

# Characterization of Household Waste in Islamabad and Exploring Possible Reuse and Recycling Options

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## ABSTRACT

Increased solid waste generation creates additional environmental problems as many cities are unable to manage it. Unfortunately, none of the cities of Pakistan has a proper solid waste management system right from collection of waste up to its proper disposal. Islamabad, being a capital city of Pakistan with 90% literacy rate faces the similar solid waste management problems. In Islamabad around 91% of total municipal waste is composed of green and household waste which may support composting. Currently, there is no proper sorting system of municipal solid waste which indicates insufficient and inefficient recycling of organic/inorganic waste materials in Islamabad. The major portion of the recyclable household waste collected is gone wasted and buried at dumping sites in sectors H-12 and H-10. The paper is an initiative to determine reusable components of household solid waste in Islamabad and explore possible recycling/reuse options. By adopting stratified random sampling design, the primary research is carried out in sector G-7, Islamabad. Districts within the sector have been made on the basis of income groups. 2% sample size is taken as waste generated within the income groups has high degree of similarity. The study concluded the possible reuse and recycling options for the major household waste in Islamabad.

**Keywords:** Solid waste management, Household waste, Recycling, Stratified random sampling.

## 1. INTRODUCTION

According to UN-HABITAT (2010) "In a rapid urbanized global society, solid waste management (SWM) is a key challenge facing all the world's cities". SWM can be defined as the subject associated with the control of generation, storage, collection, transfer, processing and disposal of Municipal Solid Waste<sup>1</sup> (MSW), in a way which is governed by the best principles of public health, economics, engineering, aesthetics and other environmental considerations (Daskalopoulos, Badr, & Probert, 1997). Institutional Arrangements – Pakistan (2010) described that SWM has been the responsibility of local governments. However, with the increasing rate of solid waste generation, various institutions have got involved into one or more aspects of SWM chain. Recycling of waste may generally be considered as a key strategy for alleviating the society's pressures on environment. A variety of environmental justifications for recycling exist: recycling processes reduce demand for energy and finite resources. Moreover, recycling may be considered economically beneficial in developing countries. The recyclable waste can be converted into valuable products with minimum environmental impacts, utilizing less natural resources and creating employment opportunities by the recycle industry.

Standard Operating Procedures (SOP) (2008) estimated the daily MSW generation is about 500-550 tons in Islamabad out of which 425 tons is being collected by Capital Development Authority (CDA) (Project Procurement International (PPI), 2006). 77% of the total waste is transported to dumping sites. The total municipal waste comprised of green and household waste is 91% which may support composting whereas remaining waste of 9% is comprised of 3% plastic, 2% cloth, and 1% paper, glass and construction material. The major portion of recyclable waste collected from household is gone wasted at dumping sites. Sorting of recyclable waste is not being done either at collection/storage or at dumping/disposal stage. Thus, research is carried out to study the solid waste generation in Islamabad, its collection and sorting system and to explore

<sup>1</sup> The type and composition of solid waste depends on the nature of activity from which the waste originates (Shehri: 1997).

possible recycling/reusing options. This paper is an attempt to provide a comprehensive review of SWM Practice in Islamabad with objectives to determine recyclable/reusable components from households in Islamabad.

## 2. SOLID WASTE MANAGEMENT IN ISLAMABAD

In Islamabad, CDA is responsible to perform municipal functions (Govt of Pakistan, 1960) which also incorporate SWM within the area enclosed by municipal limits. Later on with the growth of the city a separate Directorate of Sanitation was created with main job allocation of SWM in Islamabad (Standard Operating Procedures (SOP), 2008). According to M/s Ceres Associates: EIA Report of Landfill (2006) CDA has a program to implement an integrated waste management<sup>2</sup> project for the city.

Directorate of Sanitation, Directorate of Sanitation CDA (2008) estimated about 550 to 600 metric tons of mixed solid waste daily generated in Islamabad and has relatively much organized system of solid waste collection and disposal. Islamabad urban generates 205.382 tons of daily household waste in which 76.71% is biodegradable waste. Due to acute shortage of sanitary staff, machinery, equipments and expansion in the size of the city, the sanitation services of six sectors that are G-7, G-10, I-10, G-9, G-8 and G-6 had been privatized by CDA (Directorate of Sanitation CDA, 2008). 900 employees are responsible for sweeping, collection of waste and its transportation to final disposal site. At present there is no proper engineered sanitary landfill site. The solid waste is being disposed off at final garbage containment site located in sector H-10 on Kashmir Highway (Hayat, 2010).

Composition of SW generated in Municipal area of Islamabad from five sectors, G-5, G-9, F-7, H-8 and I-9 is depicted in the Table 1. As per table 6.87% of the MSW which has been reached at dumping sites at H-12 and H-10 is composed of recyclable waste. From total waste only 2.72% recyclable waste is collected by scavengers. From the table it is also clear that the major components of MSW are household waste and green waste (kitchen and garden waste) i.e. 92.07%.

**Table 1.** Composition of Solid Waste, Islamabad.

Islamabad during February 2006) Waste Components	Waste/week (kg)	%age w.r.t. total
OCC (Card Board)	1131	0.37
Tetra Pack	1131	0.37
Cloth	6411	2.12
Paper	2025	0.67
Plastic (PET and other)	8531	2.82
Metals (Ferrous and Non Ferrous)	119	0.04
Aluminum	22	0.01
Glass	1160	0.38
Wood Waste	241	0.08
Green Waste	77210	25.54
Household Waste (Kitchen and Garden waste)	201084	66.53
Construction and Demolition waste	2836	0.94
Others	350	0.12
<b>Total</b>	<b>302251</b>	<b>100</b>

Source: Waste Characterization Study by Project Procurement International.

ECNEC (2005) indicated a site measuring 100 acres in Mouza Kuri that has been allocated for planning and development of landfill in Islamabad but according to Master Plan of Kuri Agro Farming Scheme (2004) development of landfill has not been started due to issues regarding its land acquisition. An area of 20 acres adjacent to landfill site in Kuri has also been allocated for establishment of compost plant in Islamabad (Figure 1). The land has been leased out for composting of biodegradable components of MSW. The hurdle in the establishment of compost is the delivery of land possession due to which project is being delayed. Also a land measuring 1.79 acres has been allotted in CDA Board Decisions (2007) at sector H-11/2 for construction of

<sup>2</sup> Integrated waste management is a system of waste disposal that includes separating materials according to type, and finding the best used for discarded products, which may or may not include depositing in a landfill. (<http://www.wisegeek.com>)

material recovery facility<sup>3</sup> (MRF) and transfer station<sup>4</sup> in 2007. Consultant has submitted conceptual plan and land utilization plan for the approval of the authority.

### 3. Research Design:

Islamabad, the capital of Pakistan with an area of 906 sq km (Govt of Pakistan, 1960) having urban area comprises of sectors having series of C, D, E, F, G, H and I. Every series has numbers ascending from East to West with 61 urban sectors in which 23 sectors have been developed up till now. The master plan of Islamabad has Islamabad Capital Territory, municipal limits and the peripheral limits within which Sanitation Directorate performs its functions.

Sector G-7 Islamabad has been taken as a case study for the research (Figure 1). Sector G-7 is fully developed and densely populated having the accommodation of government and private houses with 5963 residential units (Figure 2). The plot sizes range from 3 marlas to 1 kanal which indicates the communities of various income levels. Furthermore, for the research sector G-7 has been divided into three districts. District-1 is for low income group comprising mostly government houses of categories A, B, C and D. District-2 represents middle income group and comprises of government houses category E and private houses built on small plots having the value of 5 to 8 millions. District-3 is for high income group comprising private houses built on 11 kanal plot. The detail of number of units in sector G-7 with reference to the income group is reflected in Table 2. To fulfill the research objectives following information had been gathered from primary source:

- Volume and composition of household solid waste generated in sector G-7
- Collection and sorting system of household solid waste

## 3. METHODS

### 3.1. Sampling

Before determining the sample size a pilot survey of ten households, one from high income group, three from middle income group and six from low income group was conducted for three days. From analysis of the output it was observed that the waste of recyclable and non-biodegradable waste materials is missing in 70% of the waste collected and the waste generated by low income group has large similarity. The size and type of residential plots in sector G-7 indicated the community with various income levels. Thus, the waste generated from the household is in variety and covers all types of household waste as quantities of waste are invariably lower in developing countries because of lower prosperity and consumption (Holmes, 1992). The pilot survey also showed that composition and rate of production of waste is similar in one economic group. Keeping in view the districts with diversified range of plots and income groups Stratified Random Sampling Design is followed.

**Table 2.** Number of Residential Units w.r.t. Income Level, Sector G-7, Islamabad.

Income Group	Number of Units	Number of Households
Low	5363	5363
Middle	473	946
High	127	254
Total	5963	6563

### 3.2. Sample Size

An average of 2% sample size had been taken to gather the information regarding household waste from residents of sector G-7. Keeping in view the outcome of the pilot survey and opinion of the experts a samples size 1.34%, 3.38% and 5.5% of household units has been taken to investigate the household waste in sector G-7. Household waste from 118 households in sector G-7 has been collected after every 24 hours for 7 days from 15<sup>th</sup> October 2010 to 21<sup>st</sup> October 2010. 72 households out of 5363 from low income group have been surveyed which showed large similarity in the waste generated as observed from the analysis during pilot survey 32 household out of 946 from middle income group and 14 households out of 254 from high income group have been surveyed. To explore reuse and recycling options from household waste two shopping bags with the capacity of 10 kg having transparent and black colors had been provided to every respondent with guidelines. The respondent was guided to put kitchen waste in transparent and other waste in black shopping bags. The guidelines clearly indicated which type of waste is to be put in the bag as shown in box 1.

<sup>3</sup> A materials recovery facility or materials reclamation facility or materials recycling facility is a specialized plant that receives, separates and prepares recyclable materials for marketing to end-user manufacturers. (<http://en.wikipedia.org>)

<sup>4</sup> A transfer station is a building or processing site for the temporary deposition of waste. (<http://en.wikipedia.org>)

PUT IN	
Transparent Shopping Bag	Black Shopping Bag
Vegetable residues	Biscuit packers
Peels of fruits & vegetables	Masala packers
Pieces of flesh	Ice cream packets
Tea leaves	Paper
Cereals	Card
Food residues	Plastic bottles & bags
Egg coverings	Large iron boxes
etc.	Glass
	Clothes
	Leather shoes, products etc

Box 1. guidelines indicate the type of waste is to be put in the right bag.

#### 4. DATA ANALYSIS

The total 7 days waste from 14 households of high income group was 192.69 kg, 32 households of middle income group was 282.86 kg and 72 households of low income group was 658.098 kg. The major component from households of high income group was kitchen waste with 71.49%. Other considerable components were 4.00% garden waste, 9.82% paper and 10.21% of plastic waste of the total. The quantity of kitchen waste/capita/day came out to be 0.246 kg, and garden waste was 0.013 kg/capita/day, paper waste was 0.034 kg/capita/day and plastic waste was 0.035 kg/capita/day (Figure 3). In middle income group the major components of the waste were kitchen, paper and plastic with 81.41%, 8.90% and 6.15% respectively. The paper waste was 0.016 kg/capita/day and plastic waste was 0.011 kg/capita/day (Figure 4). In low income group the major components of waste were kitchen, paper and plastic with 76.20%, 7.93% and 7.45%. The paper waste was 0.014 kg/capita/day and plastic waste was 0.013 kg/capita/day. The kitchen waste/capita/day came out 0.133 kg i.e. 76.20% of the total (Figure 5). Therefore, the major component of the waste was kitchen waste which is biodegradable and can be easily recycled. (*Biodegradable waste is a type of waste, typically originating from plant or animal sources, which may be degraded by other living organisms, commonly found in municipal solid waste*)

The character and volume of household solid waste generated by low, middle and high income groups in sector G-7 is reflected in Table 3. It is observed that the average waste generated increases with increase in income and major component of the waste is biodegradable which can easily be recycled (Figure 6).

#### 5. Recycling/Reuse Options

Sorting of waste has not been done at any stage in Islamabad. However, at the dumping site some informal sorting is done by the scavengers. Most of the recyclable waste is being dumped in an open dumping site which results wastage of resources and burden on available resources.

The characterization of household waste has set pointers towards some possible recycle and re use options.

##### 5.1 Composting

In Islamabad 157.55 tons of kitchen waste is generated per day i.e. most viable waste for composting. Composting can be done both at state level and household level. The plan to establish the composting plant near proposed landfill at Kuri needs to be given top priority by the government for effective SWM and acquiring the compost in the form of manure for horticulture or food production. At household level residents can be motivated to have their own small set ups for composting relying on their kitchen waste. One compost plant is surveyed in Lahore (Mehboob booti band) over an area of 300 kanals. It is operating on an open dump site where solid waste from various parts of Lahore is collected. Here 650 tons of daily waste is gathered. The waste is sorted into organic and non-biodegradable waste with ratio of 55% and 45%. The 55% organic waste is used for composting and compost is sold @ Rs. 258 per 50 kg whereas the expenditure of production of 59kg compost is Rs. 150. The calculated profit per ton is Rs. 2700. When kitchen waste is sorted at source level and collected separately and sequentially taken to compost plant the ratio at which compost is produced raises upto 50%. By

composting 157.55 tons of Kitchen waste in Islamabad 78.77 tons of good quality compost can be produced daily.

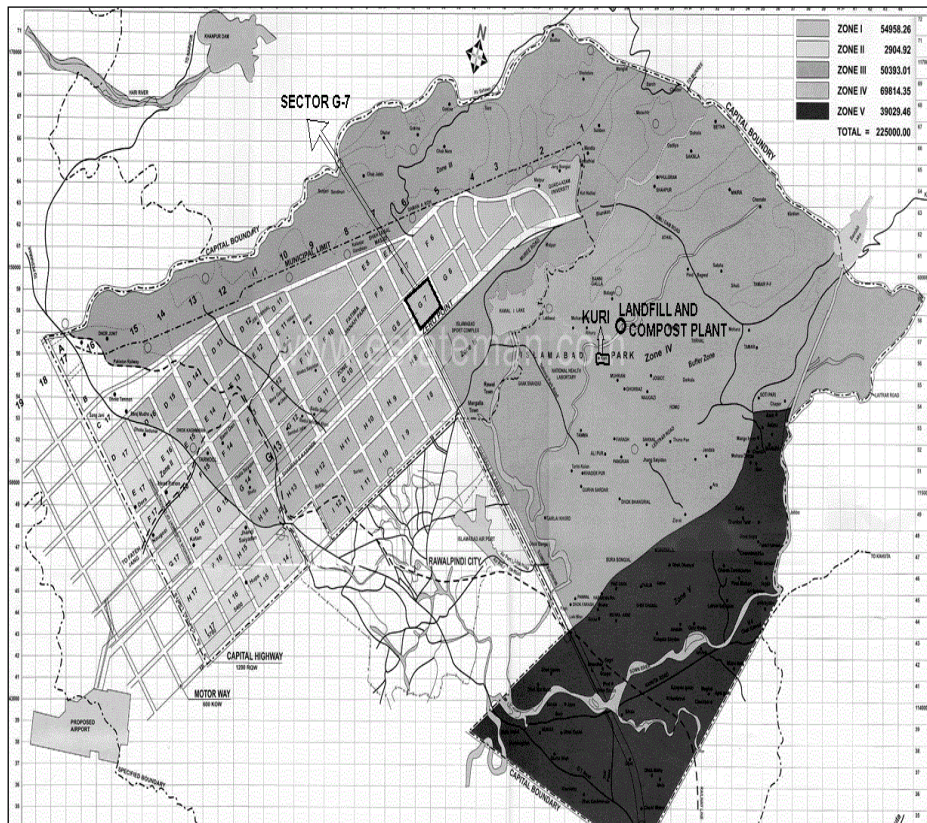


Figure 1. Islamabad Master Plan Shows Location of Sector G-7, Landfill Site And Compost Plant Site.  
 (Source: <http://www.Estateman.Com>).

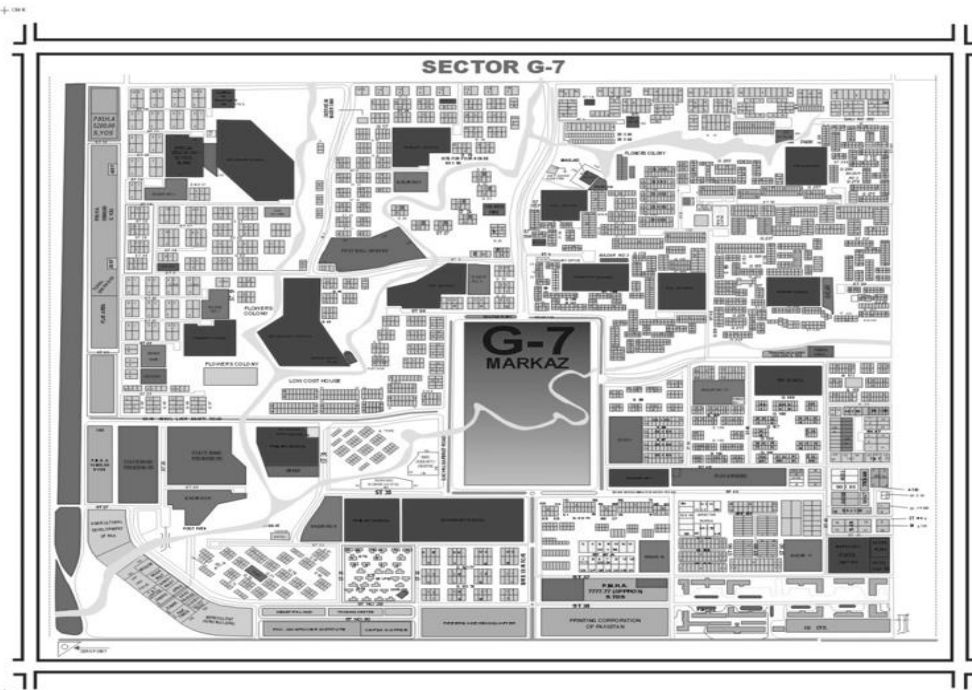


Figure 2. Detailed Plan of Sector G-7, Islamabad.

Source: <http://www.alnoorpakistan.com>.

### 5.2. Reuse of Solid Waste as Fuel

The survey of SWM practices in Islamabad has identified one reuse option being practiced by the Fauji Cement Company Limited (FCCL), a cement factory in Jhang Bhatar, district Attock. The factory in pursuance of its commitment to produce its cement under stringent environment friendly condition, has installed first refuse derived fuel<sup>5</sup> (RDF) processing plant which uses MSW as a raw material. It utilizes MSW which is collected from dumping sites and converted into fuel for subsequent usage in the cement plant. This plant has a capacity of 12 tons per hour and will replace about 170 tons of coal per day as fuel. FCCL has executed a contract with CDA to lift all the municipal solid waste of Islamabad to its cement factory site at Jhang Bhatar, 50 km away from dumping site located near sector H-10. However, currently they are only lifting about 200 tons of SWM as the factory is working 300% less than its capacity due to technical and mechanical problems. At state level other factories near Islamabad can be encouraged to adapt similar environment-friendly practices.

### 5.3. Recycling of Plastic Waste

Plastic is another major waste material generated at household level (Table 3) which can easily be recycled and can be converted into useful plastic ware with less energy, low cost and least environmental impacts. Again there is no significant plastic recycling factory near Islamabad.

The plastic waste is transported to Lahore, where plastic waste is sorted with reference to plastic composition and its colour then it is shredded. By heating shredded plastic granules are marketed and supplied to the factories which are producing plastic furniture, domestic utensils, bottles, parts of motor bikes and vehicles, shoes/chapels, housing products, cable coverings and electronic appliances.

### 5.4. Recycling of Paper Waste

The other significant household waste is paper (Table 3). The paper waste is also being supplied by middlemen to the factories in Lahore which is sorted and graded at the factories and converted into papers, cards, card boards, disposable and packaging by products. Old paper is also used in the 'paper mache' craft whereby paper is soaked and molded in beautiful shapes and decorated with colours. This technique is also experimented to produce the roofing material for the low cost housing structures at the Council for Housing and Works in Karachi.

## 6. CONCLUSION

The most important component for recycling of waste is sorting of it at source level according to the requirement. The household survey has identified that the residents of Islamabad did not appreciate sorting of waste at source level therefore it is imperative to enhance their knowledge about waste and its management through reuse and recycling options as a shared responsibility with SWM agencies.

No composting of biodegradable waste is being done in Islamabad by formal or informal sector which results wastage of resources and increased burden on the available resources. Kitchen waste is the major household waste and has the great potential for composting at domestic level and governmental level for its added advantages as manure. The organic waste hence, needs to be collected separately and not dumped with other waste that might be hazardous or toxic.

Plastic and paper are identified as other two major wastes that can be sorted, graded and recycled into new products at low cost with minimal environmental burden. Similarly, the other categories of biodegradable and non bio degradable waste materials such as glass, tin, textile and leather can be sorted, collected and graded for re-use and recycling options. Moreover, households are to be trained on reduction of waste in the first place and respecting the practices associated with re-use and recycling.

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<sup>5</sup> Refuse-derived fuel (RDF) or solid recovered fuel/ specified recovered fuel (SRF) is a fuel produced by shredding and dehydrating municipal solid waste (MSW) with a Waste converter technology. (<http://ec.europa.eu>)

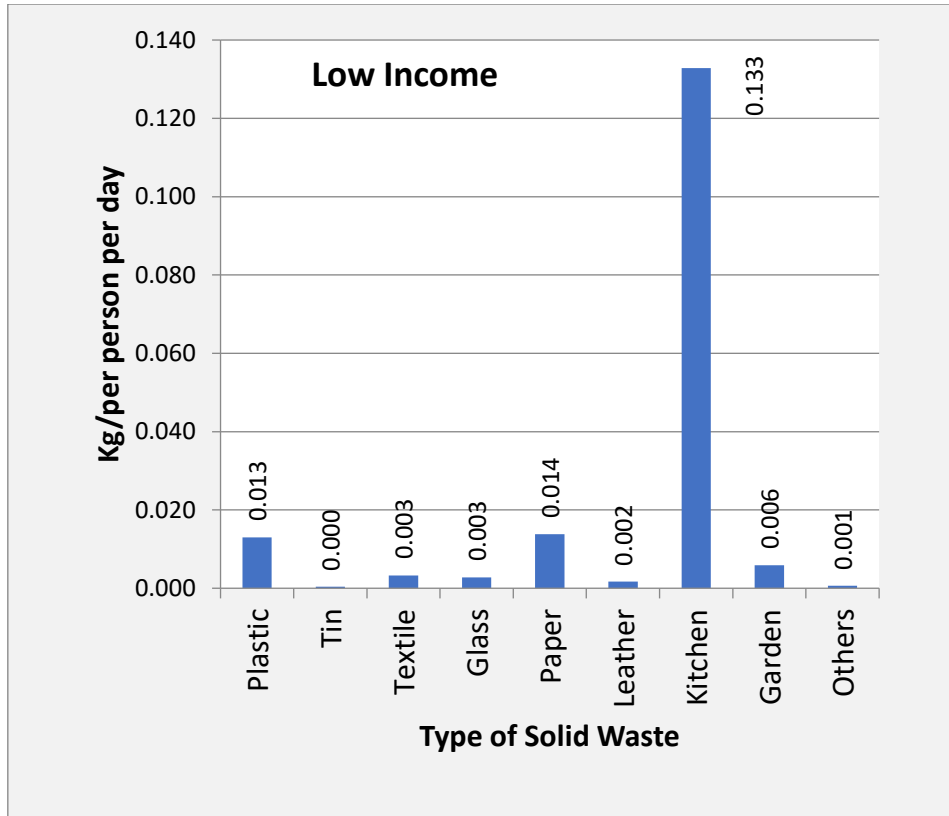


Figure 3. Household Waste Production in Sector G-7, Islamabad by High Income Group.

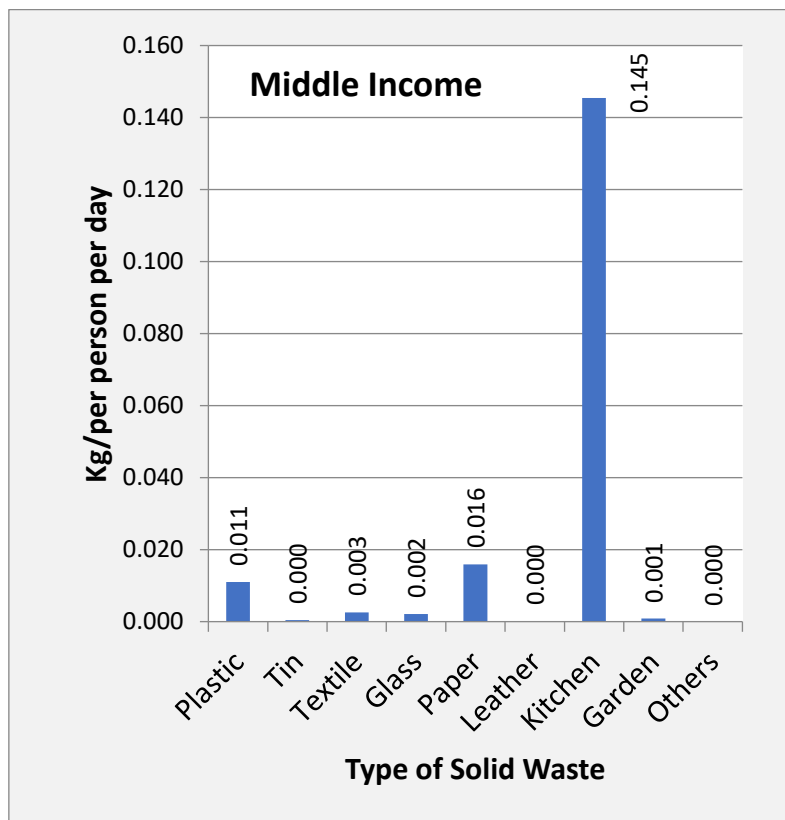


Figure 4. Household Waste Production in Sector G-7, Islamabad by Low Income Group.

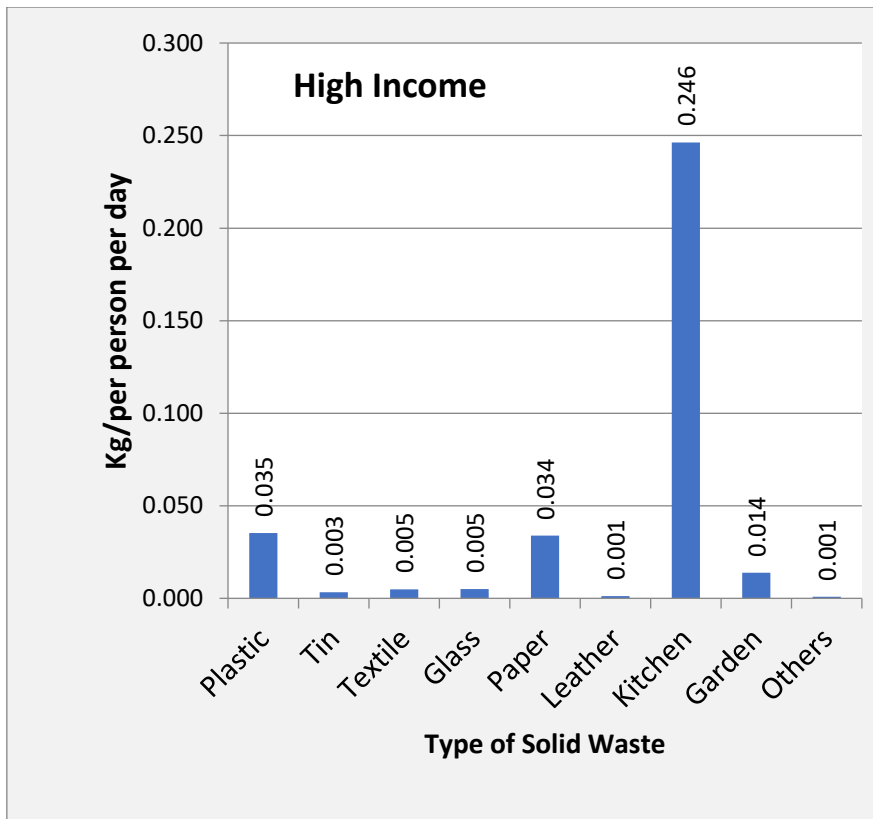


Figure 5. Household Waste Production in Sector G-7, Islamabad by Middle Income Group.

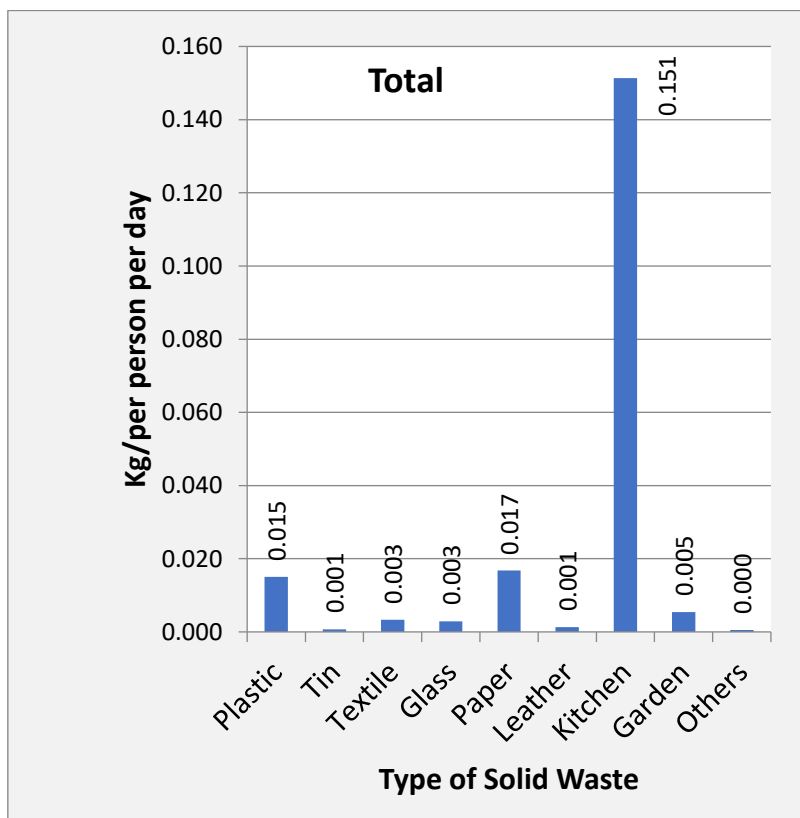


Figure 6. Average Household Waste Production in Sector G-7, Islamabad.



**Table 3.** Amount (in Kg/day) of total Solid Waste produced per day by households in Sector G-7, Islamabad.

Type of solid Waste	% of total	Amount (in Kg/day)			
		Overall (n=837)	According to Income Level of households		
			Low (n=535)	Middle (n=222)	High (n=80)
Plastic	7.60	86.19	49.07	17.42	19.69
Tin	0.37	4.14	1.59	0.70	1.85
Textile	1.69	19.11	12.34	4.06	2.71
Glass	1.47	16.67	10.42	3.40	2.84
Paper	8.50	96.34	52.20	25.20	18.94
Leather	0.65	7.35	6.36	0.31	0.68
Kitchen	76.71	869.62	501.50	230.36	137.76
Garden	2.77	31.38	22.31	1.35	7.72
Others	0.25	2.87	2.32	0.06	0.49
Total	100.00	1133.66	658.10	282.86	192.61

## 7. RECOMMENDATIONS

The Capital Development Authority (CDA) needs to play a catalyst role to improve the SWM system: a) The project for the landfill and composting site should be made operational on priority b) Extensive educational campaign should be launched at household level c) For sorting of waste low cost containers should be designed, manufactured and distributed to all the residents.

CDA should also improve the collection and transportation of the recyclable waste from residents of Islamabad. The existing Kabari and scavengers' activity needs to be regularized and patronized into a proper collection system.

Government must prioritize setting up of more recycling factories throughout the country and encouraging as well as streamlining the re-use of waste materials in the form of fuel or other by products.

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## CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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