Determinants of Solid Waste Segregation among Households in Calicut City Corporation

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Abstract
Solid waste generation and management has become a more challenging issue throughout the world. Waste segregation at source is considered as one of the biggest challenges in the process of sustainable waste management. Any effective waste management system needs the segregation of waste at household level. This empirical study aims to examine the factors influencing the households' waste segregation intention in Calicut City Corporation, Kerala. The study used primary data of 384 sample households from Calicut City Corporation by using structured questionnaire. Logit regression analysis is employed to determine the dominant factors influencing the practice of waste segregation among households. The results of Logit model show that respondent's expenditure, household size, education, availability of storage and availability of waste collection service are the most important variables that determine waste segregation among households.
Keywords: Calicut City, Household waste, Logit model, Segregation, Solid waste.

Introduction

The demographic and economic growth of cities in the developing countries is posing serious challenges to urban local authorities. Increasing population, changing life style and urbanisation together contribute massive generation of solid waste all over the world which have become an increasing environmental and public health problem everywhere in the world, particularly in developing countries (UNEP, 2004). If the current trend continue, the world may see a five- fold increase in waste generation by the year 2025. High population, rapid economic growth and change in living standard accelerate the generation of municipal solid waste in Indian cities (Sharholy et al., 2006).

Waste generation and its management has come to be serious issue in Kerala as well. There are various reasons for growing municipal waste generation such as changing lifestyles, food habits, changing living standards, economic development, urbanization and growing tourism industry (Kosi, 2010). Kerala took effective measure to address solid waste problem by launching Clean Kerala Mission in 2002, later in 2007, Malinya Mukta Keralam campaign was launched to achieve the goal of clean Kerala (Malinya muktha Kerala, 2007). The sources and composition of solid wastes generated in Municipal localities in Kerala shows that households are the major generators of solid waste in Kerala. Households contribute 49 per cent of the total waste generated in Kerala and it is followed by hostels, marriage halls,

institutions, shops and markets, etc. Composition of solid waste in Kerala shows that 80 per cent of the total waste generated is degradable in nature (Universal eco service, 2010).

Solid waste management is an unsolved problem faced by all the districts of Kerala and Calicut City is not an exception. Households, markets, institutions, marriage/ community halls, hospitals industrial establishments, residential colonies and public places are the major generators of solid waste in Calicut City Corporation. Total quantity of solid waste generated in Calicut City Corporation is estimated as 250-350 tonnes per day (Master plan for Kozhikode Urban Area, 2035. Households (47 per cent) are the major generators of solid waste in Calicut (Master plan for Kozhikode Urban Area, 2035).

Due to the increasing waste generation over the years in Kerala, there is an urgent need to addressing this major problem by implementing effective household waste management. Waste separation at source is one of the biggest challenges for sustainable waste management programs at present. Waste separation, also known as waste classification or waste segregation, is the process by which waste is separated into different elements operated manually at the household.

In Calicut city, waste collection service is carried out by both private and public service providers. Public service provider like Kudumbasree[1] collects segregated organic waste from households. Corporation sanitary workers also collect both organic and inorganic waste in separate bins. Private service providers like 'Niravu'[2] collects only inorganic waste from the households. However, waste collection service from Kudumbasree and Corporation sanitary workers are available to limited areas. Even though the majority of households who does not have waste collection service may dispose their waste without segregation and this is the context in which the study has its relevance on waste segregation as a part of sustainable waste management. This empirical study aims to examine the factors influencing the practice of waste separation among the households in Calicut City Corporation.

Methodology

The present study is designed to identify the major socio economic, geographic and environmental factors influencing waste segregation among the sample households.This study is based on both primary and secondary sources of data. Primary data are collected from the households of Calicut City Corporation and secondary data are collected from books, journals, master plan for Kozhikode Urban Area-2035, reports of Central Pollution Control Board (CPCB), National Environmental Engineering Research Institute (NEERI), Kudumbasree and annual reports of Kozhikode Corporation. Population in this study is taken as total number of households residing in Calicut city and it is 171877 households (master plan for Kozhikode Urban Area, 2035). Total sample of 384 households were selected from 20 per cent of the total wards (15/75) on the basis of stratified random sampling. The whole wards are divided into two strata on the basis of mean distance (the mean distance is 8km) from waste management plant. Strata 1 represents the wards within the mean distance and strata 2 represents wards away from the mean distance. Strata 1 consists of 33 wards and strata 2 consists of 42 wards. The study selected 20 per cent of wards each from strata 1 and strata 2 which are 7 and 8 wards respectively. Each ward represents 24-28 households in a proportionate rate and the period of data collection is from April 2017 to July 2017.

Logit[3] model is employed to examine the dominant factors that determine the waste separation among the households. In this model, practice of waste separation among households is regressed quantitatively with several independent variables. Logit model does not make many of the key assumptions of general linear regression models that are based on ordinary least squares – particularly regarding linearity, normality,

1   Kudumbasree: Self-help group of women.
2   Niravu : Private service provider for inorganic waste collection functioning at
      Calicut city in collaboration with residence association.
3   Logit model is a stastical method for analysing a dataset in which dependent varable is binary, i.e.
      it only contains data coded as 1 or 0

homoscedasticity, and measurement level. However to ensure that the collected data can be subjected to Logit regression, the study have to check some other basic assumptions such as dependent variable to be binary, no or little multicollinearity among the independent variables, linear relationship between log odds and independent variable and it requires a large sample size. Variance Inflation Factor is employed to find multicollinearity among explanatory variables. It is found that the collected data satisfied all the basic assumptions of the model.

Results

Socio Economic Variables of Sample Households

In the present study, socio economic factors of the respondents play a significant role in waste generation, separation and waste management practices they follow. Hence the important socio-economic identification of the sample household should be considered in order to develop a wider perspective analysis.

Table 3.1 Descriptive Statistics of Socio Economic Variables

Variables	Mean	SD
Household size measured by number of adults and children	4.6	1.2
Actual age of respondent in years	51.5	8.08
Monthly household income (in Rs)	26710	26194
Monthly household expenditure (in Rs)	18235	13876
Size of homestead owned in cents	7.4	4.1

Source: Primary data

Table 3.1 shows the description of some of the explanatory variables used in the analysis including their mean and standard deviation. The household size is measured by number of adults and children feeding from the same source and average family size is 5. The average age of respondent is 51.5 years. The average household income per month is Rs.26710/- and average monthly expenditure is Rs.18235/-.

Size of homestead is expressed in cents and average size of homestead is 7.4 cents. Only 4.7 per cent possess homestead above 12 cents and 6 per cent of the respondents possess only 2 cents of land. The gender distribution of the sample respondents is skewed in favour of female as females are mostly present at home at the time of interview. In the case of education 95.6 per cent of respondents have formal education in which 57.6 per cent completed secondary education or above.

Solid Waste Segregation among Households

In Calicut City, household generates waste in the form of organic, plastic covers and papers, recyclable plastics, glasses and lights, e-waste, pampers, dresses and other wastes. The generated waste should be segregated before disposal for the effective management. The practice of waste separation into organic and inorganic among the sample households are presented in the Table 3.2

Table 3.2 Waste Separation across Households

Waste Separation	Percentage
Yes	67.4
No	32.6
Total	100.0

Source: Primary data

The Table 3.2 shows that practice of waste separation among sample households in Calicut City. It reports 67.4 per cent of the sample households followed the practice of waste segregation and 32.6 per cent of

the total sample households are not practicing the behaviour of waste segregation. The study made an attempt on examine the impact of socio-economic factors on solid waste separation by posting the case of Calicut city Corporation.

Determinants of Waste Separation: Logit Model

The study follows a Logit model to determine the factors that influencing waste separation behaviour of the households. In this regression analysis, the solid waste separation behaviour of households is regressed by several explanatory variables. The study tries to identify the statistical relationship between practice of waste separation among households (dependent variable) and monthly expenditure, household size, education level, gender, age of the respondents, practice of waste storage, quantity of waste generation, and availability of waste disposal service (independent variables).

$$L\_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + e \ldots\ldots\ldots (1)$$

Where,

L_i = Logit (Segregation or not)

X_1 = Monthly expenditure (in Rs.)

X_2 = Size of Household

X_3 = Educational level (Below primary = 0, above primary=1)

X_4 = Availability of waste disposal service (No=0, Yes=1)

X_5 = Practice of waste storage (No=0, Yes=1)

X_6 = Quantity of waste generated (In Kg)

X_7 = Gender (Male=0, Female =1)

X_8 = Age

e = Error term

The regression results of factors influencing waste separation is presented in Table 2.3. The significant relationship between dependent and independent variables are examined by the value of the number of cases correctly predicted, 'z' value and 'p' value.

Table. 2.3: Logit Regression Results (Marginal Effects)

Variables	B	Std Error	z	P -Value
Constant	-1.60	1.14	-1.41	0.15
Monthly expenditure	6.00E	2.79E	2.15	0.03**
Size of household	-0.04	0.02	-2.10	0.03**
Level of education	0.11	0.05	2.03	0.04**
Availability of waste disposal service	0.21	0.06	3.55	0.00***
Practice of waste storage.	0.28	0.06	5.08	0.00***
Quantity of waste generation	0.02	0.01	1.41	0.15
Gender	0.01	0.05	0.11	0.91
Age	0.002	0.00	0.96	0.34

Source: Estimated from the primary data

Note: *** Significant at 1 %

**Significant at 5%

Number of cases 'correctly predicted' = 308 (80.2 per cent)

Likelihood ratio test: Chi-square (7) = 152.201 [0.0000]

Discussion

The regression results show that the value of number of cases correctly predicted is a measure of goodness of fit of the estimated model. Likelihood ratio test of Chi square value is also significant. Similarly, the signs for the estimated coefficients are consistent with the theoretical or prior expectations. The variables which are statistically significant are explained below.

The results show that monthly expenditure and waste separation have a significant positive relationship. In this model monthly expenditure is taken as a proxy for monthly income. The positive coefficient of household consumption expenditure holding all other variable constant indicates that higher expenditure groups follow waste separation more than lower expenditure group. This result is supported by Ling & Shen (2017) & Oyekale (2017) stated that monthly income is one of the vital determinants of waste separation.

A notable fact is that waste separation and availability of waste disposal service are positively related. Practice of waste separation is more among those who have waste disposal service and it is less in the case of those who do not have waste disposal service. The present study reveals that the intended objective of waste disposal service by government is to reduce environmental pollution and thereby ensure environmental quality. Waste segregation increases as availability of waste disposal increases and which is significant at 5per cent level. It shows that government incentives works in a right direction. This result is go in line with Oyekale (2017) stated that waste separation is positively correlated to availability of waste disposal services.

Education level of the households have positive and significant effect on their waste segregation behaviour. This is because the educated members are supposed to have relatively higher levels of knowledge, awareness and interest in environmental quality. Availability of storage of waste at source also have positive and significant effect on waste separation. Almost all households who have waste segregation behaviour is accompanied by storage facility. Segregated waste should be stored by the households either in plastic sack or in any other container for effective waste management.

The only significant variable which has negative effect on waste separation is the size of household. The negative coefficient of household size shows that, small families' practice waste segregation at large extend than the large families. Thus, the study stated that family size is one of the vital determinants of waste separation. Total quantity of waste generated by the households, gender and age of the respondents are also have positive but insignificant effect on waste separation.

A number of studies have identified several variables influencing the household's behaviour on waste separation. For instance, the findings of Ling & Shen (2017); Oyekale (2017) were in line with the findings of the current study. These studies show income and availability of waste disposal service are the important socio- economic factors affecting waste separation behaviour of household and variation in the level of household waste separation is occurred due to different socio-economic status.

Conclusion

The study concludes that the average 67.4 per cent of households followed the practice of waste segregation in Calicut city and waste segregation behaviour of households are closely linked to their socio-economic parameters. Results of logit regression analysis indicate that household income, household size, education level, availability of storage facility and waste disposal service were statistically significant in determining the waste separation behaviour of households. Accordingly the study recommends further research with new insights concerning the role of socio-economic factors in affecting household waste separation.

References

Atthirawong, W. (2016). Factors Affecting Household Participation In Solid Waste Management Segregation And Recycling In Bangkok, Thailand. In ECMS (pp. 198-203).

Biju Govind (2010, September 25). Tackling waste management in Kozhikode with technology. The Hindu, Retrieved from https://www.thehindu.com/todays-paper/tp-national/tp-kerala/bigger-kozhikode-faces-mounting-garbage-menace/article2095387.ece

Biju Govind. (2011, June 11). Bigger Kozhikode faces mounting garbage menace. The Hindu, Retrieved from https://www.thehindu.com/todays-paper/tp-national/tp-kerala/bigger-kozhikode-faces-mounting-garbage-menace/article2095387.ece.

CPCB (2004) Central Pollution Control Board, Management of municipal solid waste, New Delhi, India

CPCB. (2000). Status of Solid Waste Generation, Collection, Treatment and Disposal in Metrocities, Series: CUPS/46/1999–2000, Government of India, New Delhi.

IELRC. (2007). Malinya Muktha Keralam Action Plan 2017, Local Self Government Department Government of Kerala, November.

Koshy, P. (2006). Waste Management in Kerala- Private Sector Participation. *Universal Eco Services.* Retrieved from.http://www.universalecoservices.com/wastemanagement in_kerala.cfm

Oyekale, A. S (2017). Determinants of households' involvement in waste separation and collection for recycling in South Africa. *Environment, Development and Sustainability*, 1-29.

Sharholy, M., Ahmad, K., Mahmood, G., & Trivedi, R. C. (2008). Municipal solid waste management in Indian cities–A review. *Waste management*, 28(2), 459-467.

Sharholy, M., Ahmad, K., Vaishya, R. C., & Gupta, R. D. (2007). Municipal solid waste characteristics and management in Allahabad, India. *Waste management*, 27(4), 490-496.

Sharholy, M.,K., Mahmood, G., & Trivedi, R.C. (2008). Municipal solid waste management in Indian cities-A review. *Waste management*. 28(2), 459-467.

Town and Country Planning Department. (2017). Master plan for Kozhikode Urban Area-2035, Govt. of Kerala

Varma, R. A. (2007). Status of municipal solid waste generation in Kerala and their characteristics. *Thiruvananthapuram*: *Centre for Earth Science Studies.*

Xu, L., Ling, M., Lu, Y., & Shen, M. (2017). Understanding household waste separation behaviour: Testing the roles of moral, past experience, and perceived policy effectiveness within the Theory of Planned behaviour. *Sustainability,* 9(4), 625.