BIO DEGRADABLE SOLID WASTE MANAGEMENT IN CHENNAI CITY

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ABSTRACT

Solid waste generation is an inevitable consequence of production and consumption activities in any economy. Generally, it is positively related to the level of income and urbanization with higher income and more urbanized economies generating higher levels of solid wastes per capita. Metropolitan cities in developing countries are usually beset with solid waste management-related problems such as flooding, uncollected garbage and inadequate or inappropriate disposal sites which pollute the environment and ground water.

Among the metropolitan cities in India, Chennai has been purposively selected for the present study. The data and information were collected from 200 households by adopting random sampling technique pertained to the year 2009-10. The foregoing analysis indicates that about 45.00 per cent of households belong to the age group of 31-50 years followed by other groups in lesser per cent, the majority of the households are employed in teaching (20.50 per cent) and the majority of households are undergraduates. The results also indicate that about 38.00 per cent of households belong to the income group of Rs. 20001-30000 and the majority of the families are nuclear (55.50 per cent).

It is observed that about half of the households dispose waste in the evening and about 55.50 per cent of the households use plastic bucket with lid. About 84.00 per cent of households sort waste before disposing and about 37.00 per cent of households use open burning for disposing waste. The impact on aesthetic of the environment, water pollution, flooding, water stagnation, human health, bad odour, drainage, vested interest, availability of trained personal and social effects are high as perceived by households.

The survey results of the present study indicate that mandating households to segregate their wastes through local ordinances are important to promote compliance. In addition, it is necessary that the community residents are made aware of the benefits of waste segregation so as to engage themselves in a waste management programme. It is important too, that the problems in implementing waste segregation and resource recovery are considered when designing community programmes.

Key Words: Factor Analysis, Solid Waste, Waste Disposal and Resource Recovery

I. INTRODUCTION

Solid waste generation is an inevitable consequence of production and consumption activities in any economy. Generally, it is positively related to the level of income and urbanization with higher income and more urbanized economies generating higher levels of solid wastes per capita. Metropolitan cities in developing countries are usually beset with solid waste management-related problems such as flooding, uncollected garbage and inadequate or inappropriate disposal sites.

Rapid growth of population and industrialization degrades urban environment and places serious stress on natural resources, which undermines equitable and sustainable development. Inefficient management, utilization and disposal of solid waste are an obvious cause for degradation of environment in India. Improper disposal of this waste leads to spread of communicable diseases, causes obnoxious conditions and spoils the biosphere as a whole. Cleanliness is a major factor that influences development of any nation, which is otherwise hampered due to improper disposal of solid waste.

Waste segregation at the household level is not widely practiced and waste recycling is minimal. Past efforts to promote waste segregation at source have failed despite the issuance of city and municipal ordinances providing for sanctions and penalties for non-compliance. Some reasons that have been cited for the non-compliance include indifference of local residents to participate in community waste management-related activities, local government collection services' non-allowance for segregated waste collection, residents' attitude that government has the sole responsibility over garbage management and lack of information and education campaigns.

With this background, the present study aims to better understanding of household waste management behaviour. More specifically, it analyzes the factors that affecting solid waste generation and effects of solid waste in Chennai.

II. METHODOLOGY

Among the metropolitan cities in India, Chennai has been purposively selected for the present study. The data and information were collected from 200 households by adopting random sampling technique through personal interview method by using a pre-tested, well-structured schedule. The data pertained to the year 2009-10.

III. STATISTICAL TECHNIQUES

The frequency distribution and percentage analysis were carried out to draw meaningful interpretations about the socio-economic characteristics, time of disposing waste, container for disposing waste, sorting of waste before disposing, and methods of disposing of wastes by households in Chennai. The effects of solid waste were analyzed by working out of the weighted mean.

In order to study the factors affecting solid waste generation, the factor analysis has been employed with principal component extraction with varimax rotation. To assess the internal consistency of scale "Coefficient of Internal Consistency (Cronbach alpha) has also been computed.

The factor analysis can be expressed as:

$$Z_{ij} = a_1 f_1 j + a_2 f_2 j + \ldots + a_m f_{mj} + e_{ij}$$

Where as,

$Z =$ Solid Waste Generation

$a =$ Factor Loadings

$f =$ Factor Score

$e =$ Residual term accounting for Errors or other Source of Variation.

To assess the internal consistency of scale "Coefficient of Internal Consistency (Cronbach alpha) has been computed. The formula is:

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{k} \sigma_{Yi}^2}{\sigma_X^2}\right)$$

Where

$\alpha =$ Cronbach alpha

$K =$ Number of components (K-items or test lets)

$\sigma_X^2 =$ Variance of the Observed Total Test Scores for the Current Sample

$\sigma_{Yi}^2 =$ Variance of Component i for the Current Sample

IV. RESULTS AND DISCUSSION

The socio-economic characteristics of households were analyzed and the results are presented in Table 1. The results show that about 45.00 per cent of households belong to the age group of 31-50 years followed by less than 40 years (30.50 per cent), 51-60 years (23.50 per cent) and more than 60 years (1.00 per cent). The majority of the households are employed in teaching (20.50 per cent) followed by Central Government (19.00 per cent), State Government (18.50 per cent) and private sector (17.50 per cent). The majority of households are undergraduates (39.00 per cent) followed by post graduates (36.00 per cent), diploma (13.00 per cent) and higher secondary (12.00 per cent) education.

The results also indicate that about 38.00 per cent of households belong to the income group of Rs. 20001-30000 followed by Rs. 30001-40000 (35.00 per cent), less than Rs.20000 (22.50 per cent) and more than Rs. 40000 (4.50 per cent). The majority of the families are nuclear (55.50 per cent) followed by joint (44.50 per cent) and about 49.50 per cent of households have the family size of less than four followed by more than six (27.00 per cent) and 4-6 (23.50 per cent).

Table 1. Socio-Economic Characteristics of Households

Variables with Category	Households (N = 200)		Variables with Category	Households (N = 200)	
	Number	Per Cent		Number	Per Cent
Age (Years)			**Monthly Income (Rs)**		
<40	61	30.50	<20000	45	22.50
31-50	90	45.00	20001-30000	76	38.00
51-60	47	23.50	30001-40000	70	35.00
>60	2	1.00	>40000	9	4.50
Occupation			**Size of Family**		
Banking	13	6.50	<4	99	49.50
Business	11	5.50	4-6	47	23.50
Central Government	38	19.00	>6	54	27.00
Insurance	25	12.50			
Private	35	17.50			
State Government	37	18.50			
Teaching	41	20.50			
Educational Qualification			**Type of Family**		
PG	72	36.00	Joint	89	44.50
UG	78	39.00	Nuclear	111	55.50
Diploma	26	13.00			
Higher Secondary	24	12.00			

The time of disposing waste by the households was analyzed and the results are presented in Table 2. From the results, it is observed that about half of the households dispose waste in the evening followed by once a week (22.50 per cent), morning (14.50 per cent) and twice a week (11.50 per cent).

Table 2. Time of Disposing Waste

Time of Disposing Waste	Frequency	Per Cent
Morning	29	14.50
Evening	103	51.50
Twice a Week	23	11.50
Once a Week	45	22.50
Total	200	100.00

The type of container used for disposing waste was analyzed and the results are presented in Table 3. The results show that about 55.50 per cent of the households use plastic bucket with lid followed by nylon basket (32.50 per cent) and plastic bucket without lid (12.00 per cent) for disposing waste.

Table 3. Container for Disposing Waste

Container for Disposing Waste	Frequency	Per Cent
Nylon Basket	65	32.50
Plastic Bucket with Lid	111	55.50
Plastic Bucket without Lid	24	12.00
Total	200	100.00

The sorting of waste before disposing was analyzed and the results are presented in Table 4.

From the table, it is clear that about 84.00 per cent of households sort waste before disposing while about 16.00 per cent do not sort waste before disposing.

Table 4. Sorting of Waste before Disposing

Sorting of Waste	Frequency	Per Cent
Yes	168	84.00
No	32	16.00
Total	200	100.00

The methods for disposing waste were analyzed and the results are presented in Table 5. The results indicate that about 37.00 per cent of households use open burning followed by dumping on undeveloped land (25.50 per cent), open dumping (18.00 per cent), dumping in a water ways (8.50 per cent), transport to remote places (6.50 per cent) and burying (4.50 per cent).

Table 5. Methods of Disposing Waste

Methods of Disposing Waste	Frequency	Per Cent
Transport to Remote Places	13	6.50
Open Burning	74	37.00
Open Dumping	36	18.00
Dumping in a Water Ways	17	8.50
Dumping on Undeveloped Land	51	25.50
Burying	9	4.50
Total	200	100.00

In order to study the factors affecting solid waste generation, the factor analysis has been employed. The principal component method of factor analysis was carried out with Eigen values greater than one through varimax rotation and the results obtained through rotated component matrix are presented in Table 6.

Three independent groups were extracted which account for a total of 64.32 per cent of variations on the seven variables. The each of three factors contributes 23.49 per cent, 22.01 per cent and 18.82 per cent respectively.

Table 6. Factor Analysis for Solid Waste Generation

Solid Waste Generation	Rotated Factor Loadings on		
	Factor I	Factor II	Factor III
Lack of Advanced Technology			**.775**
Facility for Separation at Source			**.769**
Strength of Solid Waste Management Policy and Enforcement		**– .802**	
Environmental Education and Awareness	**– .810**		
Social Status		.843	
Amount Charged for Waste Collection	**.753**		
Quantity of Solid Waste	**.613**		
Eigen Value	1.69	1.55	1.27
% of Variance	23.49	22.01	18.82
Cumulative % of Variance	23.49	45.50	64.32

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Rotation converged in 4 iterations.

Factor I: From the table, it is inferred that out of seven solid waste generation variables, three variables have their high, relatively tightly grouped factor loadings on factor I.

This factor consists of:

- Environmental Education and Awareness Accessories (-0.81)
- Amount Charged for Waste Collection (0.75)

- Quantity of Solid Waste (0.61)

Hence, this factor is named as "**MAGNITUDE**".

Factor II is formed with:

- Strength of Solid Waste Management Policy and Enforcement Suitability (– 0.80)
- Social Status (0.84)

These variables are named as "**STATUS**".

Factor III: This factor includes:

- Lack of Advanced Technology (0.78)
- Facility for Separation at Source (0.77)

These variables are named as "**TECHNOLOGY**".

The solid waste generation was measured using a five point scale and the reliability coefficient is presented in Table 7.

Table 7. Cronbach's Alpha Reliability Coefficient

Variables	No. of Items	Cronbanch Alpha
Solid Waste Generation	7	0.93

The Cronbach's alpha of the scale was 0.93 indicating that each measure demonstrated acceptable internal consistency.

Table 8. Effects of Solid Waste

Effects	Weighted Mean Score	Status
Impact on Aesthetic of the Environment	3.61	High
Water Pollution	4.17	High
Flooding	4.08	High
Water Stagnation	3.94	High
Human Health	3.73	High
Bad Odour	3.81	High
Drainage	3.97	High
Vested Interest	3.90	High
Availability of Trained Personnel	3.91	High
Social Effects	3.87	High

The effects of solid waste were analyzed by working out weighted mean and the results are presented in Table 8. The results show that impact on aesthetic of the environment, water pollution, flooding, water stagnation, human health, bad odour, drainage, vested interest, availability of trained personal and social effects are high as perceived by households.

V. CONCLUSION AND RECOMMENDATIONS

The foregoing analysis indicates that about 45.00 per cent of households belong to the age group of 31-50 years, the majority of the households are employed in teaching (20.50 per cent) and the majority of households are undergraduates. The results also indicate that about 38.00 per cent of households belong to the income group of Rs. 20001-30000 and the majority of the families are nuclear (55.50 per cent).

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The directive will require the Local Government Units (LGUs) to undertake very aggressive resource recovery and recycling programme in Chennai. The law does, however, provide for mechanisms to help local governments meet this waste diversion target, one of which is the mandatory waste segregation at source more efficiently. This provision is intended to directly support and promote waste management practices that reduce the volume of wastes brought to final disposal sites. Some of these practices include waste minimization, reusing, recycling and composting.

The provision on mandatory waste segregation at source, however, is a difficult task for the local governments (who are mandated to enforce it) as well as to the households (who are mandated to implement it). Various ordinances at the local level have been issued in the past by the local government units in Chennai requiring households and businesses to implement waste segregation. So far these ordinances have not been implemented for one reason or another.

The survey results of the present study indicate that mandating households to segregate their wastes through local ordinances are important to promote compliance. In addition, it is necessary that the community residents are made aware of the benefits of waste segregation so as to engage themselves in a waste management program. It is important too, that the problems in implementing waste segregation and resource recovery are considered when designing community programmes. A major obstacle to the proper implementation of waste segregation is the unreliable and inappropriate garbage collection services provided by the LGUs. Segregated wastes are collected and dumped in the same garbage truck alongwith all other wastes.

The new law puts the greater burden of improved solid waste management on to the local level. Thus, local government units, particularly at the corporation municipality level, need to provide the leadership in their solid waste management projects. Many civic-minded middle-income communities believe that garbage management is the joint responsibility of the government and waste generators. Many households are willing to shoulder this responsibility by paying for collection services. Local governments need to consider this valuable attitude of the communities in their design of solid waste plans and programmes for sustainability.

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