QUESTIONNARE SURVEY OF SOLID WASTE MANAGEMENT FOR SOUTH DELHI MUNICIPAL CORPORATION AREA, INDIA

Dr. Anuj Kumar Purwar
Assistant Professor, School of Engineering and Technology,
IGNOU, New Delhi

ABSTRACT
Solid waste has been created since the start of human progress. Individual creates and throws away huge quantity of solid substances consistently because of quick increment in generation and utilization. Solid waste all alone is a danger for the sustainability of the environment, as it can have adverse environmental impacts which originate from unlawful dumping of waste, littering, poor sanitation and discharge of greenhouse gases (GHG). In South Delhi Municipal Corporation (SDMC), there has been huge increment in the creation of urban solid waste. Be that as it may, there is an enormous potential for decreasing greenhouse gas emission in the methods of disposing MSW. Distinctive waste management techniques can possibly decrease the amount of MSW disposed in landfill and further lessening GHG.
A questionnaire waste survey has been done in this study. Results of survey make a view that waste generation quantity depends on house size, numbers of occupants in house and income group but does not depend on occupation type. Either type of occupations does not influence the waste treatment. Few questions had been asked on present situation of waste management in study area and analyzed individual attitude on decentralized system of waste treatment as well willingness to pay fee in that direction, if required.

KEYWORDS: Solid Waste, South Delhi Municipal Corporation, Questionnaire Survey, SPSS

1.0 INTRODUCTION
Solid waste is unwanted & discarded solid fractions, arising due to human activities (Singhania, 2012). Humans have always generated solid waste since the evolution of civilization. Solid waste production is a constantly raising issue worldwide, at national level and for a locality. Society rejects and creates tremendous amount of solid substances frequently because of quick increment in creation and utilization. Currently, the earth has an aggregate human population of 6.055 billion and the aggregate waste produced by them is around 3.86 million metric tons per day. In 1990 the total municipal solid wastes generated by industrialized countries come to 408 million tons. Asian nations produced in excess of 3 billion tons of solid waste in 2000, which may rise up to about 9 billion tons by 2050 (Ray, 2008). According to the Indian census data 16.7 per cent of the aggregate population of the world is amassed in India, i.e. around 1,027 million individuals. These Indian populations live only in 2.4% of land territory of the earth. This world census normally throws away 580.26 metric tons of solid waste every day (Dhanlakshmi, 2011).

1.1 Problems Associated with Solid Waste
Solid waste all alone is a danger to the integrity of the environment, as it can have negative natural effects which result from illicit dumping of waste, littering, poor sanitation and generation of greenhouse gases (GHG) (Henry *et al.*, 2006). Environmental issues that are associated with solid waste incorporate groundwater contamination, wellbeing dangers, smell nuisance and environmental debasement (Moningka, 2000). The relative significance of impact depends on nearby conditions. The two main environmental problems as a result of landfills are emissions into atmosphere as landfill gas emissions (LFG) and infiltration of leachate in to ground water.

1.2 Objectives of the Study
The purpose of this thesis is to suggest mechanisms to strengthen the current waste management practices in South Delhi Municipal Corporation area. In order to address the solid wastes problems, study is focusing on

existing solid waste management practices, collection of secondary data and household solid waste survey to analyze present scenarios and public behavior towards waste management practices

2.0 METHODOLOGY

According to Pole *et al.* (2002), research can be defined as a careful search or to search again, able of withstanding close evaluation and is aimed at collecting information, which can be utilized to produce or to increase knowledge.

2.1 Secondary Data

Secondary data were obtained from books, articles and internet sources. These data were included; demographic data of study area, waste generation data, distances of wards as node to waste disposal facility centre, cost of different unit processes from generation point to disposal point and waste characterization data for different waste generation sources. Waste revenue data of different recyclable materials, benefits from selling of produced compost, energy/heat produced in incineration process and energy recovery as gas collection from landfill. Investment and operation cost have been calculated with the help of formulas given by COBI (2004). In calculation of cost of a disposal facility equal maximum capacity has taken as no restriction in diversion of waste. Tipping fee paid in landfill is not applied anywhere in calculation.

2.2 South Delhi Municipal Corporation-Study Area

Municipal Corporation of Delhi was broken into South Delhi municipal corporation (SDMC), North Delhi municipal corporation (NDMC) and East Delhi municipal corporation (EDMC) in 2012 (Figure 1). SDMC is managing the population of 5.6 million citizens with a commitment of maintaining, upgrading and advancing civic amenities efficiently with a view to generate a better tomorrow for citizens. SDMC occupies an area of 656.91 km^2 which is subdivided into Central, South, West and Najafgarh zone (Figure 2). SDMC is imparting civic services to highly posh residential, commercial, rural, urban villages, jughi jhopri (JJ), resettlement colonies, regularized and unauthorized colonies. There are 104 wards under SDMC. In SDMC area, 388 approved colonies, 86 rural villages, 81 urbanized villages, 111 unauthorized colonies, 252 unauthorized regularized colonies and 32 jj resettlement colonies are counted. Out of 1038 colonies, 221 in Central zone, 185 in South zone, 241 in West zone and 391 in Najafgarh zone in SDMC area *(MCD, 2014).* There are more than 13 lakh houses and population of 65 lakh in areas under the boundary of the South Delhi municipal corporation. Daily waste generation is 4238 metric tons, which is projected as annual increment of 120 metric tons per year (Mail online, 2014). SDMC has commissioned 22 green waste management centres in their zones to make the entire area under its jurisdiction free from green waste. SDMC areas generate 20-25 metric tons of green waste daily. Corporation has total of 19 wood chipper machines for the all four zones for recycling of the green waste. The machines produce powder on shredding, which can be used in production of manure and can be utilized in parks. Presently, SDMC is paying Rs 1727/ ton for transportation work.

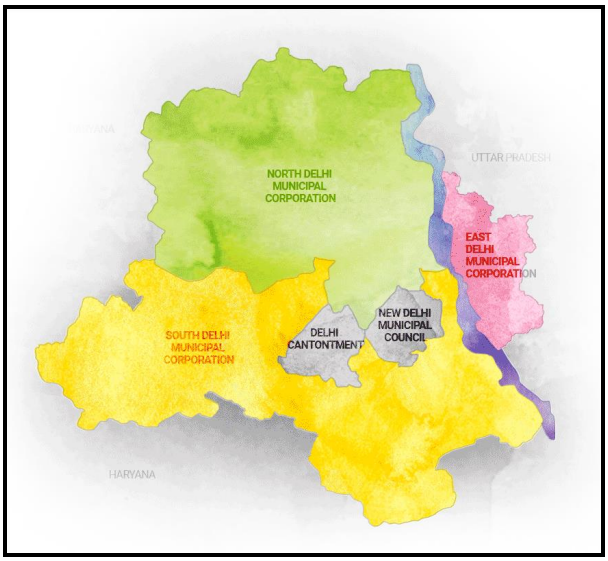

Figure 1: Showing area under SDMC (News18, 2017)

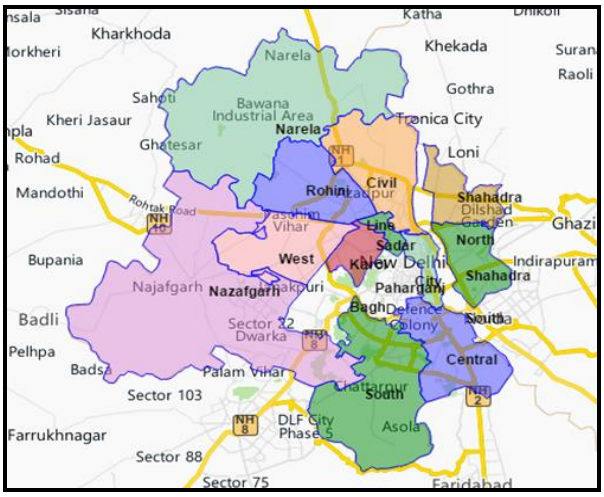

Figure 2: Showing zones under SDMC (MCD, 2014)

Below table 1 is showing results of waste composition study on different income group by COBI (2004);

Table 1 Properties and Composition of Solid Waste under SDMC Area (COBI, 2004)

Location	Area type	Biodegradables	Recyclables
Hauz khas	High income group (HIG)	71.9	23.1
Vikaaspuri	Medium income group (MIG)	75.9	21.1
Sadhnagar	Low income group (LIG)	63.2	16.6
Ring road, opposite nagla machi village	JJ cluster (JJC)	72.2	16.2
Okhla veg Table market,	Vegetable market (VEM)	97.2	2.3
Najafgarh road, motinagar to drain culvert	Street sweeping (STS)	28.4	12
Indian institute of foreign trade	Institutional area (INA)	59.7	33.8
Nehru place	Commercial area (COA)	15.6	68

Corporation is ensuring door to door collection of garbage/solid waste, their transportation at landfill sites and waste-to-energy plants. Corporation is constructing state-of-the-art transfer stations to increase the efficiency in collection of waste and quick removal of garbage with the timely availability of garbage transport vehicles. Removal of garbage from transfer stations to terminal disposal sites will be easy at night as there will be less traffic on the roads. Presently, corporation has taken decision to convert dhalaos into much-needed public toilets. Following table provides the data on no. of vehicles available in SDMC area (Table 2).

Table 2: Vehicles for Solid Waste Management in SDMC (MCD, 2014)

Name of the vehicle	No of vehicles
Truck-tipper having capacity $8m^3$	138
Tractor-trailer	40
Refuse collector/compactor having capacity $14m^3$	26
Dumper-placer/bins having capacity 1100ltrs	1151
Front end loaders	30
Auto tipper	256
PVC bins having capacity 200ltrs	800

Total no of waste receptacles in SDMC area are 5137. Table 3 below shows waste receptacles in different zones of SDMC.

Table 3: Waste receptacles in SDMC Delhi (MCD, 2014)

Zone	Dustbin/ Dhalaos + Trolleys	Open sites
Central Delhi	244	75
South Delhi	374	72
West Delhi	213	14
Najafgarh	68	135

2.3 Questionnaire Survey

The study employed questionnaire surveys for residents living under boundaries of SDMC, New Delhi. The choice of questions were included to get data that on analysis could help in getting objectives of the research and to gather data in areas of MSW management in the study area where presently there was none. The questionnaires were designed as brief worded, easy to read and understood; and being without any bias or any ambiguity.

3.0 RESULTS AND DISCUSSION

Total 1067 responds are recorded for study. Following figures 3 - 15 are giving analysis of recorded responded. In questionnaire survey, 83% respondents mentioned their occupation as service, followed by 4% businessman.

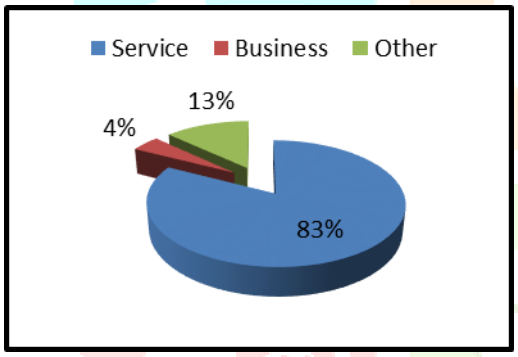

Figure 3: Percentage response based on occupation

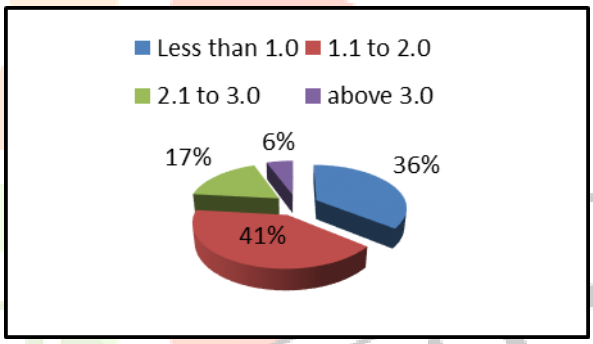

Figure 4: Percentage response for waste generation

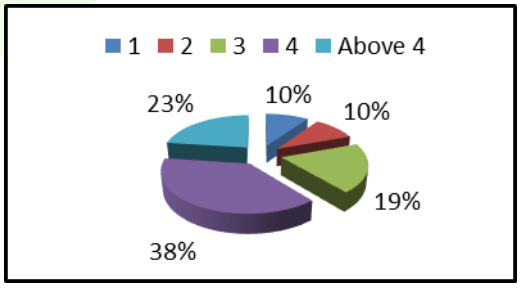

Figure 5: Percentage response based on occupant in house

On analysis of survey results, it is found that 41% of recorded responses were generating waste between 1.1 to 2.0 kg per day. Maximum 38% percent responded were living with family with total members of 4. Maximum numbers of responded (43%) were living in house size of 1001-1500 sqft. 75 % responded are living in medium income group (MIG) society.

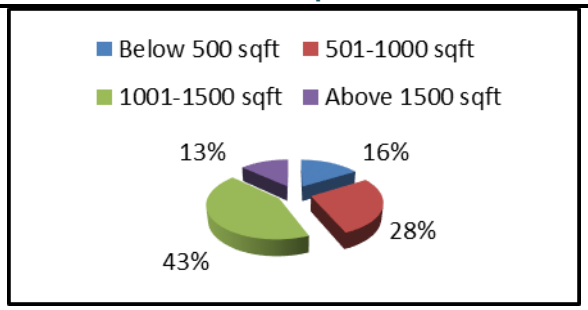

Figure 6: Percentage response based based on house size

Maximum 50% responded are saying that they are not using any specific type of the dustbin. 30% are using metal container followed by 18% are using plastic container and 2% plastic bags to collect waste in house.

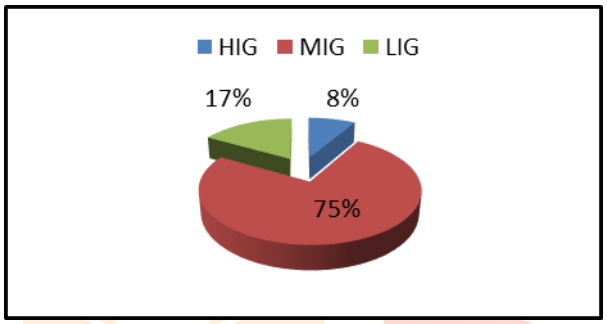

Figure 7: Percentage response based on locality

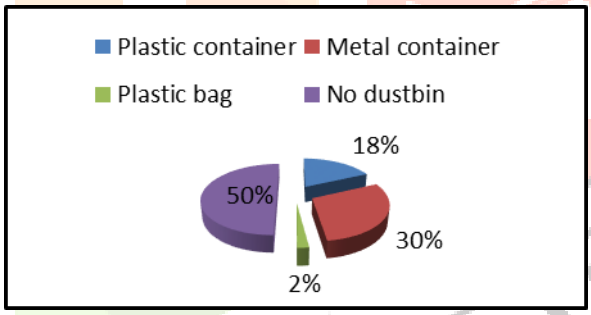

Figure 8: Percentage response for waste dustbin

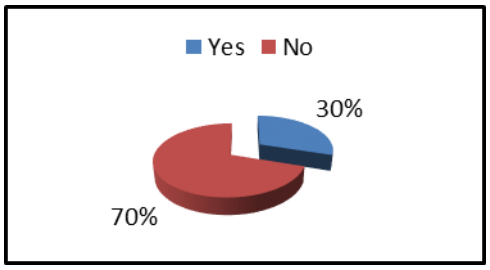

Figure 9: Percentage of responses for source separation adaptation

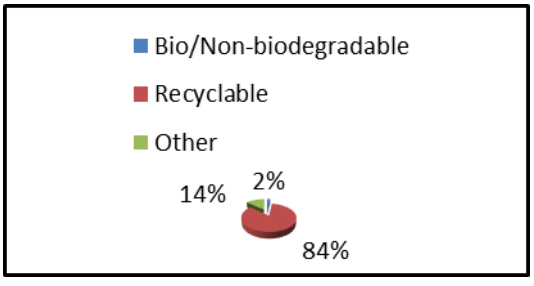

Figure 10: Percentage of responses for type of source separation

70% responded are saying that they are following waste source separation. 84 percent responded say that they are following source separation to separate bio and non biodegradable waste followed by 14% for recyclable materials.

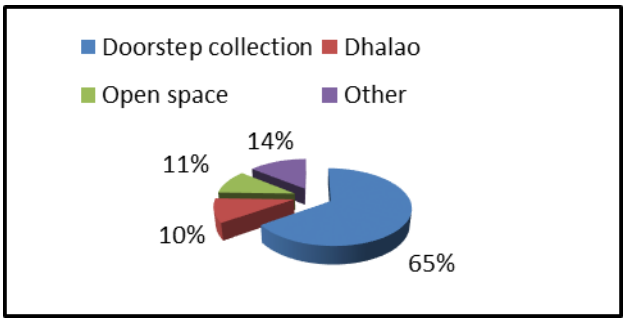

Figure 11: Percentage of responses for present waste collection mechanism

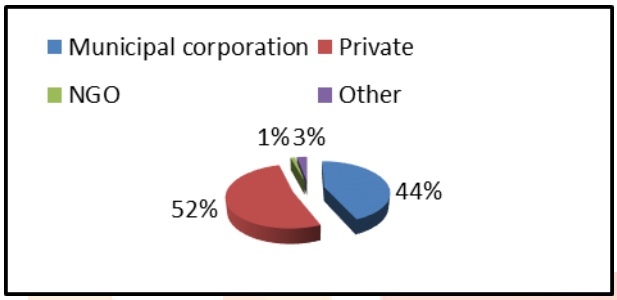

Figure 12: Percentage of responses for waste collection organization

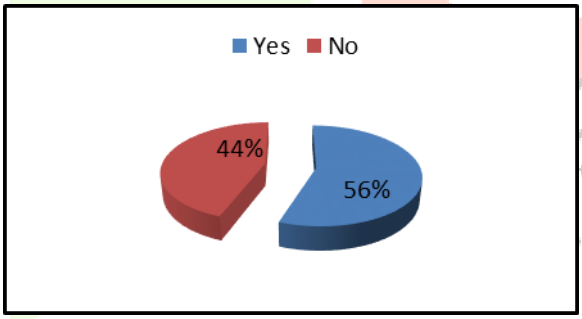

Figure 13: Responses for waste fee mechanism

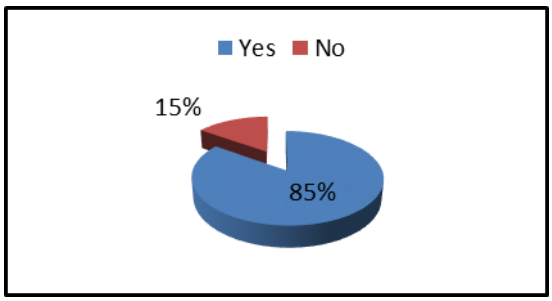

Figure 14: Willingness for decentralized waste collection

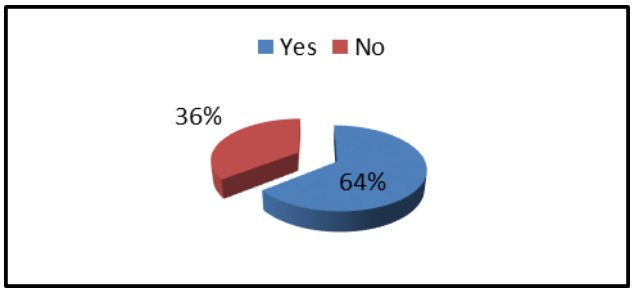

Figure 15: Willingness to pay for decentralized system

65% responded answer for doorstep collection from waste generation source. 52% responses say door step collection is done by private agency followed by 44% by Municipal Corporation. 56% responded were paying for waste collection. A survey question is asked whether responded are interested in decentralized treatment of waste, 85% responded show their interest in this direction. 64% responded are willing to pay to establish and to operate decentralize waste disposal system.

3.1 Chi Square Tests

To find the relation among quantity of waste generation and no of occupants, size of houses and income group of areas, a Chi Square tests have been done with the help of SPSS software. Table 4a, 5a and 6a show recorded responded for waste generation vs. no of occupants, size of houses and income group of area. Table 4b, 5b and 6b display results of Chi Square tests have been done on find the relations.

Table 4a: Waste generation vs. no of occupants

Waste generation(kg/d)	No of occupant 1	No of occupant 2	No of occupant 3	No of occupant 4	No of occupant above 4	Total
Less than 1.0	74	58	85	115	51	382
1.1 to 2.0	23	34	104	195	81	437
2.1 to 3.0	2	2	15	79	90	188
above 3.0	6	9	6	17	23	60
Total	104	103	209	406	245	1067

Table 4b: Chi Square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	199.723	12	.000
Likelihood Ratio	202.617	12	.000
Linear-by-Linear Association	110.895	1	.000
N of Valid Cases	1067		

Since .000 is less than .05, the null hypothesis is rejected. This results show that there is relation between waste generation and no of occupants in house.

Table 5a: Waste generation vs. Size of house

Waste generation(kg/d)	House size below 500 sqft	House size 501-1000 sqft	House size below 1001-1500 sqft	House size above 1500 sqft	Total
Less than 1.0	92	106	143	41	382
1.1 to 2.0	55	143	198	41	437
2.1 to 3.0	8	28	109	43	188
above 3.0	19	17	9	15	60
Total	173	294	459	141	1067

Table 5b: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	108.920[a]	9	.000
Likelihood Ratio	114.184	9	.000
Linear-by-Linear Association	26.284	1	.000
N of Valid Cases	1067		

Since .000 is less than .05, the null hypothesis is rejected, meaning there is relation between waste generation and house size.

Table 6a: Waste generation vs. No of occupants

Waste generation(kg/d)	HIG	MIG	LIG	Total
Less than 1.0	30	263	89	382
1.1 to 2.0	34	331	72	437
2.1 to 3.0	15	166	8	188
above 3.0	11	38	11	60
Total	90	798	179	1067

Table 6b: Chi Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	42.012	6	.000
Likelihood Ratio	46.841	6	.000
Linear-by-Linear Association	18.069	1	.000
N of Valid Cases	1067		

Since .000 is less than .05, the null hypothesis is rejected, meaning there is relation between waste generation and type of income group.

4.0 CONCLUSIONS

A questionnaire waste survey has been done online as well offline and collected 1067 responses. SPSS results make a view that waste generation quantity depends on house size, numbers of occupants in house and income group but does not depend on occupation type. Either type of occupation does not influence the waste segregation. Results of survey make a view that waste generation quantity depends on house size, numbers of occupants in house and income group but does not depend on occupation type. Either type of occupations does not influence the waste treatment. Few questions had been asked on present situation of waste management in study area and analyzed individual attitude on decentralized system of waste treatment as well willingness to pay fee in that direction, if required.

REFERENCES

Ali Delice (2002), "Educational Sciences: Theory & Practice", Department of Secondary Science and Mathematics Education, Faculty of Ataturk Education, Marmara University, Turkey

Bryman A. (1988) "Quantity and quality in social research", Sage Publications, London, United Kingdom

Delgermaa G. and Matsumoto T. (2016), "A Study of Waste Management of Households in Ulaanbaatar Based on Questionnaire Surveys", International Journal of Environmental Science and Development, 7(5), pp.368-371

Delhi Pollution Control Committee (2002), http://dpcc.delhigovt.nic.in/act_municipal

Firdaus G. and Ahmad A. (2010), "Management of Urban Solid Waste Pollution in Developing Countries", Int. J. Environ. Res., 4(4), pp.795-806

Hasheela Raili (2009), "Municipal Waste Management in Namibia: The Windhoek Case Study", Ph.D. Thesis, Universidad Azteca, Mexico

Henry R.K., Yongsheng Z. and Jun D. (2006), "Municipal solid waste management challenges in developing countries-Kenyan case study", Journal of Waste Management, 26, pp.92-100

Idris Nabih Fofana (2009), "A socio-economic sustainability assessment of livelihoods from scrap metal collection in Freetown, Sierra Leone", M.S. Thesis, Lund University International, Sweden

IL & FS Ecosmart Limited (2005), "City Development Plan of Delhi", Municipal Corporation of Delhi, New Delhi

Joshi Raj Kumar and Ahmed Sirajuddin (2016), "Status and challenges of municipal solid waste management in India: A review", Cogent Environmental Science (2016), 2, pp.1-18

Khandelwal P.K. (2007), "Solid Waste Management in Delhi with Experience on Privatization of Collection & Transportation of MSW", a presentation, Municipal Corporation of Delhi (MCD), New Delhi

Kumar Ashwani (2013), "Existing Situation of Municipal Solid Waste Management in NCT of Delhi, India", International Journal of Social Sciences, 1(1), pp.6-17

Lisa Dahlen and Anders Lagerkvist (2008), "Review Methods for household waste composition studies", Waste Management, 28, pp.1100-1112

MCD (2014), "http://www.mcdonline.gov.in/

Neumen W. Lawrence (2014), "Social Research Methods: Qualitative and Quantitative Approaches", Pearson Education Limited, Harlow, Essex, England

Pole, C. J. & Lampard, R. (2002), "Practical Social Investigation: Qualitative and Quantitative Methods, London

Rajput R., Prasad G. and Chopra A. K. (2009), "Scenario of Solid Waste Management in Present Indian Context", Caspian J. Env. Sci., 7(1), pp.345-353

Sah A.N. (2013), "Statistics for Management Using MS excel", Book, I.K. International publishing house pvt. ltd., New Delhi

Yusof M. B. M. (2004), "The Effect of Socio-economic Characteristics on Household Wastes in Johor Bahru District", Ph.D. Thesis, Universiti Teknologi, Malaysia