Survey Based Research Paper

Evaluation and Assessment of Recyclables in Households of Samanabad Town, Lahore, Pakistan

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ABSTRACT

Recycling today constitutes the most environmental friendly method of managing solid wastes. This research work was carried out to evaluate the existing situation of recyclables in the households of Samanabad Colony, Lahore. A survey was carried out of 726 houses and questionnaires were filled by the housekeepers. The housekeepers were provided with large size shopping bags and requested to put the waste in these bags and hand them over to researchers. Physical analysis of the waste was done. Chemical analysis was also done in the laboratory of the College of Earth and Environmental Sciences. All data collected through questionnaire were fed in the computer and analysed. Generation rate and collection rate of the recyclables were calculated at 0.15kg/c/day and 0.11kg/c/day respectively. The rest waste was 0.40kg/c/day. The total material which is recycled or reused is 1620.1kg/day, in which 56% is newspaper, 3.2% is magazine, 2.5% is cardboard, 2.1% is glass jam bottles, 1.7% is glass juice bottles and 16.8% is iron items, 8% is non ferrous items and 8.6% is textile. The composition of solid waste in the research area was found as follows: Paper 6.42%, Plastic 8.17%, Metal 3.18%, Organic waste 62.9%, Hazardous Waste 3.7% and Textile 6.5%.

INTRODUCTION

Municipal solid waste includes waste from residential, commercial and institutional areas as well as from construction, demolition and municipal services (Khan & Ahsan 2003) Household waste includes paper, plastic, glass, metals, yard waste, food waste and some household hazardous wastes which are generated by household activities (Pichtel 2005). Pakistan has a population of 160 million, with 35% people living in urban areas. Solid waste generated in urban areas of Pakistan is estimated at 55000 tons/day (JICA 2005).

Collection of solid waste by respective municipalities ranges from 51% to 69% of the total waste generated. The uncollected waste i.e., 31% to 49% remains on streets or road corners, open spaces and vacant plots, polluting the environment on continuous basis in some areas of large cities (Pak-EPA 2005).

Lahore is second largest city of Pakistan having population of approximately 9 million and number of houses is approximately 1.5 million. At present there are 123 containers in the city district Lahore. Storage capacity of these containers is about 4000 tons per day. There are 97 open Mazda trucks and 35 tractor trolleys which collect the open heaps/open piles. These open heaps have waste storage capacity of about 1000 tons per day. Thus, total existing storage capacity of the solid waste is 5000 tons per day. This storage capacity will be doubled if it is planed to use these in the 2nd shift (SWM 2007).

Lahore has a total of nine towns one of those is Samanabad town. Samanabad town comprises of smaller towns and colonies. Samanabad colony occurs within Samanabad town. Samanabad colony, the research area falls in the Union Council Number 106. The total number of houses in this colony is 726 with a population of approximately 4500. Most of the people in this area belong to upper middle class. The ratio of businessmen to employees is 1:1.

In this area the collection of solid waste is done by manual carts. Door to door collection is done here. This waste is stored in the CDGL containers situated at different sites. i.e., Mini market, Main market, Near First Round about, etc. From here, the waste is transported by the truck of CDGL (City District Govt. Lahore) to disposal site. Aims and objectives of the study were as follows:

- To estimate the generation rate per capita per day.
- To evaluate, the quantities of recyclables generated and source separated.
- To evaluate people's interest in improving the solid waste management in their area.
- To evaluate the amount of recyclables which are disposed to recyclers.

MATERIALS AND METHODS

The research work was done in following phases.

- Selection of the area
- Survey through questionnaires
- Sampling of waste
- Physical analysis of waste
- Chemical analysis of waste
- Statistical analysis

The area of Samanabad colony was selected for research work. This area is consisted to be upper middle class and upper class. Some lower middle class households are also present here.

Area is consisted of 726 houses. Seventy two houses were selected randomly for the questionnaire survey and sampling of the waste, which is 10% of the total number of houses.

Physical Analysis

After waste collection, its physical analysis was carried out. The components classified and quantified were paper, plastic, glass, metals, household hazardous waste, textile, organic waste, dust and dirt wood. Physical analysis included the steps of sampling, sorting and weighing.

Waste samples of the whole day were collected from 72 houses, which were randomly selected. Weight of the total waste per house was determined.

Proximate Analysis

Proximate analysis determines moisture content, fixed carbon, volatile organic compounds and ash.

Statistical Analysis

After the proximate analysis the data of questionnaires and sample collection were converted into computer software SPSS15 and different statistical analysis were made.

RESULTS AND DISCUSSION

72 houses were randomly selected for the questionnaire survey and sampling of the waste. Among these houses some of the people responded very well and answered the questions very kindly, but some people, especially housewives, were reluctant to respond. The response of people towards the questionnaire was directly related to the educational level of the respondents.

Samanabad colony is located in the western part of central Lahore. The housing scheme of this area is not symmetrical that is why houses were selected randomly for the questionnaire survey and sampling of waste.

Respondents were of different ages. There were 8 respondents of the age less than or 20 years and 22 respondents were between 21 to 30 years, 21 respondents belonged to age group of 31 to 40 years, 13 respondents belonged to age groups of 41 to 50, and 8 respondents were of the age of 51 to 70 years. There was no significant difference between the age groups to their enthusiasm to respond to questions. But a slight difference was found in young people as they took more interest in answering the questions, because they welcomed the researchers.

On the average, number of residents per house is 6 but minimum number of residents per house was 2 and maximum number of residents per house was 25. There were 44 families with residents from 1 to 6, 22 families from 7 to 10 residents, while 6 families were big as they had 11 to 25 residents per house. The average number of family members in a family was 14.

In this area there are no flats; forty families live in independent houses while 32 families live in the portion of house. In this area 46 houses were between 6-12 marlahs, 14 houses between 2-5 marlahs, while 12 houses had an area between 13-32 marlahs. The smallest house was of 2 marlahs and biggest house was of 32 marlahs.

Most of the people in this area have their own houses; forty five houses were owned, 21 were rented, 5 were relatives houses, and 1 family was residing at the upper portion of a school.

Respondents had different educational levels. Out of 72 respondents 3 were primary, 6 were middle and 17 were matric, 24 were F.A ,14 were graduates while 7 had a master degree. Their socioeconomic structure is directly related to the number of earning members in the family. Number of earning members varies in this area from 1 to 5. 52.1% of the houses have only one earning member and 2.8% have zero, 26.8% have 2 members, 11.3% have 3, 2.8% have 4, and 4.2% have 5 earning members in one family.

Recyclables

According to the questionnaires, 216 soft drink PET bottles and 39 glass soft drink bottles are consumed per week. Forty one oil tins are used per month, and 59 plastic oil bottles per month are consumed in this area. Fifteen beverages tins, 186 tetra pack juices and 329 tetra pack milk are consumed per week (Table 1).

Questionnaire show that 489 kg of vegetables, 468 kg fruits, 186 kg of mutton and 141kg of chicken are consumed per week. Packaged food use is not so mush; it is only 4 per week as shown in Table 2.

As sampling was done in the spring season that is why the amount of organic material in the waste was highest as in this season yard waste increases. The amount of organic waste is dependent on number of family members, number

Table 1: Amount of items used/week.

	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Soft drink PET bottles/week	57	1.00	14.00	216.00	3.7895	2.85818	8.169
Soft drink glass bottles/week	10	1.00	10.00	39.00	3.9000	3.28126	10.767
Oil tin/week	30	1.00	3.00	41.00	1.3667	.66868	.447
Plastic oil bottles/week	41	1.00	7.00	59.00	1.4390	1.11912	1.252
Beverages tins/week	8	1.00	4.00	15.00	1.8750	1.12599	1.268
Tetra pack juice/week	29	1.00	20.00	186.00	6.4138	5.08862	25.894
Tetra pack milk/week	42	1.00	27.00	329.00	7.8333	6.10444	37.264
Valid N (list-wise)	1						

Table 2: Food items used per week.

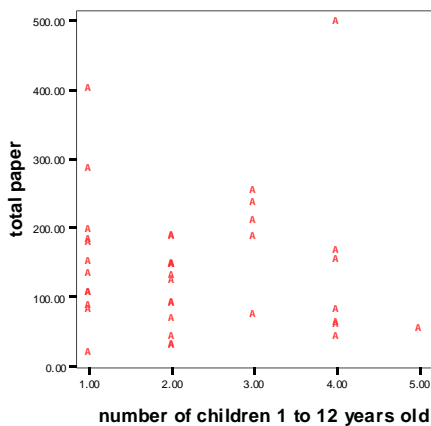|	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Vegetable, how much/week	70	1.00	21.00	489.00	6.9857	4.14761	17.203
Fruits, how much/week	67	1.00	14.00	468.00	6.9851	3.93698	15.500
Mutton, how much/week	59	1.00	46.00	186.00	3.1525	5.91262	34.959
Chicken, how much in week	60	1.00	8.00	141.00	2.3500	1.52743	2.333
packaged food/week	2	1.00	3.00	4.00	2.0000	1.41421	2.000
Valid N (list-wise)	2						

Fig. 1: Relation between children's age and paper waste.
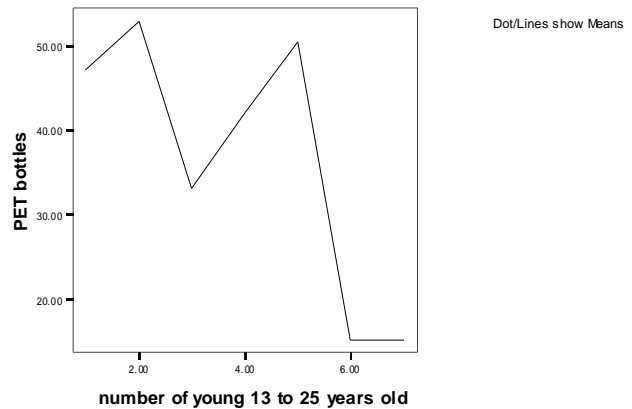
Fig. 2: Correlation between amount of PET bottles consumption and number of youngers.
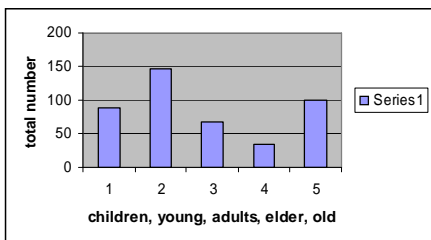

Fig. 3: Total number of different age group people.

Fig. 4: Relation between generation rate and monthly income.

of children using nappies and presence of plants or animals in house.

There are many things which are used or consumed by the residents but these all are not thrown in waste bins. So these components do not become a part of waste stream. Such items are newspaper, plastic bottles, iron material, etc. These items are either sold to scavengers and junks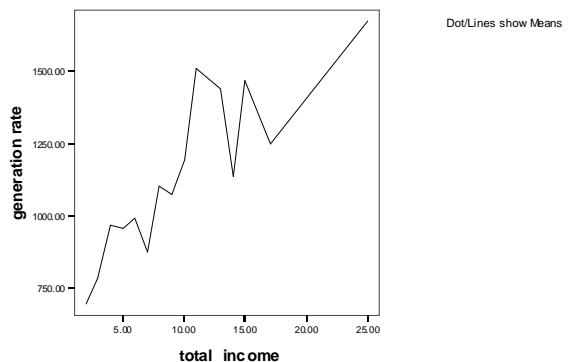hops or reused in different ways. Thus, due to this factor, the generation rate is higher than the collection rate. All the selected houses were also asked about the amount of recyclables generated each month to calculate the total generation rate.

Table 3: Do you give recyclables to maid?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	54	43.5	75.0	75.0
	No	18	14.5	25.0	100.0
	Total	72	58.1	100.0	
Missing	System	52	41.9		
Total		124	100.0		

Table 4: Reason of giving recyclables to maid.

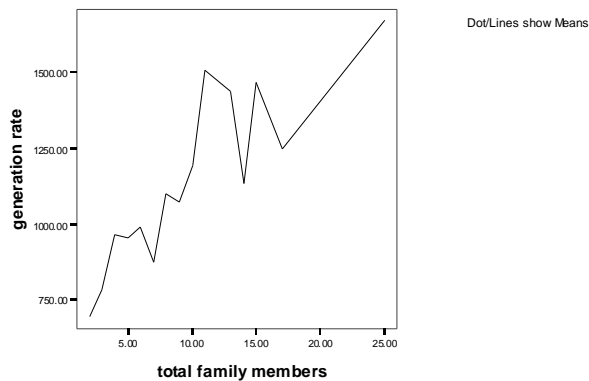|		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	For help	52	41.9	96.3	96.3
	Cheep prices	2	1.6	3.7	100.0
	Total	54	43.5	100.0	
Missing	System	70	56.5		
Total		124	100.0		

Fig. 5: Relation between number of family members and solid waste generation rate.

Behaviour of Recyclables in Households

Only a small proportion of recyclable waste is source separated. The material which is separated is either reused or sold to the hawkers. Most of the people hand over the recyclables to the maids, who sell it to hawkers or junk shops.

Recyclables handed over to maids: 75% of the people hand over recyclables to maids who sell it and finally these recyclables are recycled or reused. 25% of the recyclables are not handed over to maids, which means that either these are reused at home or become a part of waste (Table 3).

Reason of giving recyclables to maids: Two reasons were found for giving recyclables to maid. 86.1% people give recyclables to maids as a favour. 13.9% respondents do not sell the recyclables because of a very low price and give it to maids (Table 4).

Prices of Recyclables

Table 5: Price list of recyclables.

Components	Buying price of junkshop	Selling price of junkshop	Buying price of hawkers	Selling price of hawkers
Newspaper	7Rs/kg	8Rs/kg	4Rs/kg	7Rs/kg
Iron	25Rs/kg	28Rs/kg	20Rs/kg	25Rs/kg
PET bottles	15Rs/kg	20Rs/kg	10Rs/kg	15Rs/kg
Other plastic	20Rs/kg	25Rs/kg	18Rs/kg	20Rs/kg
Other paper	100Rs/40kg	120Rs/kg		

Table 6: Socioeconomic condition of people.

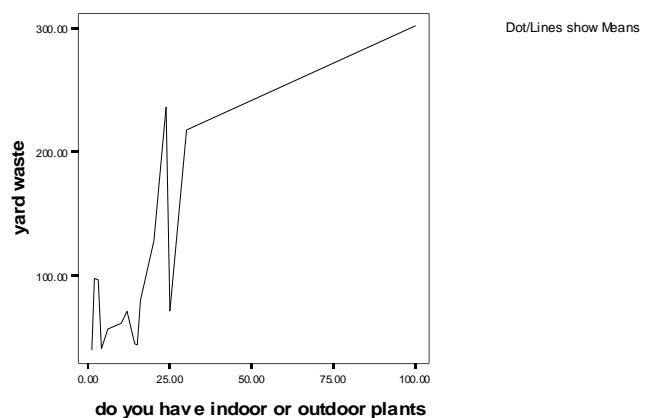|		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low income	5	4.0	6.9	6.9
	Medium income	29	23.4	40.3	47.2
	High income	38	30.6	52.8	100.0
	Total	72	58.1	100.0	
Missing	System	52	41.9		
	Total	124	100.0		

Fig. 6: Relation between indoor plants and yard waste.

The rate lists of different recyclables are given in Table 5. The junkshop owners buy these materials from the scavengers or the people of this area. But most of the time the maids or servants sell these materials to junkshops, where these waste are sorted and sold. The people who recycle or reuse this material come to junkshops and buy. Shopkeepers have a profit of about 100 Rs. per day and 3000 Rs. per month.

Recyclables which become a part of waste stream: According to the survey data, almost all people throw some of the recyclables into dust bins. 3.2% people say that they throw all the recyclables into dust bins. 20% people throw paper waste into dust bins, 8.8% people throw glass into waste, 4% people said that they throw cardboard into waste bins, 29.8% people throw garbage or food waste into the dust bins, but in reality 100% people throw garbage into dust bins, since there is no composting of garbage or food waste.

Table 7: Correlation between number of earning members in a family and socioeconomic condition.

		How many members of your family earn	Socio economic condition
How many members of your family earn	Pearson Correlation Sig. (2-tailed) N	1 71	0.341(**) 0.004 71
Socio economic condition	Pearson Correlation Sig. (2-tailed) N	0.341(**) 0.004 71	1 72

**Correlation is significant at the 0.01 level (2-tailed).

Table 8: Correlation between number of earning members and total family members.

		How many members of your family earn	Total family members
how many members of your family earn	Pearson Correlation Sig. (2-tailed) N	1 71	0.613(**) 0.000 71
total family members	Pearson Correlation Sig. (2-tailed) N	0.613(**) 0.000 71	1 72

**Correlation is significant at the 0.01 level (2-tailed).

The people do not have this knowledge that garbage can also be recycled and that is why 100% people did not answered this question. The recyclables are sorted by the scavengers at disposal site.

Materials which are no longer in use: Most of the materials which are no longer in use in households are handed over to maids or servants. 23.4% people hand over these to maids or servants, whereas 4.8% people give these to needy people like beggars, etc. 8.9% people sell these things and 11.3% people store such materials and then they reuse these after some days. 9.7% people throw these into dust bins.

Waste which is least urgent to hand over: Almost 70% of the people say that paper waste is least urgent to hand over, 1.6% of people say that glass waste is least urgent to hand over and 9.7% people say that nothing is least urgent to hand over. So there was a mixed trend in answering this question.

Wastes which are most urgent to hand over: 55.6% peoples say that garbage or kitchen waste is most urgent to hand over as it causes smell and looks very bad. 0.8% of the people say that all types of waste is most urgent to hand over and they do not want to store any kind of things. 0.8% people say that garbage and shopping bags are most urgent to hand over, and 0.8% of people say that they can not bear

Table 9: Correlation between educational level and unemployment of the respondent.

		Education of the respondent	are you presently employed
Education of the respondent	Pearson Correlation Sig. (2-tailed) N	1 71	-.215 .073 70
Are you presently employed	Pearson Correlation Sig. (2-tailed) N	-.215 .073 70	1 71

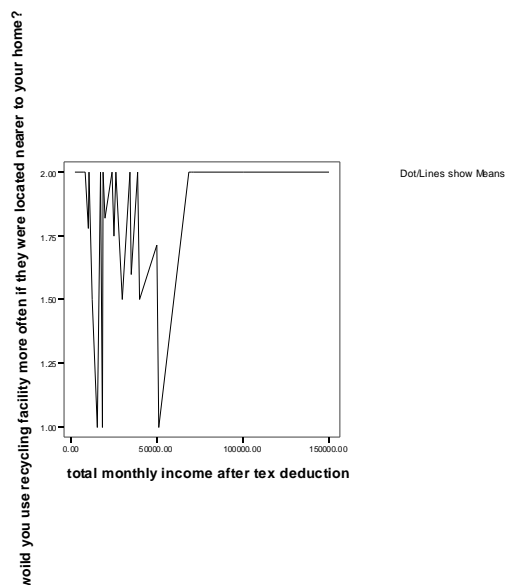Correlation is significant at 0.05 level.

Fig. 7: Relation between income level and willingness to use recycling facilities.

shopping bags in their houses.

Trend to use recycling facility: Although there are three recycling facilities in the area, but yet the ratio of using the recycling facility was not significant. 59.7% of the people do not know where the recycling facility is located in their area; 38.9% of people know that either recycling facility is present in their area or not, and 1.4% of peoples have no idea about the recycling facility in the area.

Socioeconomic Condition of the People in the Area

Thirty eight out of 72 houses have high income, i.e., more than Rs. 40000 per month, 29 houses have medium income which is from Rs. 11000 to 30000, whereas 5 houses have low income of less than Rs. 10000 (Table 6).

The Table 7 shows positive correlation between earning members and socioeconomic condition which means that both are directly related to each other.

Table 10: Percentage composition of waste.

Components	%
Paper	6.42
Plastic	8.17
Metal	3.18
Glass	9.19
Organic material	62.9
Hazardous waste	3.7
Textile	6.5
Total	100

Table 8 shows a positive correlation between total family members and number of earning members in a family. Which means that both are directly related to each other, i.e., big family has more earning members and small families have less earning members.

There is no direct relationship between the unemployment of the respondents and their education level as many respondents were well educated but did not have a job (Table 9).

Percentage Composition of the Waste

The percent composition of the waste in the area is given in Table 10, which shows that the organic matter is present in the maximum amount (62.9 %) followed by glass (9.19 %), plastic (8.17 %), textile (6.5 %), paper (6.42 %), hazardous waste (3.7 %) and metals (3.18 %).

Generation rate in kg/capita/day

The generation rate of the waste in this area is 0.15 kg/capita/day. The generation rate of different components is given Table 11.

Collection rate in kg/capita/day

The total collection rate of the waste in this area is 0.118 kg/capita/day which is smaller than the generation rate. Collection rate of different components of the waste is given in Table 12.

Statistical analysis of the data was also carried out in which the correlations between different factors were determined. The component which is in the highest amount is organic waste, and second highest component is paper waste. The component which is lowest amount is hazardous waste and metals. The highest value of organic waste is directly related to the total number of family members as more food waste is generated in a big family than in a small family. Organic waste is also related to the presence of plants and animals in houses. In those houses where children are present, more nappies are used which also contribute to the organic waste (Table 13).

Table 11: Generation rate of different waste components.

Components	Generation rate(kg/capita/day)
Paper	0.021
Plastic	0.012
Metal	0.01
Glass	0.0043
Organic	0.093
Hazardous material	0.0016
Textile	0.0084
Total	0.15

Table 12: Collection rate of different waste components of waste

Components	Collection rate(kg/capita/day)
Paper	0.0086
Plastic	0.01
Metal	00009
Glass	0.0016
Organic	0.086
Hazardous material	0.00064
Textile	0.0013
Total	0.110

Table 13: Correlation between food waste and family members.

		Food waste	Total family members
Food waste	Pearson Correlation	1	0.272(*)
	Sig. (2-tailed)		0.021
	N	72	72
Total family members	Pearson Correlation	0.272(*)	1
	Sig. (2-tailed)	0.021	
	N	72	72

Table 14: Relation between monthly income and tetra pack consumption.

		Boxboard	Total monthly income
Boxboard	Pearson Correlation	1	0.002
	Sig. (2-tailed)		0.990
	N	34	34
Total monthly income	Pearson Correlati	0.002	1
	Sig. (2-tailed)	0.990	
	N	34	72

Table 15: Correlation between number of children in houses and boxboard waste.

		Boxboard	Number of children 1 to 12 years
Boxboard	Pearson Correlation	1	0.268
	Sig. (2-tailed)		0.298
	N	34	17
Number of children 1 to 12 years	Pearson Correlation	0.268	1
	Sig. (2-tailed)	0.298	
	N	17	39

Table 16: Results of proximate analysis of the solid wastes.

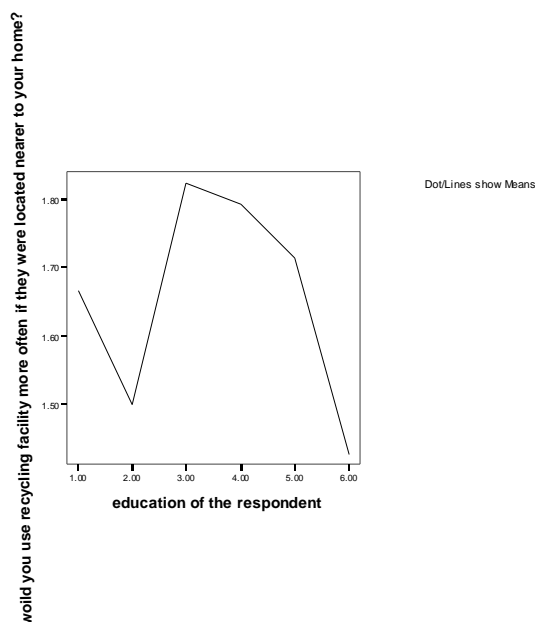| Physical property	Value (g/kg)
Moisture content	815.35
Volatile organic compound	759
Carbon content	5938
Ash	227.4

Fig. 8: Relation between educational level and willingness to use recycling facility.

The amount of paper waste is not related to the total family members as one newspaper is shared by all family members. But paper waste may be more in those houses where children are more as they use paper during playing and studying.

The hazardous waste is in low amount. The reason of this may be that one pesticide bottle or one oil bottle for car is shared by all family members and their use is low in a month. The number of safety razor blades or sharps is more in those houses where men are more in number. Battery cell usage is more in those houses where more children are present as they use battery cells in their toys.

Plastic waste is in third highest amount. In plastic, highest component is soft drink PET bottles. The use of PET bottle is very high in this area. On an average, four PET bottles of 1.5L capacity are used in one week and 2392.70g of PET bottles waste is generated in this area per week.

Fig. 1 shows that as the age of children increases the amount of paper waste decreases, which means that amount of paper waste is more in those houses where smaller children are present.

Fig. 2 shows that consumption of soft drink PET bottles is more in the houses where teen age and young people below the age of 25 are present. So, more plastic waste is generated in these houses.

As indicated in Fig. 3, the total number of younger people in this area is highest so the composition of waste will be impacted by this age group (13 to 25 years).

Generation rate may be affected by the total monthly income or socioeconomic structure of the people. As we can see in Fig. 4 that with the increase of total monthly income the amount of waste generated is also increased. The reason for this is that high income group people consume more materials, e.g., fruits, vegetables, packaged food, PET bottles, juices and milk packs, and newspapers, etc. so the amount of waste generation is more in the high class houses than in the middle or low class people.

Generation rate is also affected by the season of the year. As the study was done in the spring season, the yard waste was more. Food waste was also in high amount because in this season most of the fruits and vegetables are available in large amounts and used, which increased the amount of organic or kitchen waste.

Generation rate is also affected by the number of total family members. More the family members more will be the amount of waste generated as shown in the Fig. 5.

Fig. 6 shows that with the increase in the number of indoor plants in house, the amount of yard waste also increases.

Consumption of tetra pack milk and juices may be affected by the total monthly income and the number of children present in the house. Table 14 shows a positive relation between the income level and the use of tetra pack milk and juices. The high amount of compostable paper in the waste shows that people do no have any idea about the composting of material, and they just throw it into the dust bin and all of this is wasted. The Table 15 shows the relation between number of children per house and the consumption of tetra pack juices and milk pack which is positive relation.

The willingness of the people to use recycling facility is not directly related to the education level or to the income level of the people. Mixed trend was found between different income level and education levels of people to use recycling facility Figs. 7 and 8).

Results of Proximate Analysis

Proximate analysis was done to calculate the moisture content, volatile organic compounds, carbon content and residual ash and the results are presented in Table 16.

CONCLUSIONS

94.4% respondents in the survey were females. There was no significant difference between the answers of both genders. Respondents were of different age groups; most of the respondents were between the ages of 21-40 years. 70.8% were married, 61.6% lived in small families, 66.2% have single family system and 52.8% have an income that is from Rs. 40,000 to 100000 per month. Tetra pack milk, and juices

and soft drink bottles were most common recyclables. Vegetable and fruits were used more than meat or other foods. The generation rate of different waste components is given as paper 13.5%, plastic 7.8%, metal 7.3%, glass 4.09%, organic waste 58%, hazardous waste 1.3%, and textile 7.48%. Organic waste is the predominant component of the MSW. A direct positive correlation was found between organic or food waste generation and total family members. There was a negative correlation between age of children and amount of paper waste which showed that young children generate more paper waste than the older people. The consumption of PET bottles is directly related to the number of young people in a family. Generation rate of household waste is also directly related to the total monthly income and total family members. The collection rate of waste is as paper 6.42%, plastic 8.17%, metal 3.18%, glass 9.19%, organic wastes 62.9%, and hazardous wastes 3.7%. The amount of organic waste increases further in households with pets, indoor plants and garden area green spots. The organic waste is followed by paper waste. In paper waste boxboards dominate. The consumption of tetra pack milk and juices has a direct positive relation with monthly income. Relation between number of children per house and number of boxboard consumption was also positive. The total generation rate is 0.15kg/c/day and collection rate is 0.110 kg/c/day. It shows that 0.040kg/c/day is reduced at the source due to source separation of recyclables. The waste which is reduced at source is paper waste, since the news papers do not become part of waste stream. Magazines and catalogues are also separated at source. Seventy five % of the people hand over recyclables to maids. This shows that housekeepers do not have any direct interest in recycling of waste materials. The recyclables which become part of the waste stream are garbage, paper, textile and glass wastes. The material which is no longer in use is handed over to maid (23.4%). 4.8% is handed over to needy. 8.9% sell these items while 11.3% of the people store these. To most of the people, paper waste is least urgent to hand over while garbage is most urgent to hand over. Junkshops were near to the houses but trend of housekeepers to use these shops was not satisfactory. There is no relation between income level and willingness to recycle, and educational level and willingness to recycle. People wanted recycling facility away from their houses. 52.8% people said that it should in a market area, and 13.9% said it should be away from the residential area. Willingness to use bins for recyclables at home was quit satisfactory. Almost 1620.111 kg/month of the waste is recycled among which 56% is paper waste. Organic waste is not recycled at all.

RECOMMENDATION

- People should be educated on recycling through media (electronic and press).

- Small informative seminars and lectures should be arranged in communities to educate the people on the benefits of recycling.

- Separate recycle bins should be provided to people.

- Economic incentives should be used to encourage people to reuse and recycle and encourage them to reduce the waste at source.

- The amount of organic waste was maximum during collection, which should be recycled. Household with gardens should be encouraged to compost.

- People should be encouraged to separately store paper waste and keep it dry.

ACKNOWLEDGEMENTS

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