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BIO DEGRADABLE SOLID WASTE MANAGEMENT IN BANGALORE CITY

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ABSTRACT

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. The foregoing analysis indicates that about 62.50 per cent of households belong to the age group of 45-55 years and about 28.50 per cent of the households are working in MNCs and belong to the monthly income group of Rs. 20001-30000. The results show that about 54.00 per cent of households dispose waste twice a week and about 60.50 per cent of households use plastic bucket with lid for disposing waste. It is apparent that about 86.00 per cent of households sort waste before disposing an about 45.00 per cent of households dispose domestic waste through transport to remote places. The impact on aesthetic of the environment, water pollution, bad odour are very high, while, flooding, water stagnation, human health, availability of trained personal and social effects are high and they are neutral with drainage and vested interest as perceived by households. 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.

KEYWORDS
Factor Analysis, Households, Waste Disposal, Waste Management.

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 the background explained above, 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 Bangalore City with the following objectives.

OBJECTIVES
1. To examine the socio-economic characteristics of households of biodegradable solid waste management.
2. To study the level of awareness of the management of biodegradable solid waste.
3. To identify the factors affecting biodegradable solid waste generation.
4. To analyze the problems in biodegradable solid waste management and the effects of biodegradable solid waste.
5. To assess various application problems and suggest appropriate management strategies for improvement of biodegradable solid waste management systems.

LITERATURE REVIEW
The review of related literature is carried out mainly to
1. Prevent duplicating the work that has already been done
2. Know what others have learned and reported about the problem
3. Get good background knowledge about the problem and
4. Become more familiar with the types of methodologies applied to such problem

The literature review is done under the following sub-headings on the work carried out by various researchers spread over a period of more than 20 years (from 1991 to 2010).

BIODEGRADABLE SOLID WASTE MANAGEMENT
Cole and Mwanza (1991) declared that when plastic was thrown out to sea, it caused the deaths of up to two million sea birds each year and as many as 100000 marine species[1].

Swarup *et. al.*, (1992) postulated the growing use of packing materials as the major source of household waste. The use of paperboard has been growing at an annual rate of 4.50 per cent[2].

Ishwaran (1993) found that international tourism and global environmental awareness have both grown significantly during the last three decades. Between 1970 and 1990, tourism grew by nearly 300 per cent and the industry now employs about seven per cent of the workers of the world. Environment's role in sustaining the growth of tourism was better appreciated now than any time in the past[3].

FACTORS AFFECTING BIODEGRADABLE SOLID WASTE GENERATION
A study by World Bank (1993) found that solid waste management policies, regulations and enforcements of law, environmental education and awareness and charges for waste collections were the major elements in solid waste generation in low income countries[4].

Beede and Bloom (1994) found that as economic prosperity increased, the amount of solid waste produced consists mostly of luxury waste such as paper, cardboard, plastic and heavier organic materials[5].

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PROBLEMS IN BIODEGRADABLE SOLID WASTE MANAGEMENT

According to ILO (1995) found that higher service charges for waste collection, franchises, non-availability of separate dust bins and poor planning were the major problems in solid waste collection in less income countries[6].

Schubeler, (1996) found that in developing countries, informal solid waste handling was frequently done by disadvantaged social groups. This was because a fast growing low income residential community was comprised of diversity of social and ethnic groups[7].

EFFECTS OF BIODEGRADABLE SOLID WASTE

Yu (1997) found that the methane emission form the solid wastes created air pollution, environmental degradation and affected the food chain that led to health issues among the urban households of China[8].

Thappa(1998)identified the indiscriminate disposal of solid wastes created water and air pollution, reduced the aesthetic value of the environment, bad odour and it has huge impact of health of the households lived nearby dumping places in Kathmandu[9].

OPERATIONAL OPTIONS FOR BIODEGRADABLE SOLID WASTE COLLECTION

Silke and Zurbrügg (2009) found that recycling was the most environmentally consciousness and cost - effective method of waste disposal (Nas and Jaffe, 2004) Recycling not only improved waste management process but also brought economic benefit to those involved in it[10].

Abul(2010)found that the major models of disposal of solid waste were land filling or dumping and incineration. People wanted their refuse taken away and did not want it disposed of near their habitat, or at least not so they can see or smell it[11].

METHODOLOGY

Among the metropolitan cities in India, Bangalore 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. The frequency and percentage analyses were carried out to draw meaningful interpretations for to understand the socio-economic characteristics of households, waste disposal pattern and methods. The weighted means score was worked out to understand the perceptions of households about effects of solid waste.

In order to study the factors affecting solid waste generation, the factor analysis has been employed with principal component extraction with varimax rotation. The factor analysis can be expressed as:

$$Z_{ij} = a_1 f_{1j} + a_2 f_{2j} + ... + a_m f_{mj} + e_{ij}$$

Where as,

Z = Solid Waste Generation

a = Factor Loadings

f = Factor Score

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

RESULTS AND DISCUSSION

The socio-economic characteristics of households were analyzed and the results are presented in **Table 1.** The results show that about 62.50 per cent of households belong to the age group of 45-55 years followed by 36-45 years (15.00 per cent), less than 35 years (12.50 per cent) and more than 55 years (10.00 per cent). The results indicate that about 28.50 per cent of the households are working in MNC followed by State Government (22.00 per cent), private (18.00 per cent), business (17.00 per cent) and Central Government (14.50 per cent).

The majority of households are undergraduates (44.00 per cent) followed by post graduation (36.00 per cent), higher secondary (18.50 per cent) and diploma (1.50 per cent) 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 45.00 per cent of the households belong to the monthly income group of Rs. 20001-30000 followed by less than Rs. 20000(27.00 per cent), Rs. 30001-40000(15.50 per cent), and more than Rs. 40000(12.50 per cent). The majority (72.50 per cent) of the households belong to the nuclear family and the rest of 27.50 per cent belong to the joint family and 65.00 per cent of the households has the family size of less than four followed by four to six (27.50 per cent) and more than six(7.50 per cent) members.

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)**		
<35	25	12.50	<20000	54	27.00
36-45	30	15.00	20001-30000	90	45.00
45-55	125	62.50	30001-40000	31	15.50
>55	20	10.00	>40000	25	12.50
Occupation			**Size of Family**		
Business	34	17.00	<4	130	65.00
Central Government	29	14.50	4-6	55	27.50
State Government	44	22.00	>6	15	7.50
MNC	57	28.50			
Private	36	18.00			
Educational Qualification			**Type of Family**		
PG	72	36.00	Joint	55	27.50
UG	88	44.00	Nuclear	145	72.50
Diploma	3	1.50			
Higher Secondary	37	18.50			

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 54.00 per cent of households dispose waste twice a week followed by evening (30.00 per cent) and once a week (16.00 per cent).

TABLE – 2: TIME OF DISPOSING WASTE

Time of Disposing Waste	Frequency	Per Cent
Evening	60	30.00
Twice a Week	108	54.00
Once a Week	32	16.00
Total	**200**	**100.00**

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The container for disposing waste was analyzed and the results are presented in **Table 3.** The results show that about 60.50 per cent of households use plastic bucket with lid for disposing waste followed by nylon basket (32.00 per cent), plastic bucket without lid (5.50 per cent) and sack bags (2.00 per cent).

TABLE - 3: CONTAINER FOR DISPOSING WASTE

Container for Disposing Waste	Frequency	Per Cent
Nylon Basket	64	32.00
Sack Bags	4	2.00
Plastic Bucket with Lid	121	60.50
Plastic Bucket without Lid	11	5.50
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 86.00 per cent of households sort waste before disposing while about 14.00 per cent do not sort waste before disposing.

TABLE - 4: SORTING OF WASTE BEFORE DISPOSING

Sorting of Waste	Frequency	Per Cent
Yes	172	86.00
No	28	14.00
Total	**200**	**100.00**

The methods of disposing waste were analyzed and the results are presented in **Table 5.** The results indicate that about 45.00 per cent of households dispose domestic waste through transport to remote places followed by open burning(34.50 per cent), open dumping(14.50 per cent), dumping on undeveloped land(5.50 per cent) and dumping in a water ways(0.50 per cent).

TABLE - 5: METHODS OF DISPOSING WASTE

Methods of Disposing Waste	Frequency	Per Cent
Transport to Remote Places	90	45.00
Open Burning	69	34.50
Open Dumping	29	14.50
Dumping in a Water Ways	1	0.50
Dumping on Undeveloped Land	11	5.50
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.** There are three independent groups were extracted which account for a total of 68.17 per cent of variations on the seven variables. The each of three factors contributes 23.95 per cent, 23.74 per cent and 20.48 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		.63	
Facility for Separation at Source	.74		
Strength of Solid Waste Management Policy and Enforcement			.77
Environmental Education and Awareness	.85		
Social Status		.79	
Amount Charged for Waste Collection			.84
Quantity of Solid Waste	.73		
Eigen Value	1.99	1.66	1.13
% of Variance	23.95	23.74	20.48
Cumulative % of Variance	23.95	47.69	68.17

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:
- Facility for Separation at Source (0.74)
- Environmental Education and Awareness (0.85)
- Quantity of Solid Waste(0.73)

Hence, this factor is named as "**ACCURACY**".
Factor-II: is formed with:
- Lack of Advanced Technology (0.63)
- Social Status(0.79)

These variables are named as "**STATUS**".
Factor-III: This factor includes:
- Strength of Solid Waste Management Policy and Enforcement (0.77)
- Amount Charged for Waste Collection (0.84)

These three variables are named as "**MANAGEMENT**".
The solid waste generation was measured using a five point scale and the reliability coefficient is presented in **Table 7.**

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TABLE – 7: CRONBACH'S ALPHA RELIABILITY COEFFICIENT

Variables	No. of Items	Cronbanch Alpha
Solid Waste Generation	7	0.94

The Cronbach's alpha of the scale was 0.94 indicating that each measure demonstrated acceptable internal consistency.

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

TABLE – 8: EFFECTS OF SOLID WASTE

Effects	Weighted Mean Score	Status
Impact on Aesthetic of the Environment	4.68	Very High
Water Pollution	4.74	Very High
Flooding	3.98	High
Water Stagnation	3.84	High
Human Health	4.12	High
Bad Odour	4.84	Very High
Drainage	3.24	Neutral
Vested Interest	3.10	Neutral
Availability of Trained Personnel	3.78	High
Social Effects	4.02	High

CONCLUSION AND RECOMMENDATIONS

The foregoing analysis indicates that about 62.50 per cent of households belong to the age group of 45-55 years and about 28.50 per cent of the households are working in MNCs.

The majority of households are undergraduates (44.00 per cent) and about 45.00 per cent of the households belong to the monthly income group of Rs. 20001-30000. The majority (72.50 per cent) of the households belongs to the nuclear family and 65.00 per cent of the households have the family size of less than four. The results show that about 54.00 per cent of households dispose waste twice a week and about 60.50 per cent of households use plastic bucket with lid for disposing waste. It is apparent that about 86.00 per cent of households sort waste before disposing an about 45.00 per cent of households dispose domestic waste through transport to remote places.

The **i**mpact on aesthetic of the environment, water pollution, bad odour are very high, while, flooding, water stagnation, human health, availability of trained personal and social effects are high and they are neutral with drainage and vested interest as perceived by households.

The directive will require the Local Government Units (LGUs) to undertake very aggressive resource recovery and recycling programme in Bangalore. 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 Bangalore 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 for them to engage 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. 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 with 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 levels, 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 designs of solid waste plans and programmes for sustainability.

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