

Management of municipal solid waste generated in eight cities of Pakistan

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Abstract— The management of Municipal Solid Waste (MSW) is a major problem in developing countries. Pakistan is also facing the problem of MSW management. The MSW consists of the wastes generated daily by the residential, commercial, and institutional sources. The insufficient collection and improper disposal of MSW can pollute land, air and water and may pose threat to human health and environment. The management of MSW in eight cities of Pakistan was studied. The characterization of MSW of these cities has been discussed. Furthermore, existing pattern of collection, handling, transportation, treatment and disposal of MSW was evaluated for these cities. The study was finally concluded with fruitful suggestions that will be beneficial to encourage researcher and competitive authority to work toward further betterment and contribute to make Pakistan clean.

Index Terms— Municipal solid waste; Solid waste characterization; Pakistan; Waste Management

1 INTRODUCTION

The production of MSW started with the beginning of the civilization. In the earliest periods, the MSW could conveniently but improperly be disposed off in open land spaces. This was due to the fact that a large number of open areas were available due to less population and lack of awareness among people about problems caused by improper management of MSW. However,

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Nowadays, the phenomenon of global urbanization has caused an increase in the MSW. About 1.3_109 t MSW was generated globally in 1990 (Beede and Bloom, 1995), and the present generation is about 1.6_109 t. In Asia, urban population generate MSW about 706-103t per day and it is predicted to increase to 1.8_106 t till 2025 (Pokhrel and Viraraghavan, 2005).

The developing countries neglect the consideration of environmental management during MSW management (Murtaza and Rahman, 2000). These nations are seriously in trouble nowadays due to improper handling of the MSW (Shimura et al., 2001; Sharholy et al., 2007). The management of MSW, mostly in lower and middle income countries, draws a significant proportion of the Municipal budget. The current practices for the management of MSW cause serious threats to the public health and environment (Bartone, 1999). In various developing countries, the operation and management for the MSW collection services are comparatively undeveloped. This reflects the lack of information regarding the quantity and types of MSW collected, recovery amount, recycled and reused, and the selection for MSW dumping sites (Beunorestro et al., 2003).

An efficient and effective planning for the management of solid waste depends upon the gathering of proper and accurate information about its generation and compositions. This type of management involves selection and operation equipments for handling

and treatment and disposal facilities that will allow for resource recovery and energy generation (Chang and Davila 2008). In most developing countries like Pakistan and India, MSW management generally consist primary and secondary collection, these countries openly dump more than 90% of the collected waste. Only 60% of the generated waste is actually collected in most Pakistan and Indian cities. The uncollected waste lies in vacant plots, topographic depressions, along roads, streets and railway lines, drains, open sewers and storm drains within overall urban limits (Adila et al., 2008; Das et al., 2002; Sharholy et al., 2008) Pakistan has population of 160 million, with 65% people living in rural areas and 35% people living in urban areas. Solid waste generated from urban areas of Pakistan is about at 55,000 tons/day (JICA, 2005). Thus, it is estimated that, one-third of the total waste remains uncollected even though the municipal bodies allocate 85-90% of their total budget for collection, handling and transportation activities (Sharholy et al., 2008). The major problem for MSW management of Pakistan include shortage of competitive and trained manpower, lack of research and reliable data, poor administrative arrangements, inadequate regulatory cover, lack of equipments and finance (KOICA - World Bank, 2007). Improper collection and insufficient transportation lead to accumulation of MSW at corner and nook. The MSW is departing to critical phase, due to lack of facilities to treat and dispose. Improper disposal cause adverse impact on human health and all the components of environment. (Rathi, 2006; Ray et al., 2005; Kansal, 2002; Jha et al., 2003; Kansal et al., 1998; Sharholy et al., 2005; Gupta et al., 1998; Singh and Singh, 1998)

1.2 SOLID WASTE EFFECT ON HUMAN HEALTH

The existence of heavy metals in MSW composts can have an effect on some microbiological characteristics of soil such as the structure of the soil micro biota, which are dependable for the transformations production nutrients existing to plants. The sound effects of MSW dung and mineral-N amendments in a 2-year field test on some physical-chemical property, some enzyme activities and the genetic diversity of cropped plots (sugar beet-wheat rotation) and uncropped plots were examined. (Crecchio, C et al 2001) Solid

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waste removal reason a greater complexity because it leads to ground pollution (Qasim. M et al 2014)

Waste management activity effect on human health. Although the main focus is primarily on municipal solid waste (MSW), experience to bioaerosols from composting facilities and to pathogens from sewage treatment plants is considered. The adverse health outcomes for the common population living close to landfill sites, composting facilities and nuclear fixing are usually inadequate and questionable. There is persuasive confirmation of a high danger of gastrointestinal problems linked with pathogens originating at sewage treatment plants. (Crecchio, C 2009) The majority of households store up their waste in open containers and plastic bags in the home. Waste storage in the home is related with the presence of houseflies in the kitchen. The presence of houseflies in the kitchen during cooking is associated with the incidence of childhood diarrhea. Scarce solid waste facilities effect in haphazard burning and burying of solid waste. There is an relationship between waste burning and the incidence of respiratory health sign between adults and children. Poor treatment and disposal of waste are major causes of environmental pollution, which creates breeding grounds for pathogenic organisms, and the increase of infectious diseases. (Boadi, K. O., & Kuitunen, M. 2005). Indoor air pollution somehow caused by the solid waste. (Qasim. M, et al 2013) Solid can be increase the water pollution that caused the diarrhea in rural areas. (Qasim . M ,et al 2014)

1.3 SIGNIFICANT OF STUDY

This paper looks in brief at the current population, per capita MSW, MSW generation, MSW characterization and existing management scenario of MSW in various cities of Pakistan. This study may help in the formulation of appropriate strategies and policies for operating successful Management of municipal solid waste. It could also be useful to researchers, students and persons interested in this sector. Through caring out this research researcher will be able to give many recommendations for future studies of community characteristics to other researchers working in this field. The research also presents and summarizes a relatively large amount of literature on the subject. This study will also be a practical implementation of the knowledge which researcher gained through the academic studies at the university. It may also be a part of the university library and helpful in the future researches.

1.4 STATEMENT OF PROBLEM

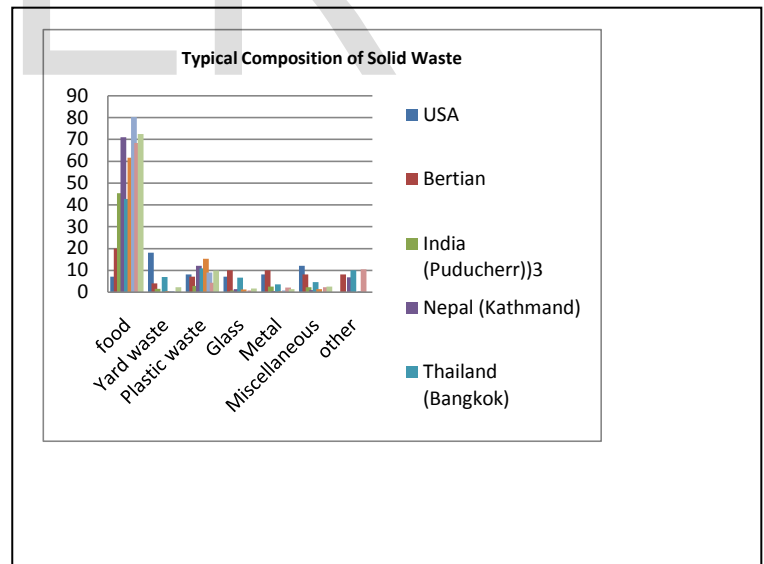
Improper MSW management poses a greater problems because it leads to land pollution if it is openly dump, water pollution if dump in low land and air pollution if it openly burnt. Due to improper collection of MSW cause public health risk and environmental degradation. In Pakistan there is no proper waste collection system. Mostly waste dump in streets, open land areas and drains. There is no proper segregation system of different types of waste. There were not proper controlled sanitary landfills. The people of Pakistan are facing threat due to improper MSW management that is increasing day by day

TYPICAL COMPOSITION OF SOLID WASTE COMPARISON

TABLE 1
TYPICAL COMPOSITION OF SOLID WASTE COMPARISON

mposition	USA	Bertian	India (Puducherr)	Nepal (Kathmandu)	Thailand (Bangkok)	Malaysia (K.Lumpu)	Iran (Rasht)	Bangl (Dhak)
food	7	20	45.3	71	42.6	61.5	80.2	68.3
Yard waste	18	4	1.5	---	6.9	0.4	0.4	
Plastic waste	8	7	2.8	12	10.88	15.3	9	4.3
Glass	7	10	0.7	1.3	6.63	1.2	0.2	0.7
Metal	8	10	2.5	0.5	3.54	0.25	0.7	2.0
Miscellaneous	12	8	2.2	0.9	4.6	1.3	---	2.2
other	---	8	---	6.7	10.04		0.4	10.4

Source (USA):Thomas j .Chichonski and Karen Hill, Ed.Recycling Source-book,1993.Source(UK):Newel,J.Recycling Bertain.New Scientific,September 1920:46.Source: Solid waste management in Asian developing countries: Challenges and opportunities 2012.



2. MATERIALS AND METHOD

2.1 STUDY SITES

2.1. 1 DATA COLLECTION STRATEGY

The data have been collected from Tehsil Municipal Administration (TMA) or relative Solid Waste Department (SWD) of eight cities of Pakistan, namely, "Karachi, Multan, Faisalabad, Lahore, Rawalpindi, Khariyan, Lala musa, Gujranwala" as shown in figure 1. Interviews was conducted from the managers of TMA and

SWD of relative cities and the data was collected about MSW. The collected data was further compared with one another and with those given in literature. The data was collected about MSW generation, physical characterization and existing MSW management system.

2.1.2 POPULATION, TOTAL WASTE AND PER CAPITA MSW WASTE

The population, total waste and per capita waste related contribute in MSW management. In this study we collect information about population, total waste and per capita waste of mentioned cities from TMA and SWD as shown in table 1. Khariyan and Gujranwala have more per capita waste as compared to Lala musa, Rawalpindi, Lahore, Faisalabad, Multan and Karachi.

2.2 CHARACTERIZATION OF MSW

The characterization of MSW play major role in MSW management. The physical characterization of MSW is showed in table 2. According to characterization of MSW, Lahore generated maximum plastic 18.49 % and glass 2.19% , Khariyan generated maximum metal 10% and paper 15%, Karachi generated maximum rags 8.4% , animal waste 3%, Bio waste 30%, Card board 3.4% and wood 3%, Multan generated maximum food waste 32.35% and stones 27.51%, Rawalpindi generated maximum leaves and grass 27%, Gujranwala generated maximum bones 3.2%, Lala musa generated Maximum construction and demolition waste 3.32%, as compared to other mentioned cities of Pakistan.

2.3 STORAGE AND COLLECTION OF WASTE

“Collection is a process in which solid waste is gathered from the storage points and hauled to a transfer station or dumping site” (Kaseva and Mbuligwe, 2005; McDougall et al., 2003). In Pakistan cities, there is improper storage of waste at source. Only house hold things are sort out at local level, while other wastes do not have proper segregation system of MSW. The collection of waste is the responsibility of TMA and Solid Waste Department of relative city as shown in table 3.

A number of municipalities of mentioned cities have deployed the sanitary workers and sweepers. They are working in evening and morning shifts. The workers collected waste from small heaps, dust bins, containers which are used in relative city.. In most cities fraction of waste is not properly collected, remains on streets. Mostly by using man power waste is collected and by brooms, wheelbarrow etc waste transfer into dustbin and Collection points. The number of collection bins such as masonry dust bins, containers etc and trolleys was too less number to accommodate the MSW management system. Furthermore, the collection bins of mentioned cities are not properly located according to population. That’s why open heaps found in mentioned cities.

2.4 TRANSFER AND TRANSPORTATION OF MSW

In Pakistan MSW collected from collection bins and small heaps and its transfer for treatment and disposal sites. For transportation purposes use bullock carts, tractor-trailers, trucks etc., are mainly used for the transportation of MSW. The transportation of MSW was generally of an open body type and was usually kept uncovered, and waste scattered on road during travelling. “Collection and transportation activities constitute about 80-90% of total budget of MSW management. Hence, it is a key compo-

nent in determining the economics of the entire MSWM system. TMA and SWD used their own vehicles for MSW transportation although in sometimes they was hired from private contractors” (Ghose et al., 2006; Siddiqui et al., 2006; Nema, 2004; Bhide and Shekdar, 1998).

2.5 TREATMENT AND DISPOSAL

Existing treatment and disposal management system of mentioned cities of Pakistan is shown in table 3. Furthermore information about existing MSW management system include relative department, collection system, treatment facility, disposal, human and machinery resources

3. RESULTS AND DISCUSSION

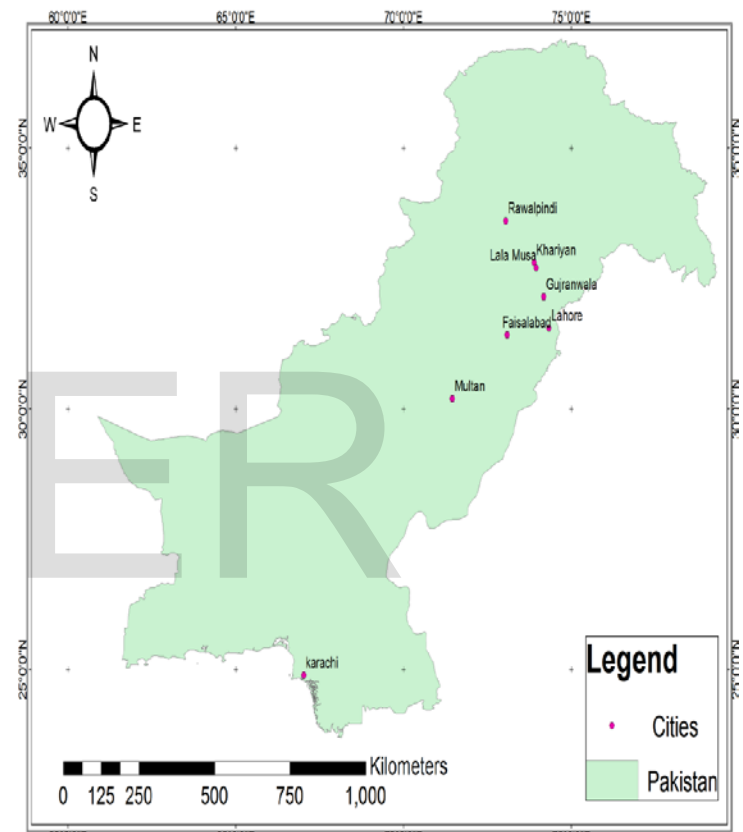


Figure 2: Locations of various cities of Pakistan under study

TABLE 2: POPULATION, TOTAL WASTE, PER CAPITA WASTE OF VARIOUS CITIES OF PAKISTAN UNDERSTUDY

SN	Cities	Population (M)	Total waste(t/d)	Per capita waste (kg/c/d)
1	Karachi	14	8000	0.5714
2	Multan	2.06	1102	0.53
3	Faisalabad	2.7	1359-1500	0.5294
4	Lahore	9.2	1388.89	0.151
5	Rawalpindi	2.5	500-550	0.21
6	Gujranwala	1.85	2000	1.081
7	Khariyan	0.035	90	2.57
8	Lala Musa	1	27	0.027

Source: TMA and relative solid waste management depart-

TABLE 3: PHYSICAL CHARACTERIZATION OF MSW O VARIOUS CITIES OF PAKISTAN UNDERSTUDY

Composition%	Karachi	Multan	Faisalabad	Lahore	Rawalpindi	Gujranwala	Kharian	Lala musa
Plastic	6.40	4.3	4.8	18.4	3	5	10	1.4
Metal	0.75	.3	.2	0.49		.03	10	---
Paper	2.1	2.4	2.10	5.04	1	2.5	15	---
Rags	8.4	6.89	5.2			3.20	----	----
Glass	1.5	.8	1.3	2.19	1	1.5	2	.8
Food waste	21	32.35	17.20	---	----	14.7	2.5	10.8
Animal waste	3	2.65	.80	---	----	1	----	----
Leaves and Grass	14	20.22	15.60	---	27	12.8	15	---
Wood	2.5	1.3	.7	---	---	0.8	5	0.432
Bones	3	1.03	2.9	---	---	3.2	2	---
Stones	3.5	27.51	4.6			5.7	4.5	
unclassified	29	.007	---	5.77	1	47.5	---	14
Textile	6.5	---	---	1	---	---	----	---
Bio waste	30	---	---	---	---	1.8	---	---
Card board	3.4	---	1.6	---	---	---	---	---
Construction and demolition	---	---	---	---	1	---	1.5	3.32

Source: TMA and solid waste department of relative city (2014)

The table presents Physical Characterization of waste at different cities of Pakistan. Majority of Plastic used in Gujranwala. Stones are 27.51 in Multan. Majority of Unclassified is in Rawalpindi about 47.5%. Majority of food waste is in Multan 32.35%. Metal is high in Gujranwala 10%.

TABLE 4 EXISTING MSW MANAGEMENT SYSTEM OF VARIOUS CITIES OF PAKISTAN UNDERSTUDY

City Name	Agency Name	City Waste Management Detail
Karachi	TMA & SWD	<ul style="list-style-type: none"> ➤ TMA and solid waste department collecting, transporting and disposing waste in the city. ➤ 11200 manpower use ➤ 4085 community bin use for collection of waste ➤ Use 567 vehicle for transportation of waste ➤ Three landfills operating by CDGK (city district Government Karachi) ➤ Jam chakro land fill 500 Acer ➤ Gond pass land fill 500 Acer ➤ Razaq Bad land fill 500 Acer ➤ Two incinerator plant at Mewa Sha Capacity 1000kg/hour ➤ TMA Multan and SW management collecting, transporting, and disposing waste
Multan	TMA & SWD	<ul style="list-style-type: none"> ➤ 4500 manpower use ➤ TMA have 26 waste collection point ➤ Plastic bin, Masonry Dust bins, Filth depots & metallic container are used to collect waste

Faisalabad	TMA	<ul style="list-style-type: none">➤ TMA have 400 machinery (including vehicle) are used➤ TMA also have 200 open heaps in Multan➤ TMA have one land fill by the name of Matti-tal road land fill 6 Acer➤ TMA also have two incinerator in Nishter Medical College➤ TMA department collecting, transporting and disposing waste➤ Collection by manual and machinery➤ 3200 Man power➤ 900 ton waste liffiting by Machine and vehicle➤ Improper disposal of hazardous waste➤ Open dumping➤ Improper treatment
Kharian	TMA	<ul style="list-style-type: none">➤ TMA department collecting, transporting and disposing waste➤ 92 manpower use➤ 14 collection point➤ Use human source and machinery for collection and disposal of waste➤ TMA kharian transport waste by vehicle➤ Land fill site Rakh pabi sarkar khairan➤ No treatment plant available at kharian
Rawalpindi	RSWMC	<ul style="list-style-type: none">➤ Rawalpindi solid waste management company (RSWMC) collecting, transporting and disposing➤ HUMAN resources and machinery used in collection transportation activities➤ 4000 manpower use➤ Municipals authorities dump in non engineer site-land fill➤ Improper treatment of waste➤ Private company start generate fuel from garbage and in future Rawalpindi will be Cleaner look
Lala Musa	TMA	<ul style="list-style-type: none">➤ TMA collecting, transporting and disposing waste➤ about 40-60% waste collecting➤ Use manually and machinery assistance➤ 15 manpower use➤ Few collection points➤ 20 steel container➤ Improper waste disposing➤ Improper burning➤ No treatment plant at Lala Musa➤ No Proper land fill at Lala Musa➤ Open heaps➤ Lahore solid waste management department (LSWMD) collecting ,transporting and disposing waste
Lahore	LSWMD	<ul style="list-style-type: none">➤ 630 waste collection points➤ 5500 manpower use➤ use human resources and machine assistance➤ 60-70% waste collecting➤ insufficient treatment➤ 1 engineer land fill and open heaps

Gujranwala	TMA	<ul style="list-style-type: none">➤ TMA Gujranwala collecting , transporting and disposing waste➤ 1130 Man power➤ Human resources and Machinery used in collection and transportation activities➤ 550 machinery used for collection and transportation➤ improper disposal of waste at Land fill➤ No treatment facility available at Gujranwala
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Source : TMA and solid waste management department of relative cities (2014)

The table illustrates city waste management detail in different cities of Pakistan. The big cities such as Karachi, Lahore, Multan, Rawalpindi, and Gujranwala used more manpower than the other cities Kharian and Lalamusa. Machinery used to collecting and disposing the waste. Lahore, Faisalabad and Rawalpindi used improper treatment of waste. All wastes disposal at Land fill.

4. CONCLUSION AND SUGGESTIONS

As a result detailed study of mention cities of Pakistan as shown in table 3, there is improper waste collection, segregation, handling, storage, transfer, transportation, treatment and disposal. Because of lack of awareness, improper setting of container at storage sites, improper size of container, Lack of vehicles, workers, and other machinery, Lack of funding, Negligence of authority ,relax rules and regulation of Pakistan contribute in failure MSW management of Pakistan that's lead to Environmental pollution including water pollution, land pollution etc. To overcome all these problems in MSW Management System of mentioned cities of Pakistan, some important suggestions are given below:

- Proper funding for MSW management system
- Awareness and training of workers and people
- Increased pay of workers and related staff
- Find the ways to implement its effective application of 3 R's (Reduce, Reuse and Recycle)
- Higher Staff should be competitive and professional
- Personal Protective Equipments (PPE's) should be done
- Proper Segregation and Collection system of Waste (covered waste collection system)
- Proper container size and setting at suitable sites
- Proper machinery for lifting, transfer and transportation of MSW
- Waste treatment technologies and method (composting and Waste to energy recovery, Bio Gas formation etc) should be introduce
- Institutional strengthening needs to implemented
- Government should develop monitoring system

ACKNOWLEDGEMENTS

Authors are thankful to TMA and SWD of the mentioned cities understudy that will help us a lot to gather data for the current paper.

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