unit Parivarthana means ‘change’ was established.

As a part of the study the waste audit was conducted in 19th - 23rd the month of January 2015 to evaluate efficiency of the present scientific practices followed on waste management in the campus.



Figure 1 Management of Solid waste in Christ University Campus

Layout of Survey Strategy : Field investigations was carried out to identify the number of sources and dustbins in the campus for SWM. It was observed different bins were employed in all places of generation for segregating waste based on its type i.e., dry and wet waste. The waste was collected at a time interval of 1 hour and was transferred to

Parivarthana centre for processing. The amount of waste generated was quantified using weighing experiments in weighing scale.(Using weighing balance of 100 Kgs with sensitivity of 0.5 Kg). The same procedure was followed to quantify the different types of waste i.e., food, paper and mixed waste generated. After quantification of waste good quality paper,tetrapacks and organic waste were processed through scientific treatment strategies such as recycling, reusing to makeeco-friendlyproducts, composting and biogas feeds. Rest of the waste like newspaper, plastic, papercups, bottles etc sent to recycling factories . The rejected waste which is not suitable/possible to undergo scientific treatments was also quantified and disposed in dumps.

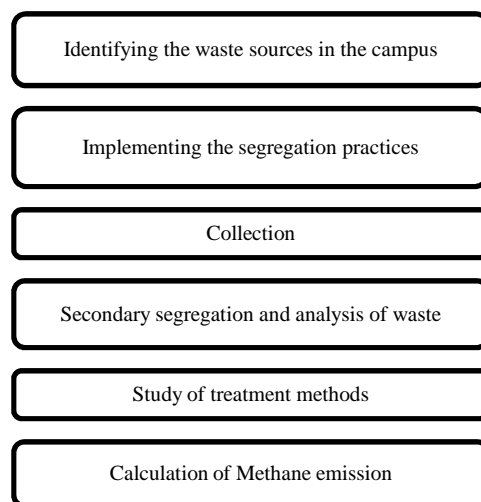
The methane emission was calculated using the formula below.

Methane Emission Calculation

$$\text{Methane Emission} = (\text{MSWFXMCFXDOC} \times \text{DOCF} \times \text{FX16/12} - \text{R}) \times (1 - \text{Ox})$$

- **MSWF** - Fraction of MSW sent to solid waste disposal sites =?
- **MCF** - Methane correction factor (fraction) = (260.172 Gg)
- **DOC** - Degradableorganiccarbon fraction = 0.18 (46.831Gg)
- **DOCF** - Degradable org. C fraction similated = (36.06Gg)
- **F** - Fraction of methane in landfill gas = 0.5 (18.03 Gg)
- **R** - recovered methane (Gg /yr) = 0.0 (18.03 Gg)
- **Ox** - methane oxidation factor = (1-0=1) (18.03 Gg)

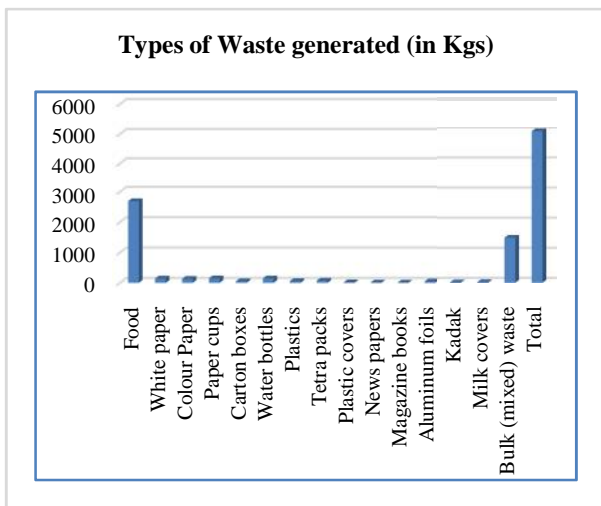
Note: Methane emission= 21 Carbon emission Flow Chart



RESULTS

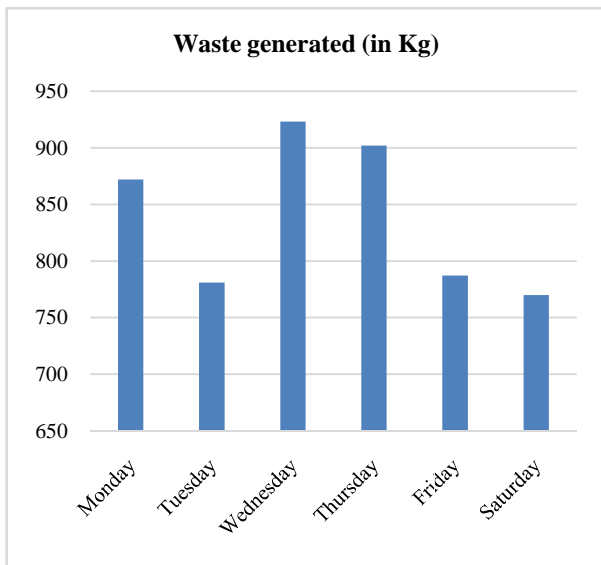
1. Total amount of waste generated in the institute during study period was found to be **5035 Kg**. The detailed amount of types of waste generated has been tabulated below and represented graphically.

Waste type	Amount (in Kg)
Food	2688
White paper	140
Colour Paper	130
Paper cups	147
Carton boxes	53
Water bottles	145
Plastics	57
Tetra packs	71
Plastic covers	17
News papers	10
Magazine books	7
Aluminium foils	43
Kadak	12
Milk covers	21
Bulk (mixed) waste	1494
Total	5035



2. The amount of waste generated in a day for week in the institute during the study period is tabulated and graphically represented below.

Day	Waste generated (in Kg)
Monday	872
Tuesday	781
Wednesday	923
Thursday	902
Friday	787
Saturday	770



3. Methane emission

Waste type	Weight (kg)	Methane Emission (Kg) /week	Average Methane Emission (Kg) /year
Food	2688	827.904	50364.16
Polyethylene terephthalate (Water Bottles)	145		
High-density polyethylene (Hard Plastics)	57		
Plastics Low-density polyethylene Plastic Covers	17	252	0
Low-density polyethylene (Milk Covers)	21		
High impact polystyrene (Kadak)	12		
Tetrapacks	71	0	0
Metal Aluminium foil	43	0	0
White paper	140		
Colour paper	130		
Paper waste Paper cups	147	487	22.4994
Carton boxes	53		
News papers	10		
Magazine books	7		
Bulk (mixed) waste	1494	184.0608	1197.032
Total	5035	1034.4642	62929.9055

Note: Inert materials like plastic; concrete; glass are not considered for methane emission.

DISCUSSION

Christ University implemented SWM in the year 2008 with a vision of reducing the impact of solid waste to the environment. Before implementing waste management system in the campus the institute was generating nearly 600 kgs of waste daily. The present trend of use and throw was the main reason for increase in waste generation. The waste generated was incinerated unscientifically or sent to open dumps. After the implementation of the system and educating the students and faculty the primary segregation of waste has been considerably improved. The waste audit provided the following information about the present waste management system. The composition of waste generated in the institute was found to be 53% -food waste, 10% - paper waste, 7% - plastics & tetra packs and 30% -bulk waste (mixed).

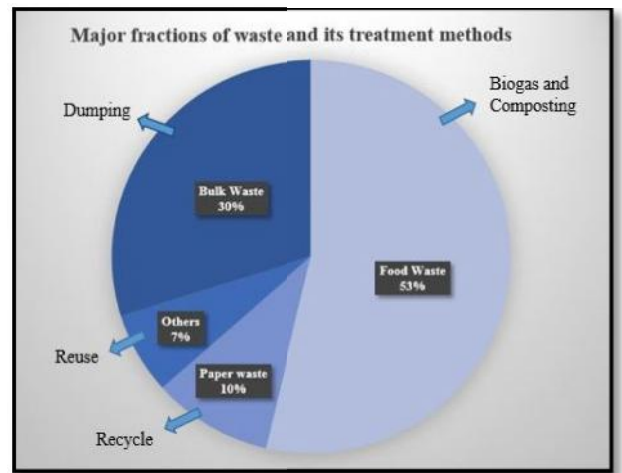


Chart 1 Major fractions of waste and its treatment methods.

Christ University as a whole could have generated **62,929.9055CH₄** kg/year (Carbon emission- **2,996.662CO₂** kg/year). The Methane emission reduced due to scientific treatment methods is **61,732.8735CH₄** kg/year (Carbon emission- **2,939.66CO₂** kg/year). Therefore the carbon footprint of Christ University is only **57.001CO₂** kg/year.

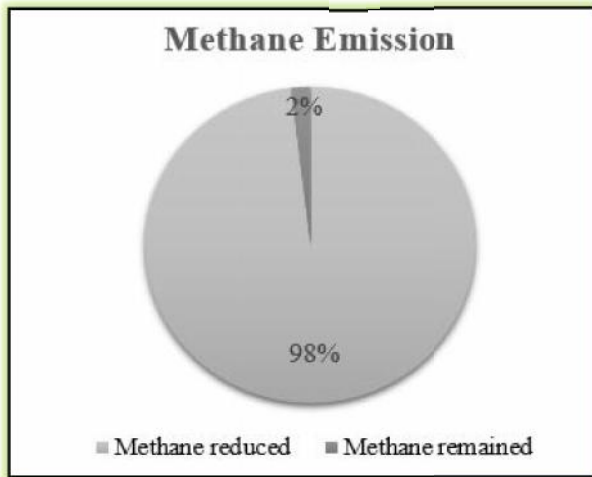


Chart 2 Percentage of methane emission

[Note: The amount of methane emitted is negligible hence it's considered to be zero. Major fractions of dumping consists of inert materials which is not accounted for methane emission.]

These initiatives in managing the generated waste is a sustainable approach for solid waste management (SWM) that serves as a model.

The following are the scientific treatments employed in the campus.

Paper Recycling Unit- Parivarthana was set up within the campus in 2009. The waste papers are recycled into handmade paper, to make different eco-friendly products. This unit also supports the livelihood of women from economically backward families.

Process: The paper waste of good quality is segregated and used for the recycling treatment. Paper and cotton waste (such as cotton clothes) along with water are introduced to beater machine to get pulp for half an hour. (Cotton is used to strengthen the paper produced). Later the pulp is further treated with required amount of water for the desired thickness of paper in Univet machine. Later the treated pulp is pressed in pressing table and is given smooth finish by subjecting it to smoothing press. The paper is colored using organic dyes and marketed.

Biogas Plant- There are 3 Biogas plants in the campus. This convert food waste, into cooking gas. Two of these plants are small units, used as live models. A large plant that has feeding capacity of 500kg generates 1000 m³ biogas equivalent to 500 KG of LPG or 25 Domestic cylinders of LPG.

Process: The food waste collected from canteens are introduced to biogas plant and allowed to undergo anaerobic digestion for biogas production. The biogas produced is used as

source of fuel for Dharmaramvidyakshetram residents for cooking purposes. The slurry from the plant is used as compost for the gardens in the campus.

Composting Unit- All the food waste and dry leaves are converted to organic compost in the composting unit. The organic compost is used for gardening as manure within the campus.

Process: The dry leaves are collected from the campus during the autumn season and stored for yearlong use. The leaves are dried and powdered. The leaves and food waste collected are introduced in alternate layers in the tank and left for microbial degradation for time period of 45 days. The compost is collected after degradation, kept for drying and packed to use for gardening in the campus and sold to open markets.

CONCLUSION

Christ University is moving towards a "zero waste" campus. The waste generation and treatment practices are scientific and environment friendly. Such initiatives reduce the carbon/methane emission to the environment that reduces pollution to the environment which contributes to the making of Bengaluru a low carbon city/sustainable city. This also provides socio-economic opportunity to marginalized women from local communities. Thus this initiative serve as a replicable model for other institutions and organizations. Creating awareness amongst the youth will inturn have a long term impact in making sustainable changes in the society.

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