

## **ASSESSMENT OF MUNICIPAL SOLID WASTE MANAGEMENT PRACTICES IN SAUDI ARABIA**

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### **ABSTRACT**

There is much concern about the problems caused by improper handling and disposal of solid wastes in Saudi Arabia. This article assesses current practices and policies for managing municipal solid wastes in Saudi Arabia. A detailed description and analysis of the municipal solid waste management systems of the two major cities in the Kingdom, Riyadh and Jeddah, is presented.

### **INTRODUCTION**

Saudi Arabia covers some four-fifths of the Arabian peninsula and has an estimated area of 2.15 million square kilometers, including 40 percent rangeland and 1 percent forests. The climate in Saudi Arabia is hot and dry but is mild in winter. The 1993 census places the official total population in Saudi Arabia at 16.0 million of which 4.0 million is foreign. Presently there is much concern regarding municipal solid waste (MSW) problems in Saudi Arabia. This concern is due to the decline in funds allocated for the collection and disposal of MSW, housing and population growth in major cities, and the public's concern about the associated environmental problems generally.

Based on a study prepared by the Arab Institute for Cities Development [1], the total estimated quantity of MSW generated in eleven major cities in Saudi Arabia is more than 9 million metric tons per year. The quantity of solid wastes generated per capita averages 1280 grams per day. The generation of MSW in the cities and towns of Saudi Arabia is expected to rise considerably in coming years.

The typical sources of MSW generation in Saudi Arabia include: 1) households, roads, public places and markets, 2) butcheries, 3) hospitals, 4) industrial plants,

5) animal waste, 6) farming and landscaping wastes, 7) discarded furniture, damaged cars and equipment, and 8) construction and building rubble wastes. The quantities of MSW generated annually at several major cities are presented in Table 1. As shown in Table 1, the construction and rubble wastes constitute approximately 77.0 percent of the annual wastes generated per capita while hospital wastes constitute only 0.3 percent.

The predominant means of disposal of wastes from households, roads, public places, and markets are by burning and then burying in landfills. Roughly 83.0 percent of these wastes are burned and buried in landfills while 12.0 percent is burned only. A small percentage (4.0%) of these wastes typically is disposed of at

Table 1. Quantities of Municipal Solid Wastes Generated at Several Major Cities in Saudi Arabia

Source of Municipal Solid Wastes	Annual Quantity in Metric Tons	Population of the Cities in Thousands (number of cities reporting)	Annual Generation Rate Per Capita in Kilograms (percent of the total)
Households, roads, public places and markets	1474664	3222 [11]	457.7 [16.4]
Butcheries	76107	3317 [11]	22.9 [0.8]
Hospitals	31650	3359 [12]	9.4 [0.4]
Industrial	137258	2645 [7]	51.9 [1.9]
Animal	15500	1035 [5]	15.0 [0.5]
Farming and landscaping	58395	3009 [10]	19.4 [0.7]
Discarded furniture, damaged cars and equipment	237680	3689 [13]	64.4 [2.3]
Construction and building rubble	7101671	3304 [11]	2149.4 [77.0]

**Source:** The Arab Institute for Cities Development, Riyadh, Saudi Arabia

landfills without any burning. The remaining wastes (1.0%) are usually converted to fertilizers.

Nearly one-half (48.7%) of the butcheries' waste is disposed of directly at landfills; 33.4 percent is burned and then landfilled while 17.9 percent is burned but not landfilled. The most common way to dispose of hospital wastes in Saudi Arabia is to burn them before ultimate disposal in landfills (62.8%); 36.9 percent of hospital wastes are burned only, and the remaining 0.3 percent is disposed of at landfills without burning.

Industrial wastes (67.8%) are usually disposed of at specific remote locations located outside the cities, while 30.6 percent of these wastes are placed in landfills after burning and the remaining 1.6 percent is landfilled without any burning. Some 27.0 percent of animal wastes are disposed of at landfills while 7.1 percent is burned. The remaining animal wastes (65.9%) are disposed of by other means. As for farming and landscaping wastes, 66.3 percent is disposed of at landfills after burning and 25.7 percent is burned only. Only 1.5 percent of these wastes is converted to fertilizers. An estimated 5.1 percent is thrown away in remote lowlands. The remaining farming and landscaping wastes (1.4%) are not accounted for.

Most (70.8%) of the discarded furniture, damaged cars, and equipment is gathered at designated locations around the cities; 0.6 percent of these wastes is dumped in lowlands. Only 26.5 percent of these wastes are compacted and used in landfilling operations. The fate of remaining quantity (2.1%) is not known. A large portion of the construction and building rubble wastes (76.0%) is used in road construction and to fill in low-lying areas. The remaining 24.0 percent is discarded in remote locations around the cities.

Municipal administrations of eight cities in Saudi Arabia have let contracts with private companies to collect and dispose of MSW. These companies in most cases are responsible for providing the manpower and equipment needed for the proper management of the MSW systems. Usually there are five manpower categories involved in the management of MSW: 1) ordinary labor, 2) drivers, 3) maintenance technicians, 4) field supervisors, and 5) administrators. Manpower statistics in each category for each of the eight major cities are shown in Table 2. The MSW management systems in the Saudi Arabian cities are heavily labor intensive.

In most smaller cities the municipalities are fully in charge of their own MSW systems. For example, nine cities employ in total 5,772 ordinary workers (of whom 94% are foreign), 455 drivers (70% foreign), 216 maintenance technicians (50% foreign), 304 field supervisors (59% foreign), and 101 administrators (25% foreign). Most of the manpower involved in the management of MSW in Saudi Arabia is foreign. The reason is that most of the locals can easily find jobs, in other sectors, which are financially more rewarding and culturally more respectable.

In the following sections MSW management practices in the two largest cities in Saudi Arabia are described and analyzed.

Table 2. Numbers and Categories of Manpower Involved in Solid Wastes Management

City	Ordinary Labor	Drivers	Maintenance Technicians	Field Supervisors	Administrators
Riyadh	2490	542	492	225	608
Jeddah	1620	390	320	110	75
Qatif	245	59	—	15	2
Tabuk	600	60	40	60	40
Khobar	1248	175	—	31	4
Alahsa	866	143	36	50	25
Industrial Jubail	176	57	62	31	51
Industrial Yanbu	121	60	6	23	12
<b>Total</b>	<b>7366</b>	<b>1468</b>	<b>956</b>	<b>545</b>	<b>817</b>

Source: The Arab Institute for Cities Development, Riyadh, Saudi Arabia.

## SOLID WASTES MANAGEMENT IN RIYADH

Concern about problems of solid wastes in Riyadh has recently prompted the Ministry of Municipal and Rural Affairs to request statements of interest and conceptual proposals for waste management systems from private companies involved in the management of solid wastes. The Ministry is interested in a MSW system that is economically sound and environmentally safe. Since the composition of the wastes, as will be shown later, constitutes a significant portion of recyclable materials the Ministry requires that the proposed MSW system include processes to recycle, recover for beneficial use, or otherwise divert from landfill disposal a significant portion of the system's average throughput tonnage.

### Background

Riyadh is located in the central Najd region of the Kingdom of Saudi Arabia. It is the largest city in the Kingdom with a population estimated at 2.3 million in

1991. The hottest month is July with an average daily minimum and maximum of 26-42 degrees centigrade. The coldest month is January with an average daily minimum and maximum of 8-12 degrees centigrade. The driest months are July, September, and October (0 millimeter average rainfall) and the wettest month is April with 25 millimeter average rainfall.

Currently, Riyadh relies on two major landfills for the disposal of more than 2.0 million metric tons of MSW annually. The locations of landfills in Riyadh are provided in Table 3. The Ministry is planning to construct a new landfill located in the eastern sector of the city. It is expected to be in operation by mid 1996.

### Current Waste Management System

The quantity of MSW generated in Riyadh has been steadily increasing due to increased population and a higher per capita generation rate. Per capita generation rates are approximately 2.2 kilogram per person per day, exclusive of demolition materials. This high per capita waste generation rate, compared to the national average of 1.3 kilograms per person per day, is attributed to social and economic factors pertinent to the region where Riyadh is located.

Refuse collection is provided by the Ministry and a private contractor without direct charge to the residents. Recycling activities operated in the City by private firms divert relatively small amounts of materials from landfill disposal. Current landfill capacity is estimated to be six to ten years. The new landfill which is expected to be ready for MSW disposal by mid 1996 will add an expected additional twenty years of landfill capacity.

### Waste Composition

The quantity and composition of refuse generated in Riyadh shows a seasonal variation, primarily due to differing climatological conditions and religious holidays. The waste transferred to landfills is estimated to be 55 percent household and commercial and 45 percent construction and demolition waste. Approximately composition of waste in Riyadh is shown in Table 4. As shown in Table 4 food residues constitute the largest percentage of waste (34%) followed by paper

Table 3. Landfills in Riyadh

Name	Location	Area in Hector	Operation
TANGO (1)	25 Km South	70	1977-1985
TANGO (2)	25 Km South West	90	1982-
TANGO (3)	25 Km South	75	1985-

Source: AL-Dar-Al-Saudia for Consultation Services, Riyadh, Saudi Arabia, 1984.

Table 4. Approximate Composition of Waste in Riyadh

Contents	Percentage by Weight
Paper and cardboard	32
Food residues	34
Metals	7
Plastic materials	6
Glasses	3
Rubber and leathers	4
Textiles	3
Wood	5
Mixed non-organic	6
Moisture	25-35%
Density	250-350 Kg/m <sup>3</sup>

Source: AL-Dar Al Saudia for Consultation Services, Riyadh, Saudi Arabia, 1984.

and cardboard waste (32%). The quantities and volumes of the wastes generated in Riyadh are presented in Table 5. The figures in Table 5 reveal that there will be an increase in the generation of household and commercial waste, the number of junk cars, and household appliance discards in the future while the amount of construction and demolition waste will decrease, due to the fact that most of the infrastructure of the city has already been built.

### An Integrated Environmental Waste Management System

Presently, the Ministry is in the process of developing an integrated environmental waste management system that utilizes recycling, composting, and resource recovery to manage the MSW of Riyadh and reduce dependence on landfill disposal of solid wastes. The goal of the Ministry is to recycle a significant portion of the wastes handled by the proposed system in support of the Ministry's 25 percent recycling goal.

The specific objectives of the system include the minimization of the long term waste disposal costs; reducing Riyadh's dependence on landfill disposal for solid wastes and maximizing the amount of waste diverted by recycling, composting, and materials recovery systems; acquiring enough dedicated capacity to accommodate the entire waste stream during emergency or unscheduled system outages; processing a minimum of 450 metric tons per day of MSW; controlling air

Table 5. Quantities and Volumes of Waste in Riyadh

Waste Type	Year		
	1984	1989	1994 <sup>a</sup>
<b>A. Quantity of Waste Produced in Thousand Ton</b>			
Household and commercial	1500	1900	2350
Construction and demolition	8400	7300	6350
Junk cars	21.4	53.6	66.0
Junk of household appliances	2.1	5.4	6.6
<b>B. Volume of Waste in Thousand cubic meter</b>			
Household and commercial	2700	3400	4200
Construction and demolition	5700	4900	4300

<sup>a</sup>Expected

Source: AL-Dar Al-Saudia for Consultation Services, Riyadh, Saudi Arabia, 1984.

emissions and ash resulting from any waste-to-energy or other incineration technology facilities; and determining the quantities of paper, wood, metals, glass, plastics, and other products, to be recovered and/or recycled by the system or facility, and determining the potential markets for the end product.

## SOLID WASTE MANAGEMENT IN JEDDAH

There has been a substantial increase in the population of Jeddah. In 1947 the population was 35,000; it was 1.25 million by 1980. The 1989 estimates put the population of Jeddah at 1.45 million. The Municipality of Jeddah has the responsibility to supervise the collection and disposal of city refuse.

### Background

The city of Jeddah is located in the western part of Saudi Arabia. Jeddah is considered to be the commercial capital of the country. Many people from all over the world visit Jeddah during the Hajj season. There are two major landfills, one is located south of the city and the other north. The area of each landfill is about 300,000 m<sup>2</sup>. In the early nineteen-eighties the Municipality of Jeddah approved the installation of three mechanically controlled incinerators with a capacity of 300 metric tons per day.

## **Waste Composition**

A study had been prepared by Khan and Bayunus analyzing the composition of solid wastes in the city of Jeddah [2]. They reported that the average waste generation rate from residential sources is 2.2 pounds per capita per day, of which food material comprises 49 percent, paper and cardboard, 24.1 percent, metals 11.0 percent, glass 4.4 percent and other items 11.5 percent.

Additionally, with respect to waste component recovery and reuse, the study has indicated that about 5500 lbs/day of glass, 132,300 lbs/day of cardboard, 147,700 lbs/day of ferrous materials and 30,900 lbs/day of nonferrous materials, together comprising approximately 18 percent of the 2,007,400 lbs/day total residential wastes, can be recovered and recycled.

## **Current Waste Management System**

The present MSW collection and disposal system in Jeddah, as the one in Riyadh, is labor intensive which increases the collection cost. Additionally collection frequencies are not defined and there is no optimum scheduling and routing of vehicles, which results in uneconomic utilization of labor and equipment.

Presently the Municipality of Jeddah has a contract with a private company to manage its solid wastes. The responsibilities of the company as reported by the former Mayor of the City of Jeddah and his cleansing consultant [3] include the collection, transporting, and disposing of all generated and accumulated refuse and waste (domestic, commercial, industrial, as well as building rubble, damaged cars, and other metal bulky household waste).

The company is also in charge of cleaning and sweeping the streets, disposing of dead animals, and vacuuming any water from any source causing flooding or ponding of the streets and open land. Cleaning and maintaining all buildings of the central and sub-municipalities as well as public toilets and monuments are also the responsibilities of the private company.

Additionally, the company has to operate the Municipality workshops, and maintain and repair all existing cleansing equipment and vehicles. The company has to control the extermination of insects, rodents, rats, and stray dogs under the internationally acknowledged regulations for public health. It is also the responsibility of the company to construct a proper number of fully mechanized transfer stations where operational circumstances dictate their use. The company is also in charge of the management and operation of all final disposal sites which include mechanical incinerators and two sanitary landfills for the north and south of the city.

## **SUMMARY AND CONCLUSIONS**

Presently the municipalities of cities and towns in Saudi Arabia are concerned with the improper collection, handling, and disposal of municipal solid wastes.



This concern is due to the decline in funds allocated for the collection and disposal of municipal solid wastes, residential and population growth in major cities, and public concern about the environment.

The sources, quantities, and disposal methods of municipal solid wastes in Saudi Arabia have been presented and discussed. Larger cities in Saudi Arabia usually depend on private companies to collect and dispose of their municipal solid wastes while smaller cities run their own municipal waste systems. The municipal solid waste management systems in Saudi Arabian cities are heavily labor intensive, and most of the manpower involved in the management of municipal solid wastes is foreign.

The management practices of municipal solid wastes in the two largest cities in Saudi Arabia, namely Riyadh and Jeddah, have been identified and discussed. The wide regional differences in climate, the character of the wastes, and types of housing, such as the presence of large number of flats in high rise buildings in congested parts of Jeddah compared to Riyadh's limited numbers of this type of housing but large housing units scattered all over the city, require that the two cities develop municipal solid waste systems tailor-made to their own physical and economic environments.

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