

IMPACT OF KNOWLEDGE ON WASTE MANAGEMENT TOWARDS REDUCTION OF CARBON FOOT PRINT IN BANGALORE CITY.

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Abstract

Keywords:

Carbon foot print;
waste management;
Eco-friendly;
Conventional;
Greenhouse gases.

Waste management or **Waste disposal** is the activities and actions required to manage waste from its inception to its final disposal. Waste generated and improperly segregated and disposed will lead to putrefaction and poisonous gases emitted along with formation of bacteria and fungi which is harmful to all living beings. These gases produced increases emission of Greenhouse gases and effects Carbon Foot Print Management. The present study focuses on impact of waste management towards carbon foot print reduction at domestic level in two different types of dwellings, the eco-friendly and conventional apartments. The design of the study is Survey method. Purposive sampling method was used for sample selection. The total sample size comprising of 50, out of which 25 samples were chosen from residents who are living in conventional apartments and another 25 samples were chosen from the residents who were living in eco friendly apartments. The questionnaire was developed as a tool to evaluate the knowledge on waste management of the respondents residing in eco friendly and conventional apartments. Further the intervention program was carried on the selected 50 respondents using modules for a period of three months. Post test was carried after the intervention program to obtain the knowledge on waste management.

The study found that the residents had moderate knowledge (52%) during pre-test with scores of 51-75 %. During post test the knowledge levels were Adequate, increased with 62.0% with scores above 75. The results subjected to variation in the knowledge level among the respondents between pre and post test found to be statistically significant ($\chi^2 = 56.09^*$). The enhancement of knowledge found higher after post test for waste management (78.6%) Further the enhancement of knowledge scores of residents on carbon foot print reduction among the waste management aspect under study found to be significant ($p < 0.05$).

By creating awareness on importance of waste management among individuals, households, social circles and communities towards carbon foot print reduction for protecting the environment, one can create healthy living spaces for the society.

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1. Introduction

Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area. It may be categorized according to its origin (domestic, industrial, commercial, construction or institutional); according to its contents (organic material, glass, metal, plastic paper etc); or according to hazard potential (toxic, non-toxin, flammable, radioactive, infectious etc) . Management of solid waste reduces or eliminates adverse impacts on the environment and human health and supports economic development and improved quality of life. Methods of waste reduction, waste reuse and recycling are the preferred options when managing waste.

Proper waste disposal management is essential to sustain healthy living conditions in any environment. Strict adherence to appropriate waste management practices in any community will insulate the inhabitants from detrimental and hazardous environmental conditions and improve the living standard of the people. The waste hierarchy refers to the "3 Rs" reduce, reuse and recycle, which classify waste management strategies according to their desirability in terms of waste minimization.

Solid wastes ⁽¹⁾ are any non-liquid wastes that arise from human and animal activities that are discarded as useless or unwanted. These are the organic and inorganic waste materials such as product packaging, grass clippings, furniture, clothing, bottles, kitchen refuse, paper, appliances, paint cans, batteries, etc. produced in a society, which do not generally carry any value to the first user (Ramachandra 2009) ⁽⁸⁾.

With an estimated population of 9.4 million, Bangalore is among the largest five cities of India. The solid waste management practice in Bangalore is very interesting. Waste generated per person per day is about 0.5 - 1kg. It generates more than 4,500 tonnes of Urban Solid Waste a day, which the Bruhat Bangalore Mahanagara Palike (BBMP) is clear approximately about 60% ⁽⁵⁾.

Each household ⁽³⁾ generates garbage or waste day in and day out. Items that are no longer needed or do not have any further use for fall in the category of waste and we tend to throw them away. There are different types of solid waste depending on their source. In today's polluted world, learning the correct methods of handling the waste generated has become essential. Segregation is an important method of handling household solid waste. Segregation at source is one of the important aspects in effective managing of waste. One of the important methods of managing and treating wastes is composting.

I. Types of waste ⁽⁹⁾: Generally, waste could be liquid or solid waste. Both of them could be hazardous. Liquid and solid waste types can also be grouped into organic, re-usable and recyclable waste. **Liquid type:** Waste can come in non-solid form. Some solid waste can also be converted to a liquid waste form for disposal. It includes point source and non-point source discharges such as storm water and wastewater. Examples of liquid waste include wash water from homes, liquids used for cleaning in industries and waste detergents. **Solid type:** Solid waste predominantly, is any garbage, refuse or rubbish that we make in our homes and other places. These include old car tires, old newspapers, broken furniture and even food waste. They may include any waste that is non-liquid.

Hazardous type: Hazardous or harmful waste are those that potentially threaten public health or the environment. Such waste could be inflammable (can easily catch fire), reactive (can easily explode), corrosive (can easily eat through metal) or toxic (poisonous to human and animals). Examples include fire extinguishers, old propane tanks, pesticides, mercury-containing equipment (e.g, thermostats) and lamps (e.g. fluorescent bulbs) and batteries.

Organic type: Organic waste comes from plants or animals sources. Commonly, they include food waste, fruit and vegetable peels, flower trimmings and even dog poop can be classified as organic waste. They are biodegradable (this means they are easily broken down by other organisms over time and turned into manure). Many people turn their organic waste into compost and use them in their gardens.

Recyclable type: Recycling is processing used materials (waste) into new, useful products. This is done to reduce the use of raw materials that would have been used. Waste that can be potentially recycled is termed "Recyclable waste". Aluminum products (like soda, milk and tomato cans), Plastics (grocery shopping bags, plastic bottles), Glass products (like wine and beer bottles, broken glass), Paper products (used envelopes, newspapers and magazines, cardboard boxes) can be recycled and fall into this category.

II. Management of Waste: Waste management simply means the segregation, collection, transport, processing or disposal, managing and monitoring of waste materials to minimize its' consequences on humans and environment.

1) **Segregate at source:** Household waste should be separated daily into different bags for the different categories of waste such as wet and dry waste, which should be disposed of separately. One should also keep a bin for toxic wastes such as medicines, batteries, dried paint, old bulbs, and dried shoe polish. Wet waste, which consists of leftover foodstuff, vegetable peels, etc., should be put in a compost pit and the compost could be used as manure in the garden. Dry waste consisting of cans, aluminium foils, plastics, metal, glass, and paper could be recycled.

2) **Door-to-door collection:** of waste is another method of segregation, but it is not a common practice as yet in India except in the metros where some private organizations are doing such work. The rag picker plays a very important part in the segregation of waste.

3) **The role of the rag picker:** Rag pickers are the people who are actually going through the garbage bins to pick out the 'rags'. These rag pickers, women, children, and men from the lowest rung in the society, are a common sight in most cities and towns around the country. Rag picking is considered the most menial of all activities and it is people who have no other alternative that are generally driven to it. Rag pickers contribute a great deal to waste management as they scavenge the recyclable matter thereby saving the municipality of the cost and time of collecting and transporting this to the dumps.

4) **Transport of waste:** The waste collected from the households is brought to a common point from where the waste is shifted to the treatment sites through compactors & tipper lorries. The collected waste by the rag pickers or local and government authorities are taken to processing units, composting or landfills.

5) **waste processing:** The segregated and collected dry waste goes to the dry waste collection centers set up for recycling the dry materials like plastic, paper, glass, metals etc. The wet waste Some of the areas where RWA's are performing Door to Door collection, the waste is segregated at source & the organic waste is composted in the community in a small scale. The waste which are cannot be recycled around 30 to 40 percent of inert rejects which are going to the scientific landfill.

III. Carbon foot print is the accumulation of carbon dioxide and other green house gases in the atmosphere by human activities which leads to green house effect and which in turn is the cause for the climate change. A Carbon footprint is a measure of the impact our activities have on the environment, and in particular climate change. It relates to the total greenhouse gas emission produced directly and indirectly in our day to day lives through our activities like waste generation, pollution, burning fossil fuels and electricity, heating and transportation etc. We can reduce our carbon foot print by managing our waste by recycling our wastes which has enormous environmental and economic benefits in the form of reduced landfill space, fewer demands for raw materials, less energy consumption, less air and water pollution, lower waste-disposal bills, and cheaper goods.

The main greenhouse gases emitted from waste management is CH₄. It is produced and released into the atmosphere as a by-product of the anaerobic decomposition of solid waste, where-by methanogenic bacteria break down organic matter in the waste. Similarly, wastewater becomes a source of CH₄ when treated or disposed anaerobically. It can also be a source of N₂O emissions as well due to protein content in domestically generated waste water (INCCA, 2010⁽⁶⁾; Hogue, et al⁽⁴⁾., 2010; Marlies et al., 2009⁽⁷⁾).

2. Research Method

The Study was undertaken in two apartments at Bangalore city. One Conventional apartment and one Eco friendly apartment were selected for the study. Total sample size comprising of 50 respondents viz., 25 respondents from Conventional apartments and 25 from Eco friendly apartments were selected. The sampling method adopted using purposive random sampling.

Constructed a structured questionnaire and validated by the experts and information obtained from the respondents under different components

i) Socio-demographic characters considered were Age, Gender, Education, Occupation, Type of family, family members, Residence and Income.

ii) Knowledge assessment comprising of 92 statements. Response obtained as 'Yes' and 'No' and further scoring given as 'One' and 'Zero' respectively.

Evaluated the knowledge of residents using questionnaire comprising of components as 1) Environment 2) Waste Management 3) Reduce Reuse and Recycle 4) Carbon foot print management.

After obtaining pre test information from the respondents, intervention program was conducted for three months to selected samples using modules scheduled on weekly once for two hour duration. The modules were developed and covered the topics on a) Environment b) Waste Management c) Reduce

Reuse Recycle d) carbon Foot Print management. Further, Post test was administered and obtained information on knowledge from the same respondents to measure the Impact and effectiveness of the intervention program . The data was analyzed under both descriptive (number, mean and standard deviation) and inferential statistics (paired t-test).

3. Results and Analysis

The data obtained from the study samples subjected for tabulation and analysis carried out and results indicated in the following tables.

TABLE 1. Classification of Respondents by Personal Characteristics

N=50

Characteristics	Category	Respondents	
		Number	Percent
Age group (years)	21-30	9	18.0
	31-40	14	28.0
	41-50	14	28.0
	51+	13	26.0
Gender	Male	36	72.0
	Female	14	28.0
Educational level	PUC	8	16.0
	Graduate	19	38.0
	Post graduate	23	46.0
Occupational status	Government	10	20.0
	Private	31	62.0
	Self employed	4	8.0
	Agriculture	5	10.0
Total		50	100.0

From the above table 1 it is evident that the higher respondents were from the age group of 31-40 and 41-50 years (28%). Further 26% belong to the age group of 51+ and remaining 18% belong to the group of 21-30%.

Result indicate that majority of the respondents (72%) were male as compared to that of female (28%). With regard to the educational qualification of respondents the results indicate (table-I) that most of the respondents (46.0%) were postgraduates followed by 38% were graduates and remaining 16% were PUC qualified.

According to the table-1 majority (62%) of the respondents worked under private firms, followed by 20% government employees, 10% in the agricultural field and only 8% of the respondents were self-employed.

TABLE 2. Classification of Respondents by Family Characteristics

N=50

Characteristics	Category	Respondents	
		Number	Percent
Type of family	Nuclear	28	56.0
	Joint	15	30.0
	Extended	7	14.0
Number of family members	2-3	28	56.0
	4-5	14	28.0
	5-6	8	16.0
Earlier Place of Residence	Rural	19	38.0
	Semi-urban	23	46.0
	Urban	8	16.0
Family income/month	Rs.3,500-6,000	17	34.0
	Rs.6,000-12,000	14	28.0
	Rs.12,000-18,000	19	38.0
Total		50	100.0

From table 2, respondents family type ,it is evident that majority(56%) of them belonged to nuclear family followed by 30% belonged to joint family and only 14% of the respondents belonged to extended family.

Number of family members of the respondents showed that 56% family consisted of 2-3 family members, 28% family consisted of 4-5 family members and only 16% family consisted of 5-6 family members.

Most of the respondents had their earlier place of residence as semi-urban (46%), 36% of the respondents came from rural area and 16% respondents earlier settlement is urban.

With regard to the family income of respondents, majority (38%) of them belonged to the income range 12,000- 18,000 followed by 34% of the respondents belonged to the income range 3,500 -6,000 and only 28% of the respondents were in the income range 6,000- 12,000.

TABLE 3. Classification of Respondents by Characteristics

N=50

Characteristics	Category	Respondents	
		Number	Percent
Apartment type	Two BHK	28	56.0
	Three BHK	17	34.0
	Duplex	5	10.0
Mode of Purchase	Rented	8	16.0
	Leased	6	12.0
	Own	36	72.0
Total		50	100.0

From Table 3 it is evident that the respondents dwelling in the type of apartment showed that majority (56%) of them resided in two BHK apartments followed by 34% resided in 3 BHK apartments and only 10% of the respondents resided in Duplex type of apartments.

It is also evident from table -3 that the mode of purchase of apartment by the respondents, the majority (72%) of the residents were owners of the apartment followed by 16% of the respondents had taken the apartment on lease and only 12% had taken the apartment for rent.

TABLE 4. Classification of Respondent Pre test Knowledge level on Carbon foot print management

Knowledge Level	Category	Respondents	
		Number	Percent
Inadequate	≤ 50 % Score	21	42.0
Moderate	51-75 % Score	29	58.0
Adequate	> 75 % Score	0	0.0
Total		50	100.0

From table 4 it is evident that 58% of the knowledge level on carbon foot print management of the respondents was moderate gaining scores up to 51-75%, and 42% respondents knowledge was inadequate obtaining scores less than or equal to 50% , none of the respondents had adequate knowledge on carbon foot print management (0% residents achieved more than 75% scores.

TABLE 5. Aspect wise Pre test Mean Knowledge scores on Carbon foot print management

N=50

No.	Knowledge Aspects	Statements	Max. Score	Knowledge Response			
				Mean	SD	Mean(%)	SD(%)
I	Environment	12	12	5.62	1.0	46.8	8.4
II	Waste management	7	7	3.64	0.9	52.0	12.5
III	Reduce reuse & recycle	10	10	5.14	1.1	51.4	11.3
IV	Carbon foot print management	2	2	10.02	0.6	51.0	31.1
	Combined	31	31	15.41	2.6	49.7	8.4

Table 5 indicates the aspect wise pre-test mean knowledge scores on carbon Foot Print Management by the respondents.

According to the results obtained reveals that Waste management (52.0%) stands first followed by Reduce reuse recycle (51.4%), Carbon Foot Print Management (51.0%). However, the less pre test knowledge noticed on Environment (46.8%).

In a study conducted by Arora L et al ⁽²⁾; it was found that 162(54%) of the respondents could be classified as possessing low knowledge, whilst 138(46%) respondents were having medium level of knowledge regarding waste management.

TABLE 6. Classification of Respondents of Post test Knowledge level on Carbon foot print management

Knowledge Level	Category	Respondents	
		Number	Percent
Inadequate	≤ 50 % Score	0	0.0
Moderate	51-75 % Score	20	40.0
Adequate	> 75 % Score	30	60.0
Total		50	100.0

From table 6 it is evident that 40% of the knowledge on carbon foot print management of the respondents was moderate level as compared to 60% of respondents knowledge was adequate and none of the respondents had inadequate knowledge level on carbon foot print management under post test study. It was found that in the study by Kumar. M et al ⁽⁵⁾ only 14.2% were aware about solid waste generation and 5.5% had knowledge of recycling of wastes.

TABLE 7. Aspect wise Post test Mean Knowledge scores on Carbon foot print management

N=50

No.	Knowledge Aspects	Statements	Max. Score	Knowledge Response			
				Mean	SD	Mean(%)	SD(%)
I	Environment	12	12	9.18	1.0	76.5	8.7
II	Waste management	7	7	5.50	0.8	78.6	11.6
III	Reduce reuse & recycle	10	10	8.14	1.0	81.4	9.7
IV	Carbon foot print management	2	2	1.52	0.7	76.0	35.3
	Combined	31	31	24.34	2.5	78.5	8.1

Table 7 Indicates the aspect wise post test mean knowledge scores on carbon Foot Print Management by the respondents. The overall post test knowledge score noticed as 78.5 percent.

The results reveals that the highest knowledge found in the aspect of Reduce reuse recycle (81.4%) followed by Water management (78.6%) and Environment (76.5%). Further, the less knowledge response noticed on (76.0%).

The study on Municipal solid waste: Generation, composition and GHG emissions⁽¹⁰⁾ reveals relationship between family income and per capita waste quantity was found to be significant i.e., as the family income increases the consumption pattern and purchase trend increases which in turn leads generation of more solid waste quantity.

TABLE 8. Over all Pre test and Post test Mean Knowledge on Carbon foot print management

N=50

Aspects	Max. Score	Knowledge Response				Paired 't' Test
		Mean	SD	Mean (%)	SD (%)	
Pre test	31	15.41	2.6	49.7	8.4	26.45*
Post test	31	24.34	2.5	78.5	8.1	
Enhancement	31	8.93	2.4	28.8	7.7	

* Significant at 5% level,

t (0.05, 49df) = 1.96

Table 8 reveals the overall pretest and Post test Mean Knowledge on Carbon foot print management. The result indicate that the mean pre test knowledge found to be 49.7% as compared to post test knowledge of 78.5%. It is further evident from the findings that the enhancement of knowledge found to be 28.8% on Carbon Foot Print Management. The data subjected for statistical test reveals that the enhancement of knowledge found to be significant ($t = 26.45^*$).

A study by Tatlonghari⁽¹¹⁾ et al in Philippines showed that majority of the respondents knew segregation and reuse and recycling. The Study also revealed among the various media available for use within the community, local cable channel was the most widely preferred medium of solid waste management information. In the present study it was observed that neighbors, friends, newspapers of respondents were the major source of information about solid waste management.

TABLE 9. Aspect wise Mean Pre test and Post test Knowledge on Carbon foot print management

N = 50

No.	Knowledge Aspects	Knowledge Response (%)						Paired 't' Test
		Pre test		Post test		Enhancement		
		Mean	SD	Mean	SD	Mean	SD	
I	Environment	46.8	8.4	76.5	8.7	29.7	11.2	18.75*
II	Waste management	52.0	12.5	78.6	11.6	26.6	14.4	13.06*
III	Reduce reuse & recycle	51.4	11.3	81.4	9.7	30.0	13.9	15.26*
IV	Carbon foot print management	51.0	31.1	76.0	35.3	25.0	25.3	6.99*
	Combined	49.7	8.4	78.5	8.1	28.8	7.7	26.45*

* Significant at 5% level,

$t(0.05, 49df) = 1.96$

Table 9 Indicates the Aspect wise Mean Pretest and Posttest Knowledge on Carbon foot print management, the paired 't' test was applied on the aspect wise enhancement and the following results were revealed.

The enhancement of knowledge found higher in Reduce reuse & recycle (30.0%), followed by Environment aspect (29.7%) and Waste management (26.6%). Further, the enhancement of knowledge scores on Carbon foot print management found to be less (25.0%). The test establish that the difference from pre test to post test i.e., enhancement found to be significant at 5% level ($p < 0.05$) on all the aspects under study.

TABLE 10. Classification of Pre test and Post test Knowledge level on Carbon foot print management

Knowledge Level	Category	Classification of Respondents				χ^2 Value
		Pre test		Post test		
		N	%	N	%	
Inadequate	≤ 50 % Score	21	42.0	0	0.0	52.65*
Moderate	51-75 % Score	29	58.0	20	40.0	
Adequate	> 75 % Score	0	0.0	30	60.0	
Total		50	100.0	50	100.0	

* Significant at 5% level,

$\chi^2(0.05, 2df) = 5.991$

Table 10 indicates the Classification of Respondents Pre test and Post test Knowledge level on Carbon foot print management.

The findings reveal that 42.0% of the respondents in the pre test found to be inadequate knowledge on Carbon foot print management as compared to 58.0% of respondents noticed with moderate knowledge level. However, none of the respondents showed adequate knowledge level in the pretest.

Further, it is evident from the data that 40% of the respondents in the post test noticed with moderate knowledge level as compared to remaining 60% the respondents noticed with adequate knowledge level on Carbon foot print management.

The study falls in line with Adeyemo⁽³⁾ et al where the subjects had a good knowledge about what is solid waste also knew about recycling of wastes.

The results subjected to variation in the knowledge level among the respondents between pre and post test found to be statistically significant ($\chi^2 = 52.65^*$).

4. Conclusion

The study found that majority of the respondents were from the age groups 31-40 and 41-50 years, males, post graduates working in private organizations. Among the respondents male members were the highest (72.0%). Majority from nuclear family, family size with 2-3 members, semi urban background and income range between Rs.12, 000-18,000. The study also found that majority (52%) of the residents had moderate knowledge level during pre test increased to adequate (62.0%) knowledge level in post test. The pretest aspect wise knowledge on Waste management was high (52.0%) followed by Reduce reuse recycle (51.4%), Carbon Foot Print Management (51.0%). However, the less pre test knowledge noticed on Environment (46.8%). However after post test the enhancement of knowledge found higher in Reduce reuse & recycle (30.0%), followed by Environment aspect (29.7%) and Waste management (26.6%). Further, the enhancement of knowledge scores on Carbon foot print management found to be less (25.0%). The test establish that the difference from pre test to post test i.e., enhancement found to be significant at 5% level ($p < 0.05$) on all the aspects under study. It is also, it is evident from the data that 40% of the respondents in the post test noticed with moderate knowledge level as compared to remaining 60% the respondents noticed with adequate knowledge level on Carbon foot print management.

The results subjected to variation in the knowledge level among the respondents between pre and post test found to be statistically significant ($\chi^2 = 52.65^*$).

Proper waste disposal management is essential to sustain healthy living conditions in any environment. civic sense should be inculcated among citizens with regard to cleanliness and waste management. Awareness programmes on carbon foot print management is the need of the hour to sensitize issues on reduction of green house gases and waste management from source of waste to safe disposal. As an individual and a responsible person in a society every one should join hands towards reducing waste and have a cleaner and healthier environment –Every individual's motto should be **“To make New India -towards Clean India.**

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