PLANNING FOR MUNICIPAL SOLID WASTE MANAGEMENT OF JAIPUR CITY, RAJASTHAN STATE

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF URBAN AND RURAL PLANNING

By

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CERTIFICATE

Certified that the report entitled **"PLANNING FOR MUNICIPAL SOLID WASTE MANAGEMENT OF JAIPUR CITY, RAJASTHAN STATE",** which has been submitted by **Mr. GANPAT LAL SUTHAR**, for partial fulfilment of the requirement for the award of the degree of **Master of urban and Rural Planning**, submitted in the Department of Architecture and Planning, Indian Institute of Technology- Roorkee, is his own work done by him under my supervision and guidance. The matter embodied in this dissertation has not been submitted by him for the award of any other degree of this or any other institute.

Date: 14-06-2012

Place: Roorkee

Prof. Rajesh Chandra 14/6/12

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CANDIDATES DECLARATION

I hereby certify that this report entitled **"PLANNING FOR MUNICIPAL SOLID WASTE MANAGEMENT OF JAIPUR CITY, RAJASTHAN STATE"**, which has been submitted in partial fulfilment of the requirement for the award of the degree of **Master of urban and Rural Planning**, submitted in the Department of Architecture and Planning, Indian Institute of Technology- Roorkee, is an authentic record of my own work carried out during the period from July 2011 to June 2012, under the supervision and guidance of **PROF. RAJESH CHANDRA ,** Department of Architecture and Planning, Indian Institute of Technology, Roorkee, India.

The matter embodied in this dissertation has not been submitted by me for the award of any other degree of this or any other institute.

Date: 14-06-2012

Place: Roorkee

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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ACRONYMS

CPCB	:	Central Pollution Control Board
EPA	:	Environment Protection Act
ISWM	:	Integrated Solid Waste Management
JDA	:	Jaipur Development Authority
JNNURM	:	Jawaharlal Nehru National Urban Renewal Mission
JMC	:	Jaipur Municipal Corporation
Kg/c/day	:	Kilogram per Capita per Day
LSG	:	Local Self Government
MSWM	:	Municipal Solid Waste Management
MoEF	:	Ministry of Environment and Forests
MTpd	:	Metric tonne per day
MSW	:	Municipal Solid Waste
MSWMS	:	Municipal Solid Waste Management System
NGO	:	Non Government Organization
NUSP	:	National Urban Sanitation Policy
RDF	:	Refuse Derived Fuel
RSPCB	:	Rajasthan State Pollution Control Board
RUIDP	:	Rajasthan Urban Infrastructure Development Project
SLF	:	Sanitary Landfill Facility
TPD	:	Tonne per day
UDH	:	Urban Development and Housing

EXECUTIVE SUMMARY

Solid waste management is one among the basic essential services provided by municipal authorities in the country to keep urban centers clean. However, it is among the most poorly rendered services in the basket—the systems applied are unscientific, outdated and inefficient; population coverage is low; and the poor are marginalized. India is the second most populated country in the world with 1.2 Billion populations and also the second fasted growing economy. For the first time since Independence, the absolute increase in population is more in urban areas that in rural areas. Rural – Urban distribution is 68.84% & 31.16%. Level of urbanization increased from 27.81% in 2001 Census to 31.16% in 2011 Census. The proportion of rural population declined from 72.19% to 68.84%. The decadal growth rate of population from 2001 to 2011 is 17.59% and at the same rate, the population will be approx. 1673.73 million in 2031, and urban population at the decadal growth rate 31.82%, will be approx. 665 million by 2031.

There are total 423 class I cities in India which have population more than 100000. Class I cities include 7 mega cities (which have a population of more than 4 million), 28 metro cities (which have a population of more than 1 million), and 388 other towns (which have a population of more than 100,000). The class I cities alone contribute to more than 72.5 percent of the total municipal solid waste (MSW) generated in urban areas. Per capita waste generation in India is about 0.46 kg (MOUD, 2005) and as a general assumption at present population, total waste generation in India is about 556600 MTpd, and this is expected to rise to 769916 MTpd by 2031. According to the report by World Bank, it will be 440,460 tonnes/day by the year 2026 (Hoornweg & Laura, 1999).

This high increase in the amount of Municipal Solid Waste generated is due to economic growth, changing lifestyles, food habits and living standards of the urban population. The collection efficiency ranges between 70% and 90% in the major metro cities in India, whereas in several smaller cities, the collection efficiency is much below 50% (CPHEEO, 2000). The majour problem of the waste management is its disposal system and, it has been observed that Indian cities dispose of their waste in open dumps located in the outskirts of the city. This creates major problems to environment and public health. Further, the financial and infrastructural constraints, which includes non-availability of land for sanitary landfill sites, and the lack of awareness to public as well as the municipal employees also creates major hurdles in safe waste management system.

Jaipur better known as the 'Pink City', is the capital and largest city of the Indian state of Rajasthan. The city was founded in 1727 by Maharaja Sawai Jai Singh for the population of approx 50000 and now it accommodates more than 3 million people. According to National Urban Sanitation Policy-

2008, Jaipur is ranked at 230th position out of total 423 cities surveyed in sanitation condition. The worst affected urban service in the city is the solid waste management.. Solid waste management is one of the major headaches for any municipal corporation in India and Jaipur is also one of the examples of most neglected waste management system. The waste generation in Jaipur city is around 1200 MTpd and the collection efficiency is about 80% (JMC), which is projected to rise 3643 MTpd by 2021 (CDP, 2006) . Development research group also figured out the waste generation around 1740 MTpd and collection efficiency to only 50%. There is one treatment plant also, with private sector partnership (Grasim Industries) a new refuse derived fuel paletization unit has been set up Lengriyawas sanitary landfill site with 500mtpd capacity. Due to poor collection of MSW and several operational problems, this plant is not able to run its full capacity. Most of the waste is disposed in three uncontrolled open landfills sites at the outskirts of the city. In absence of proper sanitary landfill sites, these landfills are a major source of groundwater contamination and air pollution. In this report, author tried to figure out this most neglected system in India and carried out a special study of waste management in Jaipur city. The report compiled with the study of different types of waste, waste generation phenomenon in different countries, the differences in the waste generation rates and common waste management practice in India and abroad. The report has general introduction to Jaipur city with its geography, demography, climate, economy and infrastructures. The national urban sanitation policy has mentioned Jaipur as the worst sanitized city in India which also mentioned in the report with all the details of the policy. A detailed study has been carried out to understand the real situation of solid waste management in Jaipur city and current scenario with every stage of the system. The current waste management system in Jaipur and its effects has been discussed and finally the guidelines and proposals for better waste management system with special considerations to walled city have been given in the last section of the report.

Jaipur is one of the best planned cities in the world, but it is also a sour truth that the city is one of the worst managed cities in the world. The worst affected urban service in the city is the solid waste management. Solid waste management is a worldwide phenomenon. It is a big challenge all over the world for human beings. Solid waste management is also one of the most ignored services in Indian cities. Jaipur is one of the top city in terms of per capita waste generation in India. Some of these wastes have been proved to be extremely toxic and infectious. One of the worst about Jaipur's waste management is its open dump phenomenon. The uncontrolled and unscientific dumping of such wastes has brought about a rising number of incidents of hazards to human health. The city also generates lots of commercial waste which includes hazardous waste also. The management is not following strict rules and regulations for segregation and disposal of these wastes. More serious

risk to human health is envisaged due to contamination of surface and ground water. The problem of municipal solid waste management (MSWM) is also prevailing throughout the urban environment of Jaipur and need to improve at the large scale. The old city, one of the Heritage structure on Indian urban environment is worst affected area of negligence. The city is one of the best commercial hub in the state but it has worst affected area due to negligence of proper management. Therefore the present study was taken to find out the problems and prospects of Municipal solid waste in Jaipur city.

This study examined the present status of waste management in India, Waste management practices in India and abroad, legal frameworks applicable in waste management in India, plastic nightmare and its effects on public health and the environment, and the prospects of introducing improved means of disposing municipal solid waste (MSW) in India.

This report is the result of one year of research and includes data collected from the literature, communication with professionals in India, and field investigations by the author in Jaipur. One field visit in Jaipur over a period of one week covered waste management practice in Jaipur city and disposal site assessment. The visit included travelling to informal recycling hubs, waste dealers shops, composting facilities, unsanitary landfills, and Jaipur municipal corporation office. The visit provided the opportunity to closely observe the impact of waste management initiatives, or lack thereof, on the public in Jaipur.

The main objective of the study was to find out the current situation of waste management practice in Jaipur and compare it with the legal framework in India. The guiding principle of this study is that "responsible management of wastes must be based on Solid Waste Management and Handling rules 2000". The Solid waste management handling rules 2000 compliance report by P. U. Asnani shows that the Municipal Corporations in India are far behind from implementing the regulations and Jaipur is also one of these.

In the final section of the report, a proposal for municipal solid waste management has been given with special consideration to walled city. A proposed locations of community bins (which include three colours bins for collection of biodegradable, non-biodegradable and recyclable materials) and vehicles routes to collect the waste from these bins have been marked. The proposal includes both the general guidelines for solid waste management practices and a specific planning for the waste management in walled city Jaipur.

Chapter 1. INTRODUCTION

1.1 Background

Solid Waste Management is very expensive municipal services for any municipal corporation it is a compulsory task for municipal authority and it consumes almost 1% of GNP in the urban areas. About four to six persons per 1000 population are required to handle this amenity, which is about 1% to 2% of the total National Work Force.

In early time before the industrialization, waste was composed mainly of ash from fires, woods, bones, bodies and vegetable materials. It was usually dumped in the ground where it would act as compost and help to improve the soil fertilization. As city populations grew, areas for disposal decreased, and people began developing necessary waste disposal systems. Athens and Rome are the best examples of ancient civilizations that instituted different waste management systems.

People were unaware that solid waste was a threat until urban populations increased. As cities began to develop, citizens burned their waste trash, buried it, or let keep it pile up. As waste piled up in urban settings, this resulted filth caused stench, harbored rats and other pests, led to adulterated water supplies and much human disease. Some of the top plagues to ever impact humanity resulted from these issues. Some of the earliest well organized waste management techniques developed during this period to break this and prevent further disease.

In rapidly urbanizing cities of the developing nations, problems and issues of municipal solid waste management are of immediate importance. Most governments have appreciated the importance of waste management; however, high population growth overwhelms the capacity of most municipal authorities to provide even the most basic services.

High population growth and industrial development have created some serious waste management problems in the cities of developing nations like India. The heavy quantity of waste generation requires a system of collection, storage, transportation and disposal. Knowledge required of what is the composition of waste, and process of disposal. Energy generation, recycling of waste, and job openings from waste management also have tremendous potential. However, it has been widely noticed that the municipal corporations in India do not have sufficient resources or the technical expertise required to handle this problem. Successful waste management system requires the contribution of citizens, local governments, and entrepreneurs. The rapid increase in the population and high income growth in India has changed the lifestyle of urban residents, thus changing the quantity and composition of the garbage generated. The presence of paper, plastic and metal is on the rise, which resulted more disposal difficulty. Scavengers and rag pickers have helped the

municipalities with the collection of the garbage generated, since they collect it from households to waste dumps and carry out the important function of waste segregation.

In country like India, solid waste management is at very poor level as the systems adopted are old and inefficient, institutional weakness, shortage of financial support, improper choice of technology, less coverage and lack of planning policies. The city of Jaipur is also facing these deficiencies in varying levels and there is a need to make significant improvement in the municipal solid waste practices existing in the city to improve the standards of health, sanitation and urban environment running with rapid urbanization and growing population.

1.2 Defining need for the study

Jaipur known as the best planned cities in the world, but it is also a sour truth that the city is one of the worst managed cities in the world. The worst affected urban service in the city is the solid waste management. It is a big challenge all over the world for human beings. It is also one of the most ignored services in cities. With the rapid growth of population and modern life style, there has been a significant increase in the generation of solid waste resulting into environment and land pollution. Situation of Jaipur MSW is not different. Jaipur is one of the top cities in terms of per capita waste generation in India. Some of these wastes have are extremely hazardous and infectious. One of the worst about Jaipur's waste management is its open dump phenomenon. The city also generates lots of commercial waste which includes hazardous waste also. The management is not following strict rules and regulations for segregation and disposal of these wastes. The problem of municipal solid waste management also exists throughout the urban environment of Jaipur and need improvements. The old city, one of the Heritage structure on Indian urban environment is worst affected area of negligence. The city is one of the best commercial hub in the state but it has worst affected area due to negligence of proper management. Therefore the present study was taken to study the problems and prospects of MSW in Jaipur city with special consideration of walled city area.

1.3 Study area at a glance

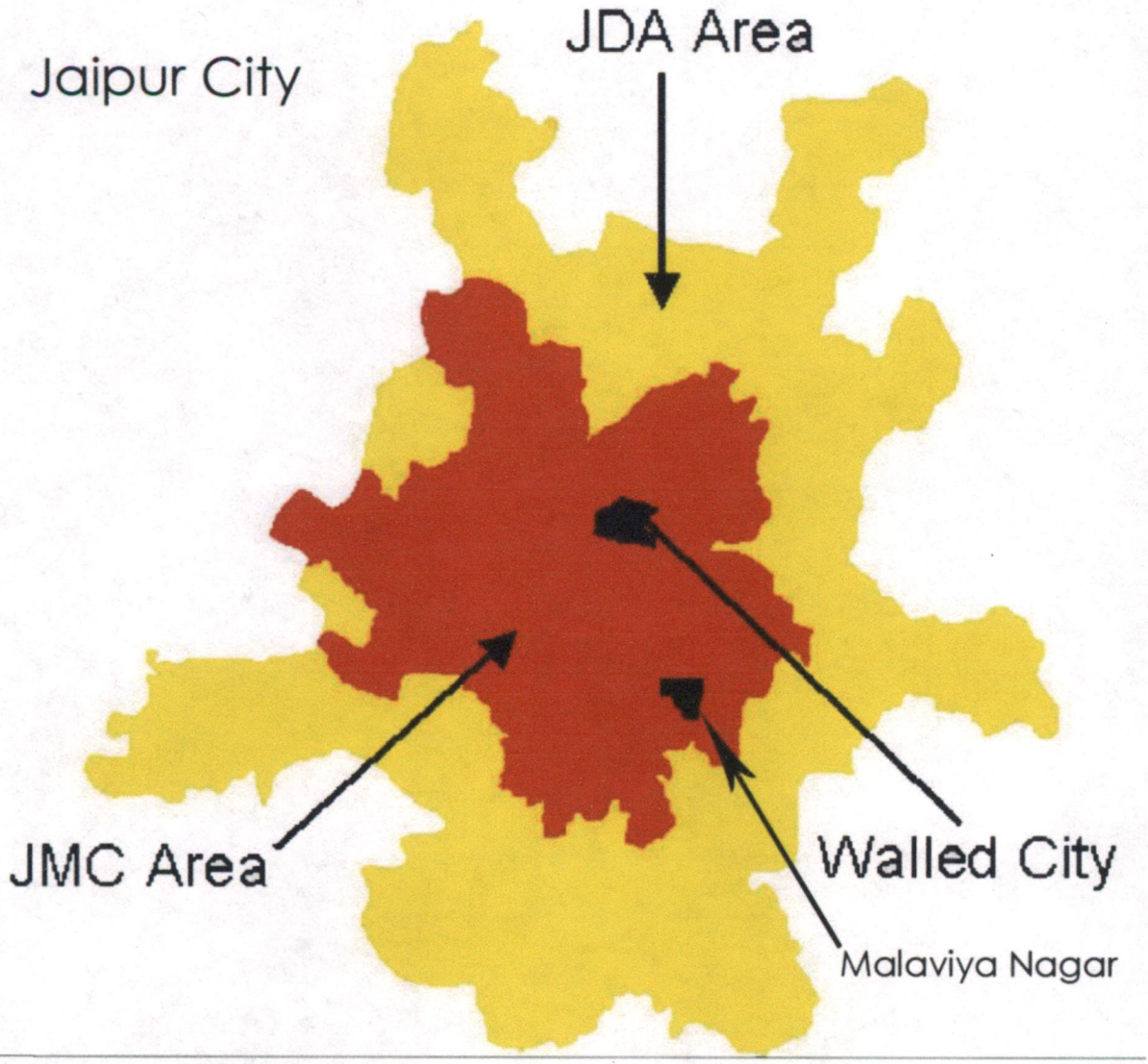


Figure 1.1: Study area map

Table 1.1: Area and populations of walled city, JMC and JDA area

S.No.	Area	Total Area (sq. km.)			Total Population (Million)		
		1991	2001	2011	1991	2001	2011
1.	JMC	218.3	288.4	391	1.52	2.32	3.07
1a.	Walled City	6.7	6.7	6.7	0.5	0.4	NA
1b.	Rest of JMC	192.3	281.7	384.3	1.02	1.92	NA
2.	Rest of JDA	1220	1149.9	1568	0.35	0.36	0.43
3.	Total JDA	1464	1464	1959	1.87	2.68	3.5

Study Area includes total JMC area and survey study includes walled city and Malaviya Nagar area. The special proposals have been given for the walled city area.

1.4 Objectives of the study

1. To understand the solid waste phenomenon,
2. To study the MSWMS in developed countries and developing countries.
3. To assess of existing solid waste management system of Jaipur,
4. To study the available resources and infrastructure pertain to waste management system in Jaipur,
5. To identify the major problems related to MSWM in Jaipur, and
6. To evolve the set of policy guidelines and suggest feasible solutions for the improvement in Municipal Solid Waste Management in Jaipur.

1.5 Scope and limitation of the study

1. The scope of the study is limited to the Municipal Solid waste of Jaipur city
2. It does not include agricultural, industrial and hospital waste of the city.
3. Study area includes Jaipur Municipal Corporation boundary with special consideration of old city but does not include total JDA area.

1.6 Research Methodology

The following methodology was employed in this dissertation. At the outlet, a literature review was done on four main areas:

1. Solid waste phenomenon and types,
2. Municipal Solid waste and waste generation rates in different countries,
3. Waste management practices in developed countries,
4. Waste management practices in India with a case study of one best practice.

For the collection of data, two methods used, Secondary data collection from websites, books, journals, reports etc. and then a detailed field and household surveys were carried out in Jaipur city for the primary data collection. After the getting all the required data and having done literature

review, analysis part has been completed with use of the different tools and techniques. After the analysis, some results occurred and after discussing these results, got some issues and findings which later resolved in the proposals and guidelines part.

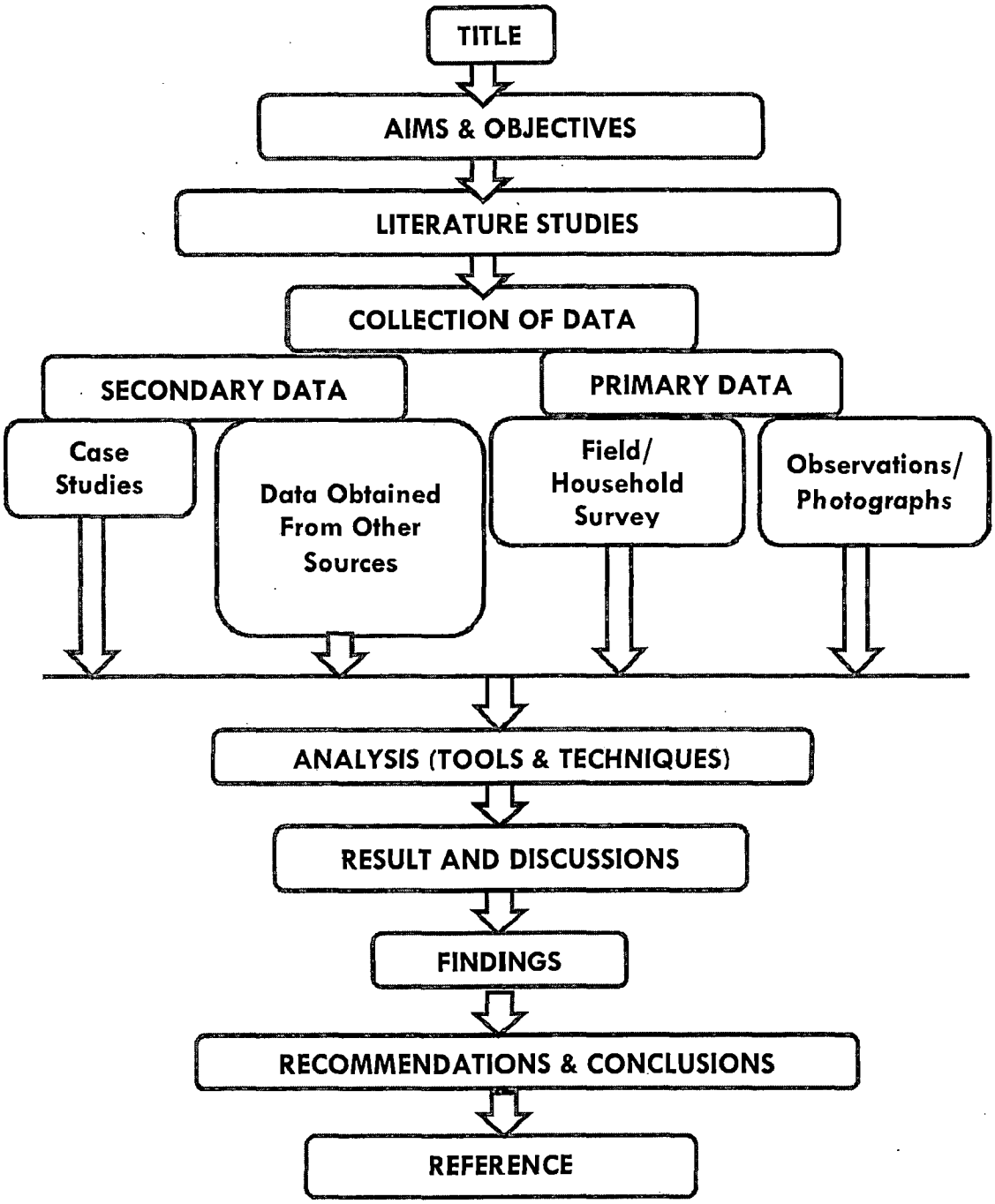


Figure 1.2: Research Methodology

Chapter 2. BASICS OF SOLID WASTE

2.1 Solid waste phenomenon

Since the beginning of the world and civilizations, humankind has been generating waste, be it the bones and other parts of animals they slaughter for their livelihood or the wood they cut to make their carts and shelters. At the end of the 19th century the industrial raised the number of consumers. Not only did the air get more and more polluted but the earth itself became more polluted with the generation of various non-biodegradable and non-recyclable wastes. The increase in population and urbanization was the main responsible reason for the increase in solid waste.

2.2 Definition of waste

- ✓ It is a trash, garbage and other solid discarded materials.

  www.answer.com

- ✓ Being considered of no further use in relation to the original purpose of a mechanism. It is unwanted or useless materials.

  www.wikipedia.com

- ✓ "Refuse from places of human or animal habitation." Defined by.

  Merriam-Webster

- ✓ "Useless or worthless material; stuff to be thrown away."

  World Book Dictionary

- ✓ "A resource that is not safely recycled back into the environment or the marketplace." This definition takes into account the value of waste as a resource, as well as the threat unsafe recycling can present to the environment and public health.

  Zero Waste America

2.3 Solid Waste categories based on source

It can be classified as,

- Municipal waste generally known as Household waste
- hazardous waste is an Industrial waste
- hospital waste or biomedical waste or infectious waste

Table 2.1: Solid waste categories based on source

Source	Typical facilities, activities, or locations where wastes are generated	Types of Solid waste
Agricultural	Field and row crops, orchards, vineyards, diaries, feedlots, farms, etc	Spoiled food wastes, agricultural wastes, rubbish, and hazardous wastes
Industrial	Construction, fabrication, light and heavy manufacturing, refineries, chemical plants, power plants, demolition, etc.	Industrial process wastes, scrap materials, etc.; nonindustrial waste including food waste, rubbish, ashes, demolition and construction wastes, special wastes, and hazardous waste.
Commercial and Institutional	Stores, restaurants, markets, office buildings, hotels, auto repair shops,	Paper, cardboard, plastics, wood, food wastes, glass, metal wastes, ashes, special wastes, etc.
Hospital Waste	Hospital waste refers to all waste generated, discarded and not intended for further use in the hospital.	General waste, Pathological waste, Infectious waste, Sharps, Pharmaceutical waste, Chemical waste, Radioactive waste
Municipal solid waste	Includes residential, commercial and institutions	Special waste, rubbish, general waste, paper, plastics, metals, food waste, etc.

2.3.1 Hazardous waste

Industrial and hospital waste is comes in this category. Some types of household waste are also considered as hazardous. *Hazardous wastes could be highly toxic to humans, animals, and plants; are corrosive, highly inflammable, or explosive; and react when exposed to certain things e.g. gases.* In India, around 7 million tons of hazardous wastes are being generated every year, most of which is generated in four states: Andhra Pradesh, Bihar, Uttar Pradesh, and Tamil Nadu.

Household wastes like batteries, shoe polish, paint tins, old medicines, and medicine bottles are considered as hazardous waste. In Industries, hazardous waste is the metal, chemical, paper, pesticide, dye, refining, and rubber goods industries.

2.3.2 Hospital waste

Hospital waste, which is also a kind of hazardous waste, is generated during various medical activities like diagnosis, treatment, or immunization of human beings or animals or in research activities in these fields or in the production or testing of biologicals. Includes wastes like sharps, soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, etc. These are in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc.

The hospital waste is highly infectious and can be a serious threat to human health if not managed in proper scientific and discriminate manner. It has been roughly estimated that of the every 4 kg of waste generated from hospital contain about 1 kg of infected hazardous waste.

2.4 Municipal solid waste (MSW)

Municipal solid waste (MSW), which is commonly known as **trash** or **garbage** is a waste type consisting of everyday items we consume and discard.

Municipal solid waste consists of household waste, sanitation residue, construction and demolition waste and waste from streets. This garbage is generated mainly from residential and commercial units.

- It mainly includes food wastes, yard wastes, containers and product packaging, and other miscellaneous inorganic wastes from residential, commercial, institutional, and industrial sources.
- Examples of inorganic wastes are appliances, newspapers, clothing, food scrapes, boxes, disposable tableware, office and classroom paper, furniture, wood pallets, rubber tires, and cafeteria wastes.
- Municipal solid waste does not include industrial wastes, agricultural wastes, and sewage sludge.
- The collection is performed by the municipality within a given area. They are in either solid or semisolid form.
- The term residual waste relates to waste left from household sources containing materials that have not been separated out or sent for reprocessing. Following are the different types of wastes.

2.4.1 Different types of Municipal Solid Waste

Table 2.2: Different types of municipal solid waste

SN.	Type of waste	Sources
1.	Biodegradable waste:	Food and kitchen waste, green waste, paper (can also be recycled).
2.	Recyclable material:	Paper, glass, bottles, cans, metals, certain plastics, etc.
3.	Inert waste:	Construction and demolition waste, dirt, rocks, debris.
4.	Composite wastes:	Waste clothing, Tetra Packs, waste plastics such as toys.
5.	Domestic hazardous waste (also called "household hazardous waste") & toxic waste:	Medication, e-waste, paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertilizer and pesticide container, batteries, shoe polish.

2.4.2 Time taken for degradation of waste

Table 2.3: Time taken for degradation of waste

The type of waste we generate and approximate time it take to degenerate	
Type of litter	Approximate time takes to degenerate
Organic waste such as vegetables, fruit peels, leftover foodstuff, etc.	A week or two
Paper	10-30 days
Cotton cloth	2-5 months
Wood	10-15 years
Woolen items	1 years
Tin, Aluminium, and other metal items	100-500 years
Plastic	One million years
Glass bottles	undetermined

2.4.3 Urbanization and waste

Table 2.4: Urban and rural population of India (Census, 2011)

	2001	(%) of Total	2011	(%) of Total	Difference
Total(Cr)	102.9	100	121.0	100	18.1
Rural	74.3	72.2	83.3	68.84	9.0
Urban	28.6	27.8	37.7	31.16	9.1

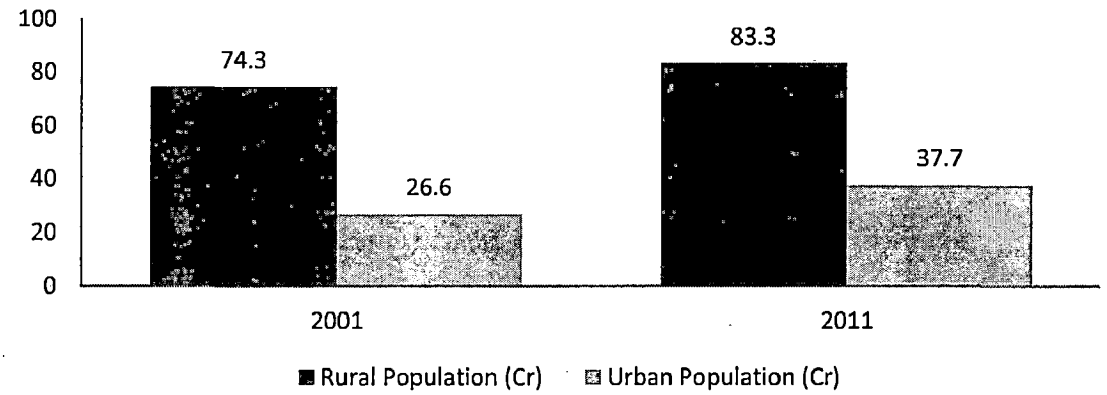


Figure 2.1: Urban and rural population of India (Census, 2011)

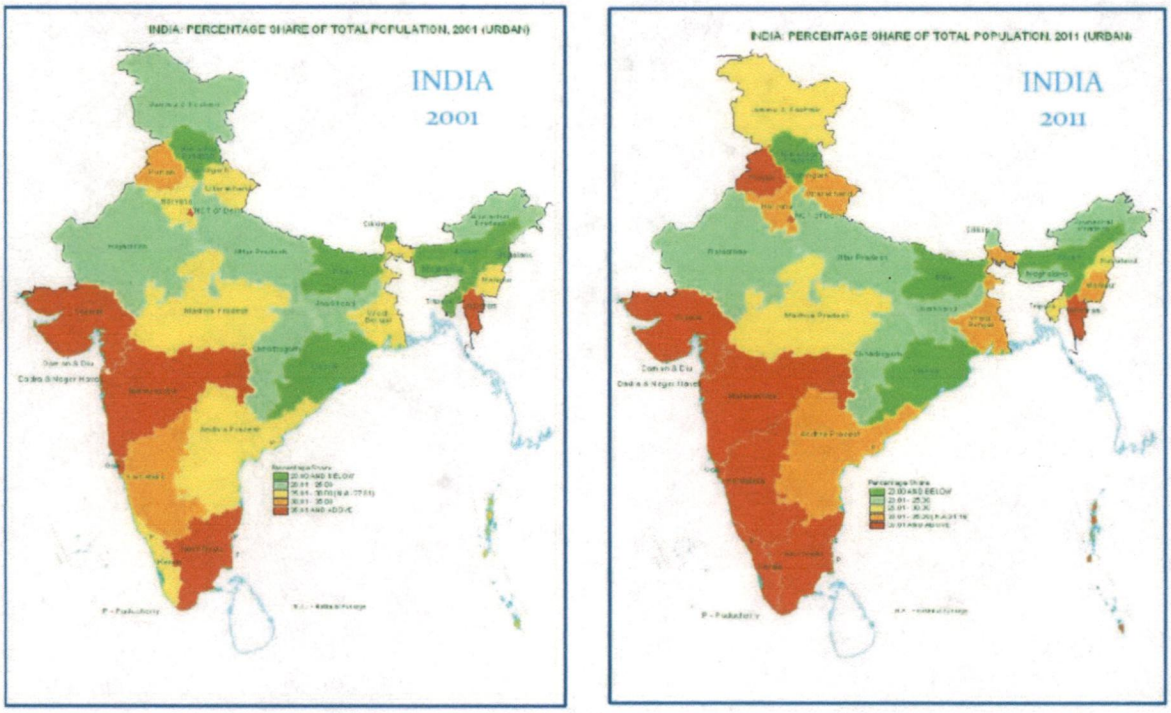


Figure 2.2: Percentage share of total population, 2001 and 2011 (Census, 2011)

Table 2.5: Increase in Urban Population in India (Census, 2011)

Increase in Urban Population in India							
Year	1950	1960	1970	1980	1990	2001	2011
Urban population (%)	17.3	18.0	19.8	23.1	25.5	26.6	37.7

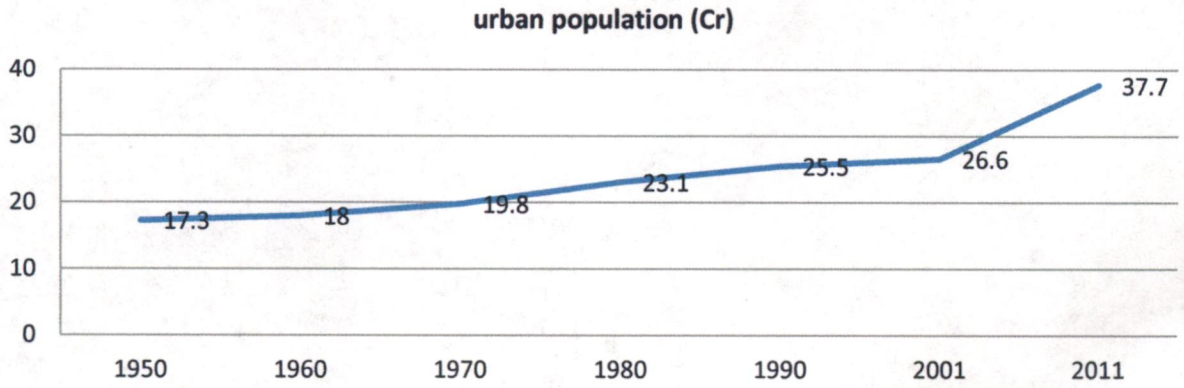


Figure 2.3: Increase in Urban Population in India

2.5 Waste Generation Rates in India and other countries

2.5.1 Waste Generation Rates in Developing Countries

Table 2.6: Waste Generation Rates in Developing Countries (WorldBank, 1999)

S.no.	Country	Current urban MSW generation (kg/capita/day)
	Low income	0.64
1.	Nepal	0.50
2.	Bangladesh	0.49
3.	Myanmar	0.45
4.	Vietnam	0.55
5.	Mongolia	0.60
6.	India	0.46
7.	Lao PDR	0.69
8.	China	0.79
9.	Sri Lanka	0.89
	Middle income	0.73
1.	Indonesia	0.76
2.	Philippines	0.52
3.	Thailand	1.10
4.	Malaysia	0.81
	High income	1.64
1.	Korea, Republic of	1.59
2.	Hong Kong	5.07
3.	Singapore	1.10
4.	Japan	1.47

2.5.2 Waste generation in Indian cities

Waste generation depends on the urban population and high population cities generate more wastes. In India, class I cities which have population more than 100,000 alone contribute to more than 72.5 percent of the total municipal solid waste generated in the country.

Class I cities include 7 mega cities (having population more than 4 million), 28 metro cities (having population of more than 1 million), and 388 other towns (having population of more than 100,000).

Table 2.7: Waste Generation in Class 1 Cities with Population above 100,000

Type of cities	Tonnes/day	per cent of total garbage
The 7 mega cities	21,100	18.35
The 28 metro cities	19,643	17.08
The 388 class 1 towns	42,635	37.07
Total	83,378	72.50

2.5.3 Per Capita Solid Waste Generation in Developed Nations

Table 2.8: Per Capita Solid Waste Generation in Developed Nations (WorldBank, 1999)

SN.	Country	MSW generation rate kg/capita/day
1	USA	2.00
2	Japan	1.12
3	Germany	0.99
4	Mexico	0.85
5	France	1.29
6	Turkey	1.09
7	Italy	0.96
8	Canada	1.80
9	Spain	0.99
10	Poland	0.93
11	Australia	1.89
12	The Netherlands	1.37
13	Belgium	1.10
14	Hungary	1.07
15	Austria	1.18
16	Greece	0.85
17	Portugal	0.90
18	Sweden	1.01
19	Finland	1.70
20	Switzerland	1.10
21	Denmark	1.26
22	Norway	1.40

USA is a leader in per capita waste generation in developed nations Australia, Canada, Norway etc. If the country has more per capita income, then the waste generation rate will also be high proportional to the income.

In India, the story is slightly different, here the per capita income is high with compare to some other countries but the waste generation is low compare to some low income countries.

The waste generation rates in India are lower than the low-income countries in other parts of the world and much lower compared to developed countries. However, lifestyle changes, especially in the larger cities, are leading to the use of more packaging material and per capita waste generation is increasing by about 1.3 per cent per year. With the urban population growing at 2.7 per cent to 3.5 per cent per annum, the yearly increase in the overall quantity of solid waste in the cities will be more than 5 per cent. The Energy and Resources Institute (TERI) has estimated that waste generation will exceed 260 million tonnes per year by 2047—more than five times the present level. Cities with 100,000 plus population contribute 72.5 per cent of the waste generated in the country as compared to other 3955 urban centres that produce only 17.5 per cent of the total waste.

2.5.3.1 Waste Quantities and Waste Generation Rates in 1 million plus Cities and State Capitals

Table 2.9: Waste Quantities and Waste Generation Rates in 1 million plus Cities and State Capitals (CPCB, 2000)

City	Waste quantity generated (MT/d)	Waste generation rate (kg/c/d/)
Vadodara*	157.33	0.12
Kohima	12.48	0.16
Nashik	200	0.19
Lucknow	474.59	0.21
Guwahati	166.25	0.21
Gandhinagar	43.62	0.225
Jabalpur	216.19	0.23
Ranchi	208.27	0.246
Nagpur	503.85	0.25
Dehradun	131	0.29
Raipur	184.27	0.3
Indore	556.51	0.35
Bhubaneshwar	234.46	0.36
Patna	510.94	0.37
Ahmedabad	1302	0.37
Faridabad	448.01	0.38
Dhanbad	77.12	0.387
Bangalore	1669	0.39
Bhopal	574.07	0.4
Agartala	77.36	0.4
Asansol	206.65	0.425
Daman	15.2	0.43
Jaipur	1040	0.44
Meerut	490	0.46
Agra	653.57	0.49
Allahabad	509.24	0.51
Ludhiana	734.37	0.53
Jamshedpur	387.98	0.59
Visakhapatanam	600	0.62

2.5.4 Physical Composition of Municipal Solid Waste in India

Table 2.10: Physical Composition of Municipal Solid Waste in India (NEERI, 1996) (CPCB, 2005)

	Composition (%)							
Year	Biodegradable	Paper	Plastic	Metal	Glass	Rags	Inerts	Other
1996	42.21	3.63	0.60	0.49	0.60	-	45.13	-
2005	47.43	8.13	9.22	0.50	1.01	4.49	25.16	4.016

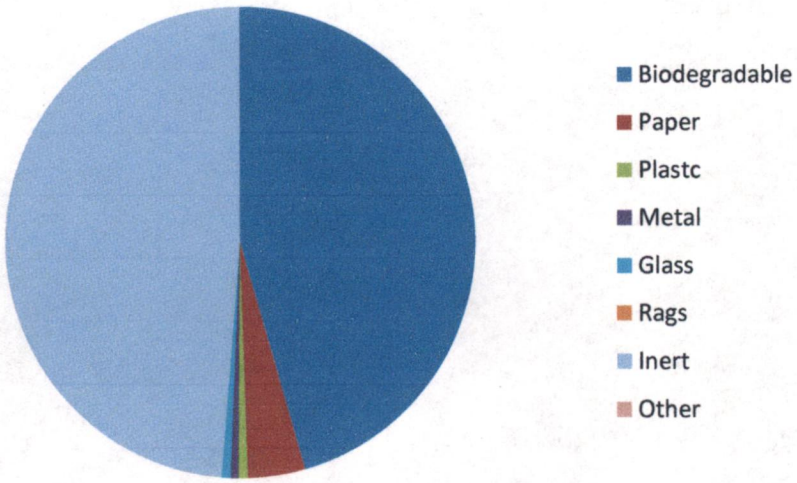


Figure 2.4: Physical Composition of Municipal Solid Waste in India, 1996

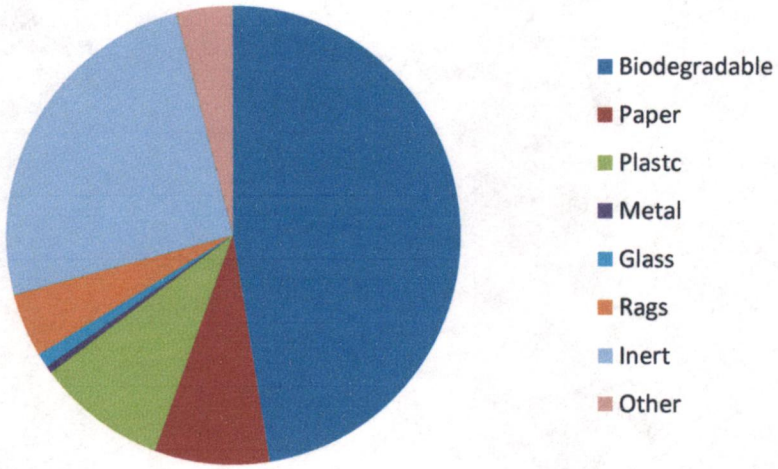


Figure 2.5: Physical Composition of Municipal Solid Waste in India, 2005

Table 2.11: Physical Characteristics of Municipal Solid Waste in Indian Cities according to population (NEERI, 1996)

Population range (in millions)	No. of cities surveyed	Paper	Rubber, leather and synthetics	Glass	Metal	Total compostable matter -	Inert material
0.1 to 0.5	12	2.91	0.78	0.56	0.33	44.57	43.59
0.5 to 1.0	15	2.95	0.73	0.56	0.32	40.04	48.38
1.0 to 2.0	09	4.71	0.71	0.46	0.49	38.95	44.73
2.0 to 5.0	03	3.18	0.48	0.48	0.59	56.67	40.07
5.0 and above	04	6.43	0.28	0.94	0.80	30.84	53.90

2.5.5 Physical Composition of Municipal Solid Waste in other countries

Table 2.12: Physical Composition of Municipal Solid Waste in developing countries (WorldBank, 1999)

	Compostable	Paper	Plastic	Glass	Metal	Others
Low income countries	41	4.6	3.8	2.1	1	47.5
Nepal	80	7	2.5	3	0.5	7
Bangladesh	84.37	5.68	1.74	3.19	3.19	1.83
Myanmar	80	4	2	0	0	14
India	41.8	5.7	3.9	2.1	1.9	44.6
Lao PDR	54.3	3.3	7.8	8.5	3.8	22.3
China	35.8	3.7	3.8	2	0.3	54.4
Sri Lanka	76.4	10.6	5.7	1.3	1.3	4.7
Middle income	57.5	14.9	10.9	2.4	3.1	11.2
Indonesia	70.2	10.6	8.7	1.7	1.8	7
Philippines	41.6	19.5	13.8	2.5	4.8	17.8
Thailand	48.6	14.6	13.9	5.1	3.6	14.2
Malaysia	43.2	23.7	11.2	3.2	4.2	14.5
High income	27.8	36 9.	4	6.7	7.7	12.4
Hong Kong	37.2	21.6	15.7	3.9	3.9	17.7
Singapore	44.4	28.3	11.8	4.1	4.1	6.6
Japan	22	45	9	7	6	11

If we talk about the physical composition of waste in developing countries, then it varies according to the per capita income of that nation. The high income countries like Hong Kong and Singapore have very high percentage of paper and plastic content. Similarly, the medium income countries like Malaysia, Philippines also have paper and plastic content high. The low income countries like India, Bangladesh have very high percentage of compostable materials.

In low income countries, there are very high potential of waste composting as they contain large amount of bio-degradable waste. High income developing nations have high potential of recyclable material in their waste content. Physical and chemical characteristics of solid waste in Indian cities vary depending on population size and geographical location. Though composition of urban waste is changing with increasing use of packaging material and plastics, yet, as compared to developed countries, Indian solid waste still comprises mostly, of large proportions of organic matter as well as inert material.

Table 2.13: Physical composition of MSW in Developed Countries (OECD, 1995)

Country	Organic	Paper	Plastic	Glass	Metal	Other
Canada	34	28	11	7	8	13
Mexico	52	14	4	6	3	20
USA	23	38	9	7	8	16
Japan	26	46	9	7	8	12
Australia	50	22	7	9	5	8
Denmark	37	30	7	6	3	17
Finland	32	26	0	6	3	35
France	25	30	10	12	6	17
Greece	49	20	9	5	5	13
Luxembourg	44	20	8	7	3	17
Netherlands	43	27	9	4	5	8
Norway	18	31	6	4	5	36
Portugal	35	23	12	5	3	22
Spain	44	21	11	7	4	13
Switzerland	27	28	15	3	3	24
Turkey	64	6	3	2	1	24
Average	38	26	8	6	5	18

2.5.6 The Plastic

It has many advantages: it is durable, light, and easy to mould, and can be adapted to different user requirements. Once hailed as a 'wonder material', plastic is now a serious worldwide environmental and health concern, essentially due to its non-biodegradable nature.

It is estimated that approximately 10 thousand tons per day (TPD) of plastics waste is generated i.e. 9% of 1.20 lacs TPD of MSW in the country.

2.5.6.1 Source of generation of waste plastics

HOUSEHOLD

- Carry bags
- Bottles
- Containers
- Trash bags
- Packages

HEALTH AND MEDICARE

- Disposable syringes
- Glucose bottles
- Blood and urine bags
- Intravenous tubes
- Catheters
- Surgical gloves

HOTEL AND CATERING

- Packaging items
- Mineral water bottles
- Plastic plates, glasses, spoons

AIR/RAIL TRAVEL

- Mineral water bottles
- Plastic plates, glasses, spoons
- Plastic bags

2.5.6.2 Plastics Manufacture and Usage (Amendment) Rules, 2003

- No person shall manufacture, stock, distribute or sell carry bags made of virgin or recycled plastic bags which are less than 8 x 12 inches in size and having thickness less than 20 microns.
- No vendor shall use carry bags/containers made of recycled plastics for storing, carrying, dispensing or packaging of food stuffs;
- Carry bags and containers made of recycled plastic and used for purposes other than storing and packaging food stuffs shall be manufactured using pigments and colorants as per IS 9833:1981 entitled "List of pigments and colorants for use in plastics in contact with food stuffs, pharmaceuticals and drinking water"
- Recycling of plastics shall be undertaken strictly in accordance with the Bureau of Indian Standard specification: IS 14534:1998 entitled "The Guidelines for Recycling of Plastics"
- Manufacturers of recycled plastic carry bags having printing facilities shall code/mark carry bags and containers as per Bureau of Indian Standard specification: IS 14534:1998 (The Guidelines for Recycling of Plastics).
- No person shall manufacture carry bags or containers irrespective of its size or weight unless the occupier of the unit has registered the unit with respective SPCB/PCC prior to the commencement of production.
- The prescribed authority for enforcement of the provisions of these rules related to manufacturing and recycling is SPCB in respect of States and the PCC in Union Territories and for relating to use, collection, segregation, transportation and disposal.

Chapter 3. WASTE MANAGEMENT PRACTICES IN DEVELOPED COUNTRIES, CASE STUDY CITY OF ALEXANDRIA, VIRGINIA, USA

3.1 Brief Introduction about the city

3.1.1 Location

Alexandria is an independent city in the Commonwealth of Virginia. Located at the Western bank of the Potomac River, Alexandria is approximately six miles (9.6 kilometers) from the south of downtown Washington, D.C.

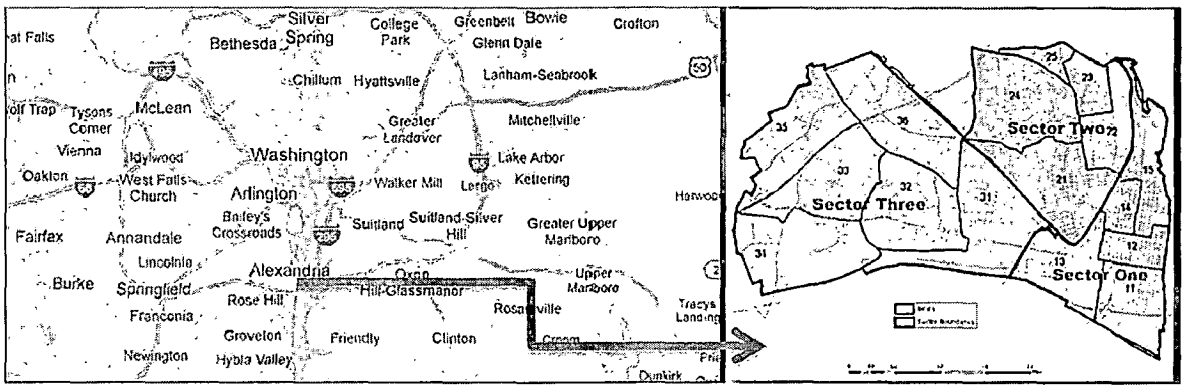


Figure 3.1: Location map of Alexandria, Virginia

3.1.2 Geography:

According to the United States Census Bureau, the city has a total area of 15.4 square miles (39.9 km²), of which 15.2 square miles (39.3 km²) are land and 0.2 square mile (0.6 km²) is water. The total area is 1.49% water. Alexandria is bounded on the east by the Potomac River, on the north and northwest by Arlington County,

3.1.3 Demography

As of the census of 2010, there were 139,966 people, 68,082 households, and 30,978 families residing in the city. The population density was 8,452.0 people per square mile (3,262.9/km²). There were 68,082 housing units at an average density of 4,233.2 per square mile (1,634.2/km²).

3.1.4 Economy

Top public employers in the city are:

Table 3.1: Public employers in Alexandria (Wikipedia)

#	Employer	# of Employees
1	United States Patent and Trademark Office	9,000
2	United States Department of Defense	7,500
3	City of Alexandria	2,500
4	Alexandria City Public Schools	1,900
5	Washington Metropolitan Area Transit Authority	1,400
6	Northern Virginia Community College	800
7	United States Postal Service	400

The top private employers in the city are:

Table 3.2: Private employers in Alexandria (Wikipedia)

#	Employer	# of Employees
1	Inova Alexandria Hospital	1,800
2	ABM Industries	1,000
3	Institute for Defense Analyses	900
4	Center for Naval Analyses	700
5	Gali Services Industries	750
6	Grant Thornton LLP	750
7	United Parcel Service	750
8	Oblon, Spivak, McClelland, Maier & Neustadt	750

3.2 City of Alexandria, Virginia Solid Waste Management System

The management system in the city of Alexendria involves citizens, private companies, and local government. Components of the system include waste generation, collection, processing, recycling, disposal, and public outreach initiatives.

Table 3.3: City of Alexandria Population

	City of Alexandria Population					
	2000	2005	2010	2015 Estimated	2020 Estimated	2025 Estimated
Population	128,283	135,036	139,966	146,486	148,840	151,552

3.2.1 Waste Generation

Table 3.4: Total waste generation in Alexandria

Fiscal Year Past	Generation (tons)	tpd	Per capita per day
2000	57,459	157	1.22
2001	58,881	162	
2002	55,365	152	
2003	58,383	160	

3.2.2 Collection

3.2.2.1 Solid Waste Collection from Residential units

During the year 2001, the City provided weekly solid waste collection for about 19,400 locations (which is about 18,500 single family homes [include residential buildings with four or less units) and various City facilities, churches and private schools] and 752 street cans. The Old Town of the City receives manual collection at the curb. The remaining areas of the City receive semi-automated or automated curbside municipal solid waste collection using a 90-gallon cart (known as SuperCan). During the year 2001, the City collected 27,899 tons of municipal solid waste. The amount increased significantly during the year 2002, when City crews collected 29,137 tons of household municipal solid waste.

Table 3.5: City of Alexandria Historical Household Municipal Solid Waste Generation

CITY COLLECTION Single Family Residential & Governmental					
	Population	Household	Recycled	Disposed	Gen.
Fiscal Year Past			(tons)	(tons)	(tons)
2000	128,283	22,571	28,550	28,412	57,459
2001	129,409	22,735	29,972	28,909	58,881
2002	130,534	22,899	27,128	28,237	55,365
2003	131,660	23,063	28,550	29,833	58,383

The following type of household waste items may be disposed of as solid waste: food scraps, soiled paper products, grass clippings, consumer packaging, old furniture and carpet, discarded clothing, and designated building materials. Household waste items that are not acceptable for disposal include liquid materials, bricks rocks, dirt, sand, concrete, drywall, hazardous waste, unbundled lumber, loose yard waste branches or wood and broken glass.

The cost recovery for residential waste collection and disposal are included in residents' real estate taxes. For the year 2005, the cost associated with the weekly solid waste collection and disposal service was ***$205 per household (Rs 10k, and monthly 854 INR), which represents a 100% direct cost recovery.***

During each spring, the City offers citizens a Spring Clean-Up service to those who receive trash collection services from the City. This program is aimed at collecting residents' appliances, mattresses, brush and other large or bulky items at the curb side. Every year, this service is provided to City residents on designated Saturdays during April.

3.2.2.2 Multi-Family Residential and Commercial Solid Waste Collection

The City's commercial solid waste stream consists of materials generated by business establishments and multi-family residences with five or more units. The commercial haulers collected 95,299 tons of MSW in FY 2003. According to data collected in 2001, there were 8,208 unique businesses located in the City with different physical addresses. These range from restaurants and hotels to auto repair shops, retail stores, doctors' offices, and more. The businesses in the City predominantly use private haulers for waste collection. Among the businesses surveyed during a 2001 telephone interview, 78 percent reported they were currently being serviced by one of the three large haulers – Browning-Ferris Industries, Inc. (Allied), Waste Management, Inc., or AAA Rainbow (Republic Inc.). The remaining 22% of the businesses had service provided by one of the small haulers or the City.

All told, 18 City-licensed collection firms and the City, resulting in an estimated 38 trucks on the streets each day, service businesses in the City. Further, many individual businesses share waste containers in large buildings and shopping complexes, significantly reducing the number of commercial waste customers. Much of the commercial waste collected in the City is disposed of at the Alexandria/Arlington Waste-to-Energy facility. Still, the GBB 2001 Commercial Waste Analysis revealed that Waste Management, Inc. collected an estimated 44,000 tons of City commercial waste that was not disposed of at the Alexandria/Arlington Waste-to-Energy facility, but was taken to its own landfill outside the region.

Private haulers pick up municipal solid waste discarded by multi-family housing (defined as five or more units). This MSW is mixed in with the commercially collected waste from businesses and is not tracked separately. As discussed above, much of this waste is taken to the Alexandria/Arlington Waste-to-Energy facility.

3.2.2.2.1 Household Hazardous Waste

In June 2001, the City opened a permanent household hazardous waste collection site on Wheeler Avenue. Prior to its startup, the City's household hazardous waste collection program consisted of

waste collection events that were held twice a year. Since June 2001, the City's permanent collection site has been available for residents to bring their household hazardous wastes. Acceptable items at the collection site are summarized in Table below.

Materials Accepted at City Household Hazardous Waste Collection Facility

Antifreeze	Garden Products	Propane Tanks
Battery Acid	Herbicides	Pet Supplies
Gasoline	Pesticides	Photographic Chemicals
Motor Oil	Ant Bait or Traps	Developers
Auto Cleaning Products	Rodent Control Products	Fixers
Car Batteries	Oil-Based Paints	Insect Spray Cans
Fire Extinguishers	Flammable Caulks &	Computers
Household Cleaning	Adhesives	Televisions
Products	Lacquers	VCRs
Flammable Waxes &	Spray Can Paint	Printers
Abrasives	Varnishes	Cellular Phones
Driveway Sealer	Thinners	Other Electronics
Household Batteries	Mineral Spirits	
Lawn Care Products	Drain Cleaners	

The City contracted with Care Environmental Corporation to operate the Wheeler Avenue facility. Data collected for the City by Care Environmental during the period June 4, 2001, through December 9, 2002, indicate that 35,650 pounds of household hazardous waste were delivered to the collection facility. That equals nearly 18 tons of material and an average of about 1 ton of household hazardous waste delivered on a monthly basis.

3.2.2.2.2 Used Oil/Oil Filters

The City contracts with U.S. Filter to manage the used oil dropped at the household hazardous waste collection site by City sources and residents. During calendar year 2002, the City reported to DEQ that 2,162 tons of used oil was recycled. Also during 2002, 35 tons of oil filters were recycled.

3.2.2.2.3 Antifreeze

During calendar year 2002, the City reported to DEQ that 132 tons of antifreeze was collected at the household hazardous waste facility for recycling. Private haulers also collected antifreeze in the City and reported their quantities to City officials.

3.2.2.2.4 Batteries

During calendar year 2002, the City reported to DEQ that 2.5 tons of car batteries and dry cell batteries were collected at the various drop-off locations in the City, including the household hazardous waste facility, for recycling. In addition, private sector collection of car batteries within the City limits was reported to City officials.

3.2.2.2.5 Construction and Demolition Collection

Private contractors collect C&D waste in the City. During calendar year 2002, the City reported to DEQ that 3,000 tons of construction waste was managed. During calendar year 2001, the City reported to DEQ that 500 tons of demolition waste was managed, along with 1,210 tons of recycled concrete and 23,269 tons of recycled asphalt. C&D materials generated in the City are typically collected by private contractor and transported to the Lorton Landfill in Fairfax, Virginia for disposal.

3.2.2.2.6 Industrial Waste Collection

The City has very few industrially-zoned areas; hence, the quantity of industrial waste collected is small. Expansion of industrial waste sources is not projected. Within the City's current solid waste system, industrial solid waste is treated as commercial waste and collected by the private haulers, with the tonnages incorporated in that waste stream.

Industrial waste is generated by light industry in the City. The industrial waste includes waste coming from warehouses, distribution facilities and some light assembly, such as paper box facilities. As a result, the composition largely consists of packing materials, including pallets, corrugated boxes, plastic wrap, metal and plastic strapping, etc. Other sources of industrial waste include an asphalt plant and an aggregate facility located in the Eisenhower Corridor, catering businesses, printing, and automobile-related operations.

3.2.2.2.7 Regulated Medical Waste Collection

The City has a variety of dental offices, medical clinics, and related facilities that generate regulated medical waste and are serviced by private contractors. The largest generator of regulated medical waste in the City is the INOVA Alexandria Hospital. This waste is managed by a private contractor who takes the material off-site and out of the region for processing. No data is available regarding

how much regulated medical waste is collected in the City by private haulers. No regulated medical waste is accepted at the Alexandria/Arlington Waste-to-Energy facility.

3.2.2.2.8 Vegetative and Yard Waste Collection & Processing

Every fall, the City provides residents with vacuum leaf collection. City crews drive through neighborhoods with specialized vacuum-equipped trucks to collect leaves that have been raked to the curb. Each neighborhood receives a minimum of six passes on their street between mid-October and the end of December. Each house receives one pickup per collection period. During FY 2001, 29,500 cubic yards of leaves were collected in the City. This was reported to DEQ as about 4,000 tons of material for calendar years 2001 and 2002. For FY 2003, about 30,000 cubic yards of leaves were collected.

During April and May, residents may pick up mulch generated from the leaves the City has collected. The leaves collected in the fall are shredded in a large "tub grinder" to produce the leaf mulch product. Christmas trees collected by the City in January are also shredded and chipped into "wood mulch." The City's mulch site on Eisenhower Avenue is generally open to the public for several months during the spring. Mulch is free of charge on a first-come, first-served basis. Mulch is also available for delivery by the City at $30 per load if delivered within the City limits, or $50 per load delivered outside the City limits.

In addition, private contractors handle debris collected from land clearing activities in the City. This material is hauled to Fairfax County for disposal in the Lorton Landfill or the other C&D facilities identified later in this section. During calendar year 2002, the City reported to DEQ that 45 tons of land clearing debris were managed.

3.2.2.2.9 Incinerator Ash

Incineration ash is the byproduct of the City's MSW burned at the Alexandria/Arlington Waste-to-Energy facility located on Eisenhower Avenue. The ash from this facility is approximately 3 percent ferrous metal, 1 percent non-ferrous metal, and 96 percent inert materials. Covanta contracts for the collection and transport of this ash from the Alexandria/Arlington Waste-to-Energy facility to the I-95 Ash Monofill in Lorton, Virginia. The ash meets all State and federal requirements for landfill disposal.

3.2.2.2.10 Sludge

City wastewater treatment plant sludge generation totals from the Alexandria Sanitation Authority (ASA) have risen from 11,000-12,000 dry tons per year in 1998 and 1999 to 14,000-15,500 dry tons during 2000, 2001 and 2002. This rise has occurred during a $330 million upgrade to the ASA facility

to meet new effluent limits imposed by the Commonwealth of Virginia and total nitrogen requirements of the Chesapeake Bay program. This on-site construction has resulted in a temporary but significant increase in chemicals used to treat incoming sewage sludge. The wastewater facility upgrade is ongoing and is scheduled to be completed by the end of 2005.

The Alexandria Sanitation Authority, which manages the City's sludge under contract, has changed from a fixed film biological treatment system enhanced by physical chemical treatment schemes to a state-of-the-art biological nutrient removal, activated sludge system. This change has affected the data.

ASA will continue to gravity thicken primary sludge and mechanically thicken waste activated sludge and tertiary sludge. All of these go through a pasteurization process to inactivate pathogens, followed by anaerobic digestion. The digested material is then mechanically dewatered and trucked to permitted land application sites in Virginia where it is recycled into farmland soil.

The Authority projects an average of 13,000 dry tons per year over the next ten years once on-site construction is complete. This is a high estimate of production for future years, and the amount of biosolids produced with the new process will not be firm until they acquire operational experience under this new process.

3.2.2.2.11 Tires

Waste tires are collected from a number of sources within the City of Alexandria, with the greatest volume coming from retail tire dealers who collect them when they sell new tires. Other sources are discount stores and auto service shops. During FY 2002, the Virginia DEQ estimated 130,500 waste tires were generated (i.e., about one tire per person) in the City, which generated about $65,000 for the State tire fund (i.e., $0.50 per tire).

The City collects tires from City vehicles in a roll-off container bin located at Fleet Services located on South Quaker Lane. These tires are subsequently processed for recycling. Additional tires are collected during the City's Spring Clean-up event. During calendar year 2002, the City reported to DEQ that 182 tons of tires were recycled.

3.2.2.2.12 White Goods

The City collects white goods with City trucks and crews and contracts with Davis Industries for processing. During calendar year 2002, the City reported to DEQ that 4,984 tons of metals were recycled. Of this total, City officials estimate that 4,653 tons were attributed to metals collection from commercial sources, and 331 tons were linked to the collection of white goods.

In addition, private companies that sell appliances will remove old appliances for a fee when replacing them with new ones.

3.2.2.2.13 Friable Asbestos

Management of friable asbestos discovered in buildings located in the City is the responsibility of the building/property owner. Friable asbestos is typically found during renovation and demolition activities, and the objective is to remediate the site to ensure that any airborne disbursement is minimized. For City buildings, the City's Code Enforcement Division of the Fire Department is involved with ensuring proper asbestos management. Data are not available regarding how much friable asbestos waste is collected in the City and then disposed of outside the City by private contractors. The City government did not handle any nor report any asbestos tonnage to the DEQ during calendar year 2002.

3.2.2.2.14 Petroleum Contaminated Soils

Proper cleanup of soils contaminated with petroleum in the City are the responsibility of the property owner, in accordance with federal, State, and local statutes. The City's Code Enforcement division of the Fire Department is responsible for ensuring proper management takes place on City property. There are typically five to six petroleum contaminated soils incidents each year within the City. These are usually due to leaks in commercial and residential underground oil and gas tanks that have been excavated for replacement. Hydraulic leaks from vehicles are another source in the City, such as the spill that occurred at the Patent and Trademark Office (PTO) site, which had to be remediated. A train derailment at the Potomac Yard area of the City also resulted in the need to remediate contaminated soil.

The metropolitan area has approximately 70 environmental engineers who will manage contaminated soil remediation. Generally, the engineering firm specifies collection and disposal to prevent further environmental damage and in order to meet all federal, State and local disposal requirements.

Data are not available regarding how much petroleum contaminated soils is collected in the City by private contractors. The City did not report any petroleum contaminated soils tonnage to the DEQ during calendar year 2002.

3.2.2.2.15 Other Special Waste

As previously noted, special wastes are materials that require or are chosen for special handling and precautions prior to recycling and/or disposal. They also are often subject to special programs and recycling.

3.2.2.2.16 Electronics Recycling

During Earth Day 2002, the City sponsored an electronics recycling collection event at a school parking lot. Residents were encouraged to recycle their old or unusable electronic equipment so that valuable precious metals could be recycled and hazardous electronics elements, such as lead and mercury, could be removed from the waste stream. During 2002, the City reported to DEQ that 30 tons of the following types of electronic equipment were collected for recycling: monitors, CPUs, printers, keyboards, network equipment, cables and peripherals, televisions, radios, stereos, cellular phones, and VCRs. Recycling service for electronics and computers is provided at Alexandria's household hazardous waste collection site. Future quantities of electronics collected for recycling are expected to remain relatively constant.

3.2.2.2.17 Tree Stumps

Data are not available relative to the quantity of tree stumps generated in the City.

3.2.2.2.18 Spill Residues

The Code Enforcement Division within the City's Fire Department is responsible for responding to any hazardous spills and ensuring proper mitigation occurs, in accordance with federal, State, and local regulations. If the responsible party can be identified, it is their responsibility to hire the remediation contractor. If one cannot be identified, Code Enforcement brings in its own contractor. If there is a non-hazardous MSW spill, the City's Solid Waste Division handles the cleanup. The City does not weigh liquid and solid hazardous waste spills; therefore, spill residue tonnage data are not available.

In addition, an emergency plan exists to properly handle spill residues at the Alexandria/Arlington Waste-to-Energy facility.

3.2.2.2.19 Dead Animals

Management of dead animals collected in the City is handled through a contract with the Animal Welfare League of Alexandria, located at 4101 Eisenhower Avenue. Animals collected by animal control officers, plus those brought to the League by citizens, are taken to a crematorium in Chantilly, Virginia. During 2002, 21 tons of dead animals were cremated. The year before, 20 tons were managed.

3.2.2.2.20 Litter

To help keep the City of Alexandria clean, the City has recently established an adopt-a-block program for litter control. Citizens and businesses sign up to keep a four-block area clean at least four times a

year. The City provides collection bags and safety vests prior to such cleanup events. No waste tonnage data are available from this program.

3.2.2.2.21 Waste Dirt

The City Maintenance Division within the Transportation & Environmental Services Department is responsible for street improvement and sewer maintenance activities that generate waste dirt. This material is disposed of at the I-95 Landfill in Lorton, Virginia. No tonnage data are available. In addition, private contractors manage waste dirt generated at construction sites within the City.

3.2.2.2.22 Street Sweepings

The City's Solid Waste Division provides all services associated with maintaining the cleanliness of the City's right-of-way by cleaning City streets through street flushing and sweeping. During FY 2001, the City swept 7,595 cubic yards of debris from Alexandria streets. This equates to about 7,600 tons. This quantity is forecasted to increase to about 8,250 tons in FY 2003.

3.2.3 Disposal

There is one municipal solid waste disposal facility located in the City of Alexandria, the 975 tons-per-day Alexandria/Arlington Waste-to-Energy facility. Additional MSW and other types of waste are managed by the private sector, which has developed a wide variety of disposal facilities in the metropolitan area that are easily accessible from the City. These are identified by waste type in the following subsections.

3.2.3.1 Municipal Solid Waste

The primary method of MSW disposal in the City of Alexandria is combustion with energy recovery at the Alexandria/Arlington Waste-to-Energy facility located in Alexandria and operated by Covanta Energy, Inc. This 975 tons-per-day facility, developed jointly by Arlington County and the City of Alexandria, has been the centerpiece of the jurisdictions' solid waste management systems since it began operations on February 16, 1988. The plant burns municipal solid waste and converts it into steam, which is then used to generate electricity for sale to Dominion Virginia Power. At the time it was constructed, it met Best Available Control Technology (BACT) air quality standards. The facility has a capacity to process 356,000 tons of waste annually and has a gross energy output of 24 megawatts, with approximately 23 megawatts of reusable energy sold to Dominion Virginia Power. The electricity generated is sufficient to power 23,000 homes.

In fiscal year 2002, the Alexandria/Arlington Waste-to-Energy Facility processed a total of approximately 288,030 tons of refuse from Arlington County, the City of Alexandria and private

haulers for a daily average of 789 tons. This included approximately 115,212 tons per year (315 tons per day) from the City of Alexandria. Of these 115,212 tons, approximately 86,794 tons were generated from commercial generators.

Most of the commercial waste generated in the City is disposed of at the Alexandria/Arlington Waste-to-Energy facility. However, one major and a number of smaller private collectors utilize other disposal facilities located outside the City. Table 3-3 shows the major licensed landfills and transfer stations accessible to haulers servicing the City of Alexandria.

After undergoing a $43 million retrofit in 1999 and 2000 to install an advanced state-of-the-art emissions control system (at Maximum Achievable Control Technology [MACT] air emissions standards) and to upgrade the scales, scale house and facility's appearance, the facility is currently operating well within its air emissions permit limits. These investments were made so the facility could meet the requirements of the 1990 Amendments to the Clean Air Act (regulations not issued until 1995 for compliance by 2001) and reduce its impact on its neighbors.

3.2.3.2 Construction and Demolition Waste

In many cases, C&D waste is disposed of in sanitary landfills along with MSW; however, there are specialized facilities available.

3.2.4 Recycling

In 1990, the Commonwealth of Virginia issued regulations that required all localities to develop ways to meet and maintain a 25 percent recycling rate. To meet this goal, the City of Alexandria developed a comprehensive recycling program that included residential curbside collection, drop-off collection centers, and voluntary commercial and multi-family recycling. The City's recycling program has successfully exceeded the Commonwealth's goal. In calendar year 2002, the City submitted a recycling rate of 28 percent to DEQ using the official state formula.

3.2.4.1 Residential Recycling

The City provides weekly curbside collection of aluminum and steel cans, plastic bottles and jugs, glass bottles, newspapers, magazines and catalogs, and telephone books on the same day as regular municipal waste collection. Each household is provided an 18-gallon yellow bin for recyclables, to be placed at the curb. There is no alley collection of the yellow bins. Citizens can mix the recyclables together in the yellow bin, with the exception of newspapers and magazines. These are placed next to or on top of the yellow bin at the curb.

During FY 2001, 3,032 tons of newspapers and 1,534 tons of aluminum, plastic and glass containers were collected curbside for recycling. For FY 2003, the City estimated 3,000 tons of newspapers and 1,550 tons of aluminum, plastic and glass containers were collected.

For elderly and handicapped residents, City collection crews will remove solid waste from containers left at the door and also provide pickup of household hazardous waste. Eligible citizens must call to establish these walkout services.

In addition, each residential unit receives call-in collection of white goods (e.g., old appliances). Scheduled pickups are typically provided on Friday. Citizens can also drop off white goods for free at the Alexandria/Arlington Waste-to-Energy facility. During FY 2001, 313 tons of white goods were collected. About 340 tons were collected in FY 2003.

Materials collected curbside for recycling are processed by Waste Management Recycle America at a materials recovery facility (MRF) located in the Merrifield section of Fairfax County. Newspaper and corrugated cardboard are processed at an environmental recycling MRF. White goods are handled by Davis Industries. Used oil is primarily handled by U.S. Filter and is collected at the City's household hazardous waste site. In addition, Mid-States Oil Refining handles a small amount of used oil. The MWCOG region is a competitive market in terms of processing services. It is expected that there will not be any trouble for the City to maintain or find new processing services once the existing contracts expire. Starting in FY 2005, the residential recycling program will be contracted out to the private sector. It is also planned that white paper and cardboard will be added to the items which can be placed in the curbside bins for recycling.

3.2.4.2 Commercial and Multi-Family Recycling

The City offers assistance to commercial entities and multi-family dwellings if there is an interest in initiating or expanding recycling efforts. The type of assistance offered includes technical advice, referrals to recycling services, and information on incentive programs.

The City Department of Transportation and Environmental Services promotes business recycling by way of a brochure, entitled "Simple Steps to Successful Recycling at Your Alexandria Business." The brochure provides a step-by-step guide for selecting a recycling company, designating collection and storage areas, collecting recyclables, transporting materials to the storage area, promoting and sustaining the program, information on local recycling haulers, pricing, collection options and more.

From a collection standpoint, the businesses in the City predominantly use private haulers for recycling. The City does recycle its own office paper. Effective in 2002, new commercial developments in the City, as part of their Special Use Permits, must put a recycling program in place.

Details are being worked out regarding the types of materials, with paper, plastics, metals and cardboard under consideration. An annual recycling report must be submitted to the City.

Commercial recycling is handled by the private sector. Most materials are taken to materials recovery facilities (MRF), where they are sorted and processed for marketing.

3.2.4.3 Plastic Bottle Collection Grant

During the summer of 2002, the City received a grant to collect plastic bottles for recycling. This effort focused on special events and festivals and collected over 1,500 pounds of plastic from eight events.

3.2.5 Public Education

The City budgets about $15,000 per year for public education efforts. A summary of program efforts is provided immediately below.

In July 2002, the City Office of Recycling launched a new website, www.alexrecycles.org, making it easier to access information about the City's recycling program. The website provides a summary of information on what to recycle in Alexandria, where recycling drop-off centers are located, how to request a new recycling bin, as well as the latest recycling program news.

The City also released the "Simple Steps to Successful Recycling" brochure aimed at increasing commercial recycling among City businesses. This is described above under the Commercial Recycling Collection section.

Another brochure, entitled "Let's Talk Trash and Recycling," describes current recycling initiatives in the City, along with trash collection information, waste disposal destinations, and relevant contact information.

Further, the Office of Recycling conducts presentations to civic associations and community groups upon request. The City also encourages citizens' groups and businesses to participate in recycling promotional events throughout the year, including America Recycles Day and Earth Day events.

The Alexandria Department of Transportation and Environmental Services publishes an annual newsletter, entitled "The 2nd Time Around." This newsletter features the latest developments in the City's recycling program, lists upcoming events, provides useful recycling insights, and contact information. Arlington and Alexandria have jointly produced brochures and information about the Waste-to-Energy plant, titled "Partners for Progress – Environmental Stewardship in Waste Management Programs."

3.2.6 Public/Private Partnerships

The City has a number of public/private partnerships as part of its solid waste management system. These include:

- A hauling contract with Browning-Ferris Industries to pick up solid waste from a compactor room serving businesses in Old Town Alexandria;
- An agreement with the I-95 Landfill to accept ash from the Alexandria/Arlington Waste-to-Energy facility;
- Private companies to process recyclables collected from different programs;
- A partnership with Arlington County and Covanta Energy, Inc. with regard to the Alexandria/Arlington Waste-to-Energy facility;
- A partnership with the Sanitation Authority with regard to the management of sludge.

Chapter 4. CURRENT PRACTICE OF SOLID WASTE MANAGEMENT IN INDIA

4.1 Functional elements of municipal solid waste management

A typical waste management system in a low- or middle-income country includes the following elements:

- Waste generation and storage
- Segregation, reuse, and recycling at the household level
- Primary waste collection and transport to a transfer station or community bin
- Street sweeping and cleansing of public places
- Management of the transfer station or community bin
- Secondary collection and transport to the waste disposal site
- Waste disposal in landfills
- Collection, transport, and treatment of recyclables at all points on the solid waste pathway (collection, storage, transport, and disposal)

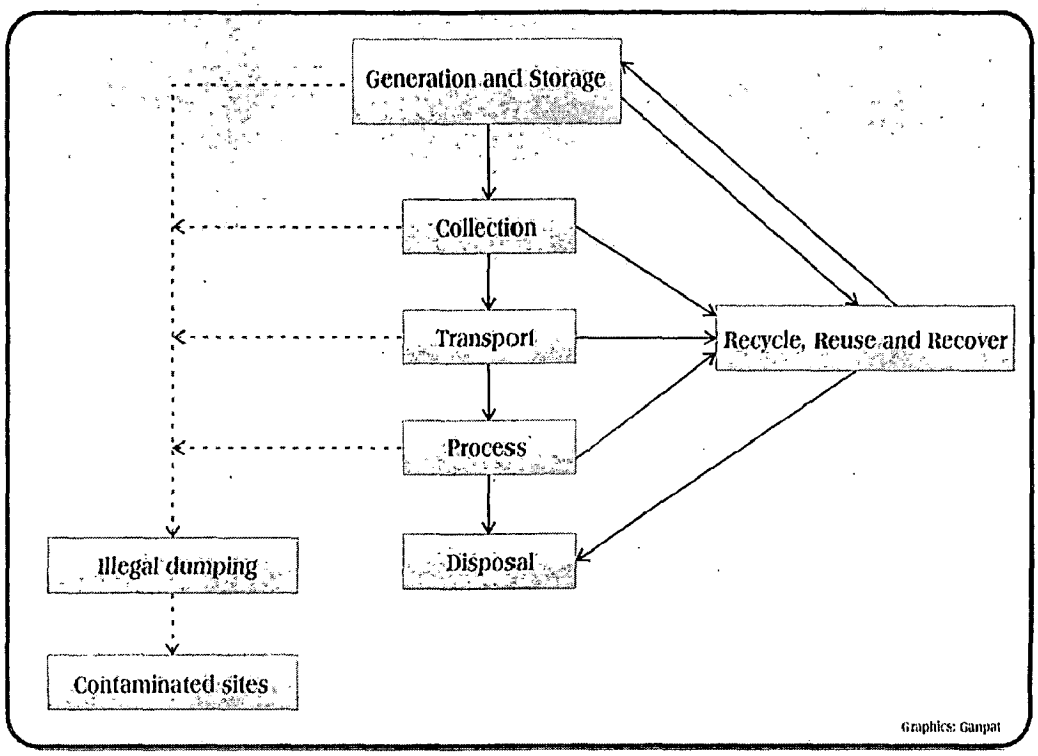


Figure 4.1: Functional elements of municipal solid waste management in India.

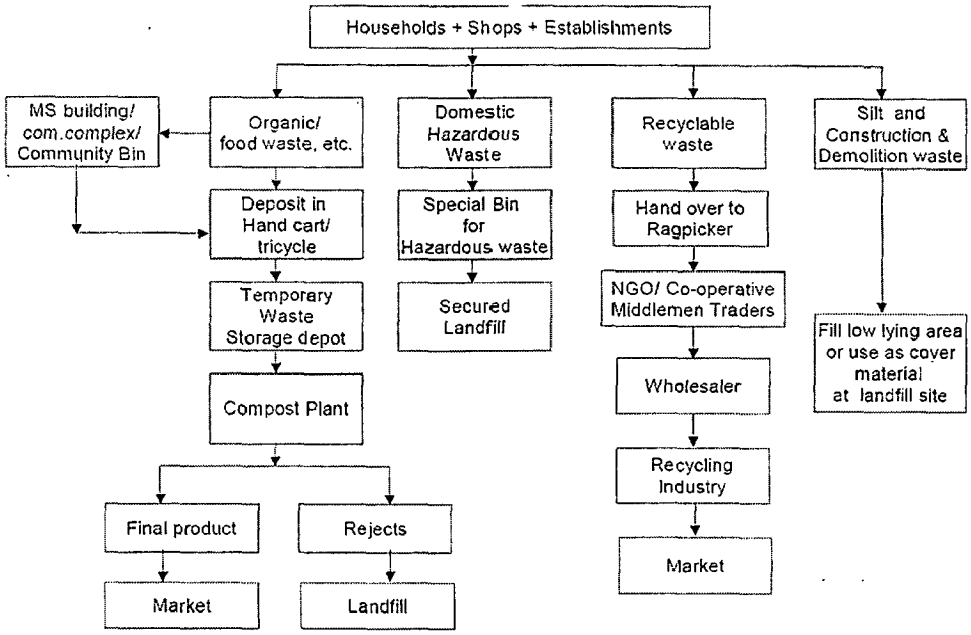


Figure 4.2: Recommended flow chart of MSW in India (Commitee, 1999).

4.1.1 Waste generation

This includes the various activates where human being generates waste which has no further value. Waste generation cannot be controlled but reduction of waste at source is possible by implementing better waste management system.

4.1.2 Waste Storage and processing at source

This step includes the processing until placed in the container for the transportation. There are various stages of sorting which can be known as:

- At the household level
- At the collection bin
- At transfer depot or transfer depot
- At solid waste processing location or site
- And at the final disposal of landfill site

Sorting can be done in three ways, manual sorting semi mechanized and fully mechanized sorting.

Storage of wastes can also be done at three levels, at sauce, community level and at transfer stations.

4.1.3 Collection

This includes the collection of waste materials before transporting it to the disposal site.

Types can me four types of Collection,

1. **Community bins** – Community bins are placed in convenient locations, where the community members carry the waste and throw it in. This method is comparatively cheaper to other methods. This is the most widely adopted method in western countries.
2. **Door-to-Door collection** – In this method the waste is placed at the doorstep of households at a set time when the waste collector arrives to collect it.
3. **Block collection** – Vehicle arrive at the at a particular place or a set day and time to collect waste from the households. It is the responsibility of households bring their waste to the put it in collection vehicles.

Table 4.1: Comparison of Door to Door Collection and Community bin collection

Type of collection	Advantages	Disadvantages
Community bin collection	Less cost intensive than door-to-door collection 24-hour availability to households	Problem of illegal waste disposal because households fi nd it inconvenient to carry their waste to the community bin Resistance from neighbors ("not in my backyard" syndrome) Nuisance from animals and vermin roaming the waste
Door-to-door collection	Convenience for households Prevention of littering Reduction of community bin Segregated collection of waste	Collection restricted to fi xed collection times Increased costs

4. **Curbside collection** – The waste has to be keep at curb side in collection bins and the containers to be emptied at the curb on the collection day and for returning the empty containers to their storage location until the next collection.

4.1.4 Processing and transformation of solid waste

This step is implemented for the recovery of the sorted materials, transformation of solid waste, and processing of solid and this occur at the locations away from the waste generation.

Sorting of the mixed waste usually occurs at a material recovery facility, transfer stations, combustion facilities and disposal sites. Sorting includes separation of bulky items, separation of

waste components by size using screens, manual separation of waste components, and separation of ferrous and non-ferrous metals.

The different types of processing techniques are:

1. **Recycling and reuse.**
2. **Energy recovery Processes**
3. **Thermochemical conversion**

4.1.5 Transfer and transport

Two steps comes under the transfer and transport, first transfer the waste from smaller collection vehicles to the larger vehicles and after that transfer it to the disposal or processing site.

4.1.6 Disposal

The final disposal of waste can be of two types,

Non-engineered disposal and fully engineered sanitary landfill.

1. **Non-engineered disposal:** this is generally called as an open dump, or disposal of waste without any scientific manner.
2. **Sanitary Landfill** – this is a fully engineered disposal method.

4.2 Various drawbacks in present SWM services in India

4.2.1 No Storage of Waste at Source

Storage of waste at the source of its generation is the first essential step toward appropriate SWM. Most urban areas of the country have yet to take this step.

Most households, shops, and establishments throw their waste just outside their premises, on streets, in drains, in open spaces, in water bodies, and in other inappropriate places. Because such waste contains high levels of biodegradable material, it attracts rodents and stray animals and thus contributes to the spread of filth and disease.

Partial Segregation of Recyclables

At least 15 to 20 percent of the country's total waste could be conveniently segregated at its source for recycling if the practice of segregation of waste at source were adopted.

Nevertheless, in all parts of the country, people by and large salvage reusable material—such as newspaper, glass bottles, empty tins, plastic bags, and old clothes—and then resell it. This sector is low profile but well established. Large numbers of waste buyers purchase recyclable waste from the doorstep and pass it on to a subdealer or a dealer with a good margin.

Other people are known as *rag pickers*. Rag pickers are generally poor women and children who pick up discarded recyclables from the streets, bins, and dumpyards; segregate various components; and sell them to a dealer for a small price to earn a living. Those recyclables are often soiled with food waste, human excreta, and biomedical waste. Accordingly, the price of such waste is much lower than the dry and clean recyclable material that is picked up directly from households or shops. Furthermore, because rag pickers are very poor, they have little bargaining power to negotiate a higher price.

Quite often, rag pickers focus their search and recovery on a few varieties of recyclables that have good returns. Other materials are discarded. Hence, much potentially recyclable waste from streets and bins ends up at the disposal site, along with other domestic waste and street sweepings. Rag pickers, who search disposal sites as well as streets, nevertheless, recover some of those materials; however, most of the waste gets buried.

Urban Indian cities generate 42 million metric tons of waste annually. Of that amount, around 4 million metric tons are retrieved for recycling. Another 4 million metric tons are disposed of in uncontrolled dumps—a problem that needs to be prevented.

The current practice of material recovery and recycling often leads to additional littering in streets when rag pickers are rummaging the waste bags and bins. A denial to rag pickers in the streets forces them to collect recyclables from landfill sites as well. This practice leads to even higher health threats and environmental pollution. In most cases, rag pickers are women and children from low-income groups, which compose the weakest group in the Indian society. They are often exploited by waste merchants because of their status. In the past 10 years, an increasing number of nongovernmental organizations (NGOs) have become active in improving the working and living conditions of rag pickers. Because the municipal waste service was until recently limited to waste collection from public bins, NGOs recognize the service gap and have started offering door-to-door collection services to households. Recognizing that recyclable waste should be collected at the source of its generation to maintain its value, NGOs and a few municipalities in India have tried to involve rag pickers in door-to door collection. Several success stories show that such efforts have significantly improved the living conditions of hundreds of rag pickers.

Most of these efforts are done on a private or nongovernmental basis. Hence, they lack further dissemination and have limited positive effects for the whole sector. Waste recycling in India has many untapped potential opportunities that could benefit the entire Indian society.

Given the current situation, India needs to upgrade and reorganize its recycling system, and to improve the working conditions of rag pickers. The key stakeholders to lead this process are the municipal authorities, because they are ultimately responsible for waste management. Another major challenge is to obtain public contribution and the involvement of the private sector. The Supreme Court's expert committee acknowledged this need in its report and recommended further action to intensify recycling, taking into account all stakeholders.

4.2.2 No System of Primary Collection from the Doorstep

Generally, primary collection is grossly neglected in India. Collection systems in India are primitive and inefficient. Municipal authorities, by and large, do not have service of door-to-door collection of waste, nor do they contract for such services to be provided by the private sector. The principal reason for this deficiency in service is the mindset of the municipal authorities. Such authorities consider themselves responsible only for waste collection at street collection points and do not feel it is their job to provide doorstep collection service, even though such service is now mandated in the rules. The second reason is the lack of citizen involvement in the storage of waste at source. Changing the habits of citizens, who are used to throwing waste on the streets and must instead learn to store it in domestic bins, will be a slow process.

In very few places does door-to-door collection exist. In such cases, it is provided by NGOs or the private sector with or without municipal initiative. The success of such efforts can be attributed to the concerted efforts of NGOs or, in some cases, a motivated municipal official or elected representative who is in a position to change the system. Imposing mandatory directions and taking punitive actions have not been enough to bring about such a change. Any change has been possible only when serious efforts were made to educate the citizens through effective public awareness campaigns.

Citizens are generally expected to deposit their waste in the street bins provided by the city governments. Sometimes citizens must take their waste long distances to dispose of it. Street bins are poorly maintained and ill designed.

Often, citizens are allowed simply to throw the waste on the streets. The primary collection of waste is, therefore, done by picking up the waste deposited on the streets through a street-sweeping operation, which is not carried out regularly.

4.2.3 Irregular Street Sweeping

Even street sweeping is not carried out on every day basis in most cities and towns in India. Generally commercial roads and main streets are prioritized and rest of neglected many times.

Without a system of primary collection of waste from the doorstep, street sweeping is the most common method adopted in India for primary collection of wastes deposited in the streets. However, only important roads and markets are swept daily. Some streets are swept on alternate days or twice a week, and some are swept occasionally or not at all. No planning is done to ensure that all streets are swept regularly.

Moreover, there is no uniform benchmark, or yardstick, prescribed by municipal authorities for street sweeping. In some places, sweepers are allotted work in terms of a given amount of road length, usually 250 meters to 1 kilometer. In other places, measurement is on the basis of square meters. In such places, a sweeper may be allotted 3,000 square meters or more. In still other places, allotment is made on the basis of a sweeper-to-population ratio: 1 sweeper per 250,500 or more people.

Each sweeper is given a "beat" (that is, an area demarcated for sweeping). The area allotted is swept in the first half of the day, and the street sweeper then carries the street sweepings to the designated waste storage depot. In the afternoon, either street sweepers generally are deployed to other areas for group sweeping or they return to the same place to repeat their sweeping. Their output in the afternoon is almost negligible given the lack of supervision and control. Hence, less use of personnel is a problem.

Some places have a two-tier system: some sweepers sweep only the streets and make small heaps, while another set of people pick up the waste in handcarts or tricycles. The lack of coordination between sweepers and waste collectors results in many heaps being left unattended, thus creating unsanitary conditions.

The street sweepers are not given appropriate tools to perform their duties effectively. They are given short-handled brooms, which necessitate constant bending and cause fatigue and loss of productivity. Municipal authorities, however, appear unconcerned about this matter, and sanitation workers—who are never keen for change, even if it is for their own good—do not bring the problem to the authorities' attention. The sweepers, approximately 50 percent of whom are women, feel comfortable with short handled brooms on account of their traditional use. They do not appreciate the advantages of long handled brooms and believe that such brooms could not be used conveniently. Moreover, they have not been educated in the benefits of long-handled brooms.

Meanwhile, the waste collectors who accompany the street sweepers are also given inefficient equipment. Their handcarts and tricycles are not adapted to the secondary collection system, often resulting in deposition of waste on the ground.

4.2.4 Waste Storage Depots

The waste depots are called dustbins, vats, dhallos, waste collection points, and so forth. Most of those sites are open and are located on the roadside. Some are constructed as cement or concrete bins, missionary bins, or large built structures.

Generally, such waste depot sites are not evenly distributed in cities and towns. In some wards, they are available in a large numbers and are very close to one another. In other areas, they are far apart, thus making it difficult and time consuming for the sanitation workers or sweepers to use them. Furthermore, they are often very poorly designed and are not synchronized with the primary collection system used. Often, waste collected by handcarts or tricycles is left on the ground just outside the bin, thus blocking the passage to the bin and further hindering correct use of the bin. Bins frequently overflow because of their less capacity, and often more waste is found outside the bin than in it. In addition, waste depots are not emptied on a regular basis. Serious complaints from neighborhood residents and resistance to new bins are a consequence. Inappropriate secondary storage of waste leads to a "not in my backyard" syndrome. Fearing mismanagement of secondary waste facilities, citizens object to having a waste storage depot nearby and agitate over placement of any new container near their premises.

Some cities have improved their secondary waste storage by using mobile containers of various sizes, ranging from 1 cubic meter to 10 cubic meters. The containers are closely linked with the primary collection system of containerized handcarts and tricycles, and they facilitate a direct transfer of waste from the handcart or tricycle into the covered containers. This system creates more hygienic conditions and ensures efficient secondary storage of waste.

4.2.5 Transportation of Waste

Waste in the cities and towns are not transported on a daily basis. Unfortunately, this service is performed very inefficiently and in an unhygienic manner. Open trucks and tractors used to transport waste are loaded manually. This time-consuming activity results in loss of labor productivity and increases the occupational health risk to workers.

Major Drawbacks of the SWM Transport System

• Trucks and tractors have open beds. During transport, waste spills from the truck, thereby causing nuisance.

• Practiced manual loading of waste without use of protective gears is dangerous to the health of workers.

• The transport system is not synchronized with the secondary storage system. Problems arise when a transport fleet is modernized, because waste at the secondary storage system is still dumped on the ground. If the secondary storage system is modernized without an sufficient fleet of modern vehicles, similar problems arise.

• Multiple handling of waste results in low labor and equipment productivity.

• Overflowing secondary waste storage depots result from irregular and untimely transport of waste.

• Areas cannot be serviced properly because of an less number of vehicles.

• Vehicles are poorly maintained because of less workshop facilities and maintenance procedures. This problem leads to frequent breakdowns and trucks that are out of service for long periods.

• Spare parts are not readily available, because the procurement system is cumbersome and slow.

• Vehicle movement is not monitored in terms of quantity of waste carried, number of trips made, and optimum use of personnel.

• Unplanned routing of vehicles results in inefficient transport logistics.

4.2.6 Processing of Waste

Waste treatment is intended to reduce the amount of waste to be disposed of or to change its composition in a way that prevents adverse effects on humans or the environment.

In India, waste contains a large proportion of organic matter, ranging between 40 and 50 percent of total waste. This organic matter could potentially be treated and converted into stabilized degraded organic matter, often called compost. Compost is a product that can be used to improve soil quality by increasing its porosity and moisture retention and by supplying nutrients and organic matter for enhanced soil structure and agricultural yield. At the same time, diversion of organic waste from the overall waste stream reduces the burden on landfills so that less land is required for the disposal of waste.

The MSW generated in Indian cities is, by and large, not treated but is directly taken to the open dumpsites. Although India is known for its age-old technology of composting agricultural waste,

composting of municipal organic waste is infrequent. In a few cities, however, initiatives exist for aerobically composting or vermicomposting of municipal organic waste. Some of the initiatives are managed by the private sector, and some are managed by community-based organizations or local authorities. Some show good results. However, many plants are not operated according to their installed capacity. Many plants face problems with compost marketing and find financial sustainability difficult.

4.2.7 Disposal of Waste

Waste disposal is a neglected practice in India. Waste is dumped in low-lying areas that are within or outside the cities and that are designated as dumping grounds or in unauthorized areas on the outskirts of the city. Sometimes waste is even dumped on the approach roads to rural areas, which do not have their own land for disposal of waste. Such practices result in extremely unsanitary conditions and create serious environmental degradation problems.

Waste is dumped in low-lying areas that are within or outside the cities and that are designated as dumping grounds or in unauthorized areas on the outskirts of the city. Sometimes waste is even dumped on the approach roads to rural areas, which do not have their own land for disposal of waste. Such practices result in extremely unsanitary conditions and create serious environmental degradation problems.

Because no segregation of waste at its source takes place, domestic waste of all types, infectious waste from medical facilities, and even hazardous industrial waste are deposited at dumpsites that are actually designated for domestic waste. The waste deposited at such sites is neither spread nor compacted. It is left uncovered to degrade under natural conditions. The sites generate leachate and thus pollute surrounding water bodies, contaminate the air with methane emissions and uncontrolled burning, and create serious health and environmental problems for the city as a whole and, more particularly, for the poor people living in the vicinity of the dumping ground.

4.3 Legal Framework of Solid Waste Management in India

Indian government is working since the fourth 5-Year plan (1969–74), to improve the waste management condition in the country and initiated efforts to establish better facilities for municipal solid waste management (MSWM) by providing grants and loans to state governments to set up MSW composting facilities for waste disposal. Later, in 1975, the Government of India (GoI) appointed a high level committee to review the problems of urban solid waste in India. This committee made total of 76 recommendations covering 8 important areas of waste management like generation, segregation, collection, transportation, disposal etc.

During the period 1975–1980, under the National Scheme of Solid Waste Disposal, 10 mechanical composting plants of processing capacities ranging from 150 to 300 tonnes of MSW per day, were set up in several Indian cities with populations over 300,000. But at the present most of the plants are not working because of the poor quality of the waste, lack of segregation practices, poor maintenance, high production cost etc. Following the failure of these mechanical compost plants, most municipal corporations showed little interest in promoting composting.

In 1998 the Ministry of Environment and forest (MoEF) prepared a draft Recycled Plastic Usage Rules 1998, which bans storing, carrying and packing of food items in recycled plastic bags and specifies quality standards for manufacturing recycled plastic bags. And later this rules was modified with Plastics Manufacture and Usage (Amendment) Rules, 2003.

In 1995, a high powered committee (Bajaj committee) was constituted to review urban solid waste management. The committee has given various suggestions like segregation at source, door-to-door collection system, charging user-fees from citizens, standardization of the design of municipal vehicles for transportation, the need for composting of waste and use of appropriate technologies for waste treatment and disposal.

In January 1998, another expert committee (Asim Burman Committee) was formed under the Honourable Supreme Court of India to identify problems and make recommendations to improve solid waste management in Class I cities. After reviewing all aspects of solid waste management, the committee submitted its detailed report of recommendations in 1999. These recommendations have been incorporated in the Municipal Solid Waste (Management and Handling) Rules 2000.

rules make it mandatory that biodegradable waste must be processed by adopting an appropriate combination of processing system or technologies (composting, vermicomposting, anaerobic digestion, pellatisation, etc.) and landfilling be restricted to only nonbiodegradable, inert waste and other appropriately stabilized biological waste. These rules mandated all cities to set up waste treatment and processing facilities by 2003 (Asnani P. , 2004). In 2000, a comprehensive manual on Municipal Solid Waste Management was published by the CPHEEO under the MoUD for the guidance of urban local bodies (ULBs) to implement the MSW Rules 2000.

Table 4.2: Various legal framework pertain to MSWM

Legal Rules	Aspects pertain to MSWM
The Water (Prevention and Control of Pollution) Act, 1974	Two aspects have been taken regard to MSWM. A consent from the state pollution control board for establishment of a sanitary landfill site and compost plant is essential and, No water pollution should be caused by the leachate that is emitted by the sanitary landfill site or a compost plant.
The Water (Prevention and Control of Pollution) Cess Act, 1977	The only aspect that should be considered in this law in regard to MSWM is provision for levying and collection of cess on water consumed for the sanitary landfilling, composting and anaerobic digesters.
The Air (Prevention and Control of Pollution) Act, 1981	The aspects to be considered in this law with respect to MSWM is the need for obtaining consent from the State Pollution Control Board for establishment of the processing plants and disposal site and from an environmental aspect would be the pollution caused by incineration plants, compost plants and landfill sites.
The Environmental (Protection) Act, 1986	The aspect in regard to MSWM would be the EIA notification, 1944, which states that for any project to be authorized an EIA report should be submitted first.
Recycled Plastic Usage Rules 1998	Plastic manufacture and handling rules.
Municipal Solid Waste (Management & Handling) Rules 2000	This is a thorough manual for MSWM

4.3.1.1 Status of Compliance with the 2000 Rules

Despite consistent efforts of different regulatory bodies and directives from Honorable Supreme Court of India and from time to time regulatory bodies, the implementation of these rules is still a distant dream (Asnani P. , 2004) carried out a study to study the compliance with the MSW Rules 2000 by Class 1 cities. The study reveals that out of 393 Class I cities, 128 responded and there is very less progress in terms of 2000 rules. Major constraints for noncompliance are: lack of technical skilled workforce, unavailability of financial resources, lack of public awareness and motivation, and non-cooperation of the households, trade and commerce (Asnani P. , 2004).

Municipal authorities report numerous reasons for noncompliance with the 2000 rules. Those reasons are listed in table next.

Table 4.3: Compliance with the 2000 Rules (Asnani P. , 2004)

	Compliance with the 2000 Rules							
Activity	storage at source	segregation	primary collection	street sweeping	Storage Depot	transport	processing	disposal
(%) Compliance	41	33	38	72	29	52	9	1.4

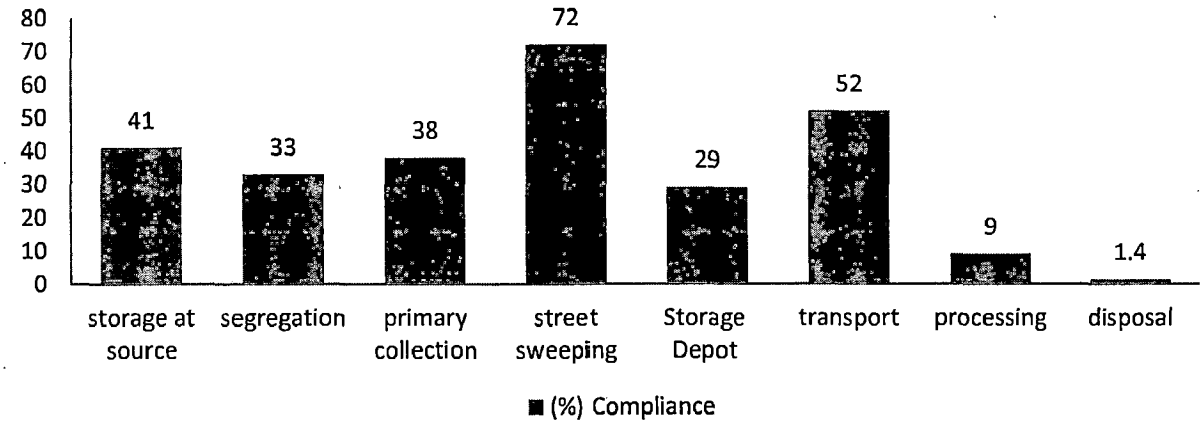


Figure 4.3: : Compliance with the 2000 Rules (Asnani P. , 2004)

4.3.1.1.1 Reasons for Noncompliance with the 2000 Rules

Table 4.4: Reasons for Noncompliance with the 2000 Rules (Asnani P. , 2004)

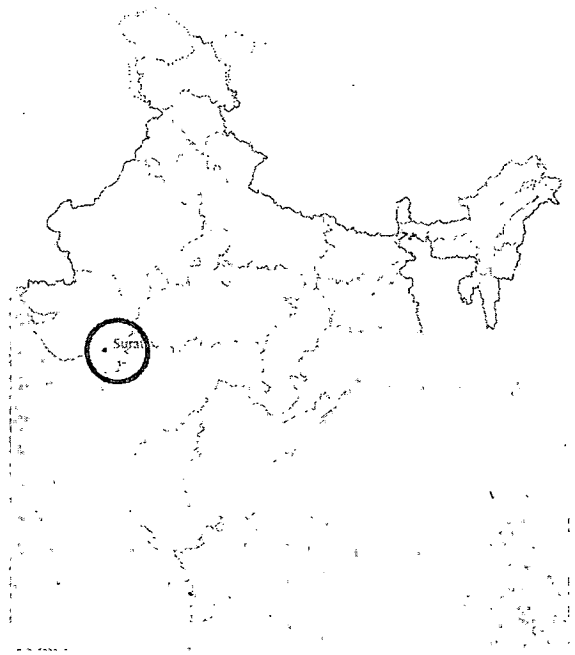
Area of compliance	Reasons for noncompliance
Storage of waste at source	• Lack of public awareness, motivation, and education • Lack of civic sense and bad habits of people to litter • Lack of cooperation from households, trade, and commerce • Lack of stringent panel provision • Lack of powers to levy spot fines • Lack of litter bins in the city

	• Long distance between community bins • Resistance to change in attitude
Segregation of recyclable waste	• Lack of wide publicity through electronic and print media • Lack of public awareness and motivation, resulting in poor response from citizens • Lack of citizens' understanding how to use separate bins for storage of recyclables • Lack of sufficient knowledge of benefits of segregation • Lack of cooperation and negative attitude of people • Lack of finances to create awareness • Difficulty of educating slum dwellers • Lack of effective legal remedy
Collection of waste from doorstep	• Lack of awareness and motivation • Unavailability of primary collection vehicles and equipment • Less response from citizens • Lack of financial resources • Difficulty of motivating slum dwellers • Lack of personnel for door-to-door collection • Lack of suitable containers
Daily sweeping of streets	• Excessive leave and absenteeism of sanitary workers • Unavailability of workers on Sundays and public holidays • Kuchha (unpaved) roads • Lack of financial resources
Abolition of open waste storage depots placement of	• Shortage of containers

containers	• Lack of financial resources • Lack of planning for waste storage depots • Inaccessible areas and narrow lanes that do not allow • sufficient space for containers
Transportation of waste in covered vehicles	• Old vehicles that are difficult to replace
Processing of waste	• Lack of financial resources • Lack of technical know-how • Lack of skilled personnel • Unavailability of appropriate land • Lack of basic facilities to set up treatment plants • Lack of institutional capacity
Disposal of waste at the engineered landfill	• Lack of financial resources • Lack of technical personnel • Lack of technical know-how for scientific disposal of waste • Unavailability of appropriate land • Lack of institutional capacity

4.4 Door to Door Garbage Collection System in Surat, a Case Study

4.4.1 Geographic location



Surat is a city of Gujarat state in western part of India. Surat is the city with a population of more than 40 lacs and the area of 325Sq. Km. located on Mumbai-Ahmedabad rail corridor. The city is having a comprehensive system of MSW management. The waste is being collected from the point of generation is being sent to the disposal site in a systematic manner.

According to national Urban sanitation policy 2008, Surat is one of the 3rd best sanitized city in India.

Figure 4.4: Location of Surat

Table 4.5: Sanitation Rank of Surat (NUSP, 2008)

Rank	City	State	TOTAL Points Scored
1	Chandigarh	CHANDIGARH	73.48
2	Mysore	KARNATAKA	70.65
3	SURAT	GUJARAT	69.08
4	N.D.M.C.	DELHI	68.265
5	Delhi Cantt.	DELHI	61.367
6	Tiruchirapalli	TAMIL NADU	59.0
7	Jamshedpur J	HARKHAND	57.9
8	Mangalore	KARNATAKA	57.3
9	Rajkot	GUJARAT	56.118
10	Kanpur	UTTAR PRADESH	55.3

4.4.2 Focus area

This door to door collection system is focused to strengthen the MSW collection system in the area of Surat urban area.

4.4.3 Situation before implementation of the practice

Before the implementation of this practice, people throw the waste in street and then collected by sweepers in handcart and then they store it to the collection bins. This makes filthy & dirty look in the street and around the container spot.

4.4.4 Problems addressed by this practice

The main moto of the practice was to compliance with Municipal Solid Waste Management and Handling Rules-2000. This system has implemented waste collection at doorstep.

4.4.5 Description of the practice

Before applying the best practice the feasibility report was prepared. Initially a Pilot project has been started as in one ward of all zones. It was further extended in three of seven zones through tender process.

4.4.6 Strategy used

- Selection the vehicle kind based on width of the road.
- Each route has coverage units between 1,000 and 3,000.
- Empowering the existing system of solid waste collection.
- Making public awareness as main priority.
- Total period for concession is kept as Seven years, keeping the idea of the working life of vehicle.
- All the waste collection vehicles are fully equipped with alarm system for better identification of the time of vehicle arrival.
- Commercial units have Facility of collecting waste during 4.00 pm to 11.00 pm daily in each zone.
- First shift is in the morning for residential zone collection timing is 7.00 am to 1.00 pm daily.
- Collection system operates for all days in a year.
- It is part of contractor's scope of work to createPublic Awareness through campaign.
- In the Head office at Mugalsarai & Contractor's office, a centralized complaint management system at with modern communication facilities has been implemented.

- Dry & Wet waste segregation provision.

4.4.7 Outcome of the practice

- The overall environments Improved.
- The waste collection on scheduled time from every house and shop daily.
- Animals around the containers spots reduced in significant numbers.
- Nuisance due to smell was also Reduced.
- Multiple types handling of solid waste avoided.
- Containers numbers has been reduced.
- Open tractors of old collection system curtailed.
- Citizens Consciousness about cleanliness has improved.
- The cost which is required for lifting of containers, has been Reduced significantly.
- The programme implemented by Surat Municipal Corporation got Overall appreciation from various organizations.

4.4.8 Factors of success

- Payment is done on weight basis
- Public is aware about the practice.
- There is a close monitoring of system.
- The contract period of Seven years.

4.4.8.1 Source of finance for the sustainability of the practice

All the major investment is being done by contractors and contract period is kept as 7 years which is viable to recover the capital investment by the agency. the mode of payment on weight basis is the other main factor of sustainability, which is also an attractive aspect for agency, to work effectively. For the finance part of Surat Municipal Corporation is concern, user fee are imposed from the year 2007-08 for municipal solid waste management system which recover the cost of Door to Door collection system to some level.

Figure 4.5: Door to door collection in Surat

Figure 4.6: Transportation and disposal at Surat

5.1 About Jaipur

Jaipur is known as one of the first planned cities of India. Until the eighteenth century, Amber served as the capital and was ruled by the Kachwaha clan of the Rajputs. However, due to its inaccessible tract on the Aravalli hills, it was unable to meet the demands of a growing population. Sawai Jai Singh in 1727 decided to move his capital to the plains, 11 km south of Amber. Jaipur City was not only planned but its execution was also coordinated by Sawai Jai Singh II, in such a manner that a substantial part of the city developed up within seven years of its foundation. His reign was probably the most glorious phase in the growth of the city. The municipality was reorganized in 1926 and a new municipal act was prepared in 1929. Post independence, planned development of the city was taken up after the city became the capital of Rajasthan.

5.1.1 Demography

The population of Jaipur region is 3.1 Million as per 2011 census and has shown a consistent increase in the past 50 years. In fact, in the last decade, the population has increased by 8 lakhs. The area of Jaipur Municipal Corporation has grown from 200 sq.km in 1981 to 218 sq. km in 1991 to 288 sq.km in 2001 to 391 sq. km. in 2011. The increase in area in 1991 was a result of addition of Sangner and Amber tehsils and in 2001-2011 due to the addition of Bagru, Bassi, Chomu, Achrol, Shivdaspura and Jamwa Ramgarh towns in the municipal area. The area under the jurisdiction of JDA has remained same since 1991.

Table 5.1: Area and Population, Jaipur region

S.No.	Area	Total Area (sq. km.)			Total Population (Million)			% JDA Population		
		1991	2001	2011	1991	2001	2011	1991	2001	2011
1.	JMC	218.3	288.4	391	1.52	2.32	3.07	81.4	86.8	87.71
1a.	Walled City	6.7	6.7	6.7	0.5	0.4	NA	26.4	15.0	NA
1b.	Rest of JMC	192.3	281.7	384.3	1.02	1.92	NA	54.7	71.8	NA
2.	Rest of JDA	1220	1149.9	1568	0.35	0.36	0.43	18.6	13.2	12.28
3.	Total JDA	1464	1464	1959	1.87	2.68	3.5	100	100	100

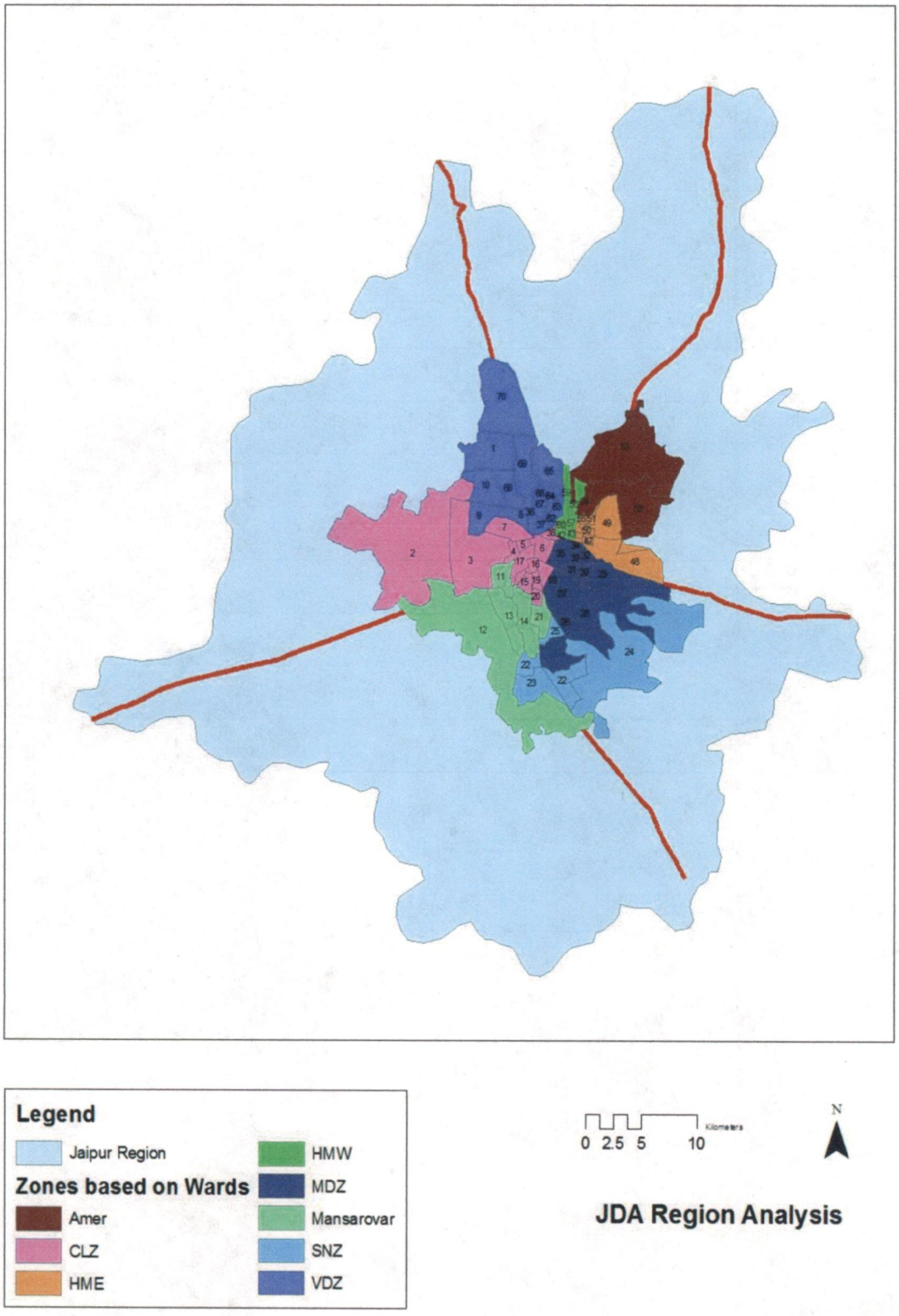


Figure 5.1: Jaipur region & JMC zones (Plan, 2025)

In terms of share, 87% of the total population lives in the JMC area, of which 7% lives in the walled city. While the proportion of population living within the JMC has increased (primarily due to

expansion in area), the proportion of population in the walled city has declined. This can be regarded as positive phenomena as the walled city is already very densely populated. The Walled City has a spatial extent of only 6.7 sq.km but houses nearly four lakh people. The 2001census shows that the population of the Walled City has declined from 1991. The reason for this is out movement of inhabitants from the area to new residential colonies being developed in the periphery in want of better living environment.

The population in the rest of the JDA area does not show much growth from 0.347 million in1991 to 0.355 million in 2001. The rest of the JDA area also includes 495 villages with nearly 0.2 million population. Rest of JDA area accounted only for 18 % in 1991 and 13.2% in 2001 of the total population. Decrease in population of the rest of the JDA area in 2001 is due to the reconstitution of the municipal boundaries.

5.1.1.1 Population Growth Rate

The population of Jaipur city was only 0.3 million in 1951 but in 2001 it has reached 2.3 Million and in 2011 it is 3.07 Million. The annual average growth rate from 1971 to 2001 has been in the range of 4.1 to 4.7.The population growth rate was the highest in the year 1981 but declined sharply by 0.6 %in 1991 and in grew again by 0.2 % in 2001.

Within the JMC, the major growth has occurred outside the walled city area. The population growth within the walled city was nearly equal to that of the rest of the JMC area between 1981-91. However, between 1991-2001, the walled city has witnessed a decline in population. On the contrary, the population growth rate in JMC area has increased partly due to migration and also due to expansion in the JMC area.

Table 5.2: JMC Population growth

JMC Population growth							
Year	1951	1961	1971	1981	1991	2001	2011
Population Million	0.3	0.41	0.64	1.02	1.52	2.32	3.07

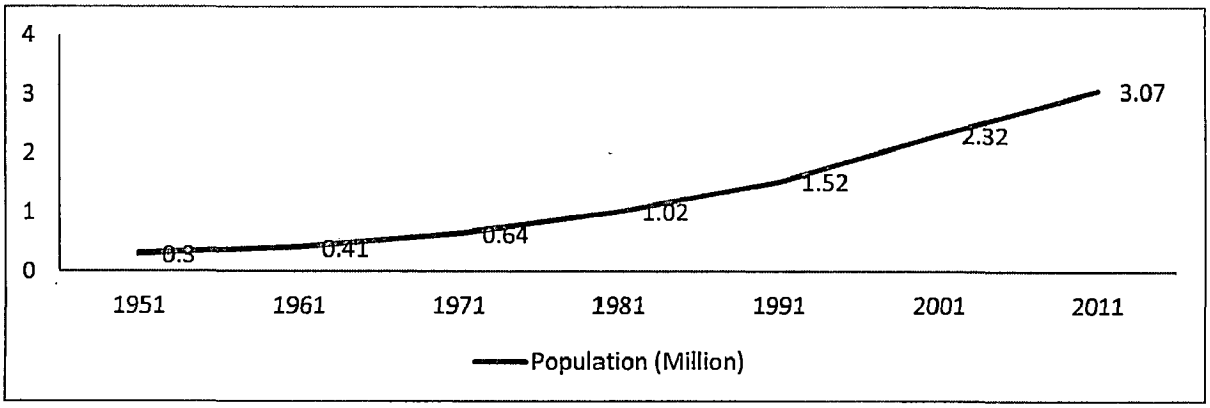


Figure 5.2: JMC population growth

Table 5.3: JMC Population decadal growth rate

JMC Population growth rate					
Year	1971	1981	1991	2001	2011
Growth %	56.09	38	50	80	75

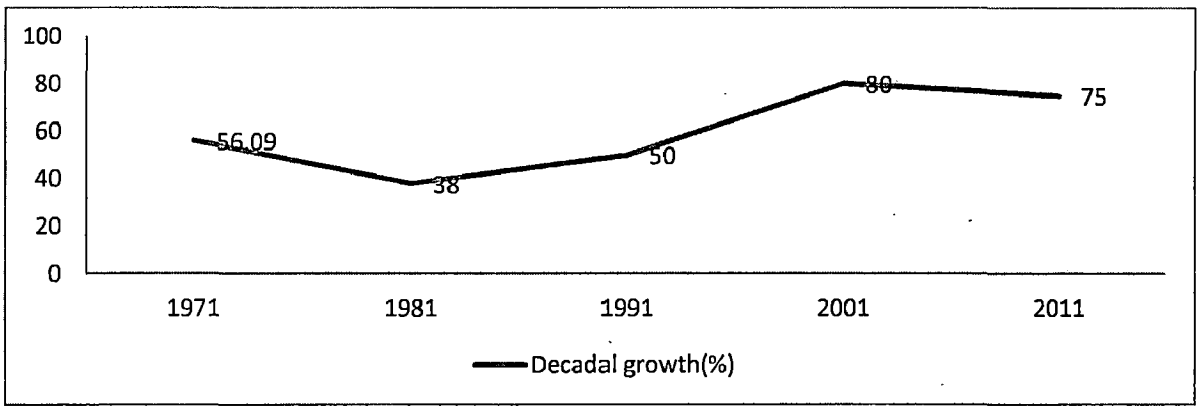


Figure 5.3: Decadal growth rate of JMC population

Table 5.4: Most populous cities in India and Jaipur (Wikipedia)

Rank	City	Population (2011)	Population (2001)	State/Territory
1	Mumbai	12,478,447	11,978,450	Maharashtra
2	Delhi	11,007,835	9,879,172	Delhi
3	Bangalore	8,425,970	5,438,065	Karnataka
4	Hyderabad	6,809,970	3,637,483	Andhra Pradesh
5	Ahmedabad	5,570,585	3,520,085	Gujarat
6	Chennai	4,681,087	4,343,645	Tamil Nadu
7	Kolkata	4,486,679	4,572,876	West Bengal
8	Surat	4,462,002	2,433,835	Gujarat
9	Pune	3,115,431	2,538,473	Maharashtra
10	**Jaipur**	3,073,350	2,322,575	**Rajasthan**
11	Lucknow	2,815,601	2,185,927	Uttar Pradesh
12	Kanpur	2,767,031	2,551,337	Uttar Pradesh
13	Nagpur	2,405,421	2,052,066	Maharashtra
14	Indore	1,960,631	1,474,968	Madhya Pradesh
15	Thane	1,818,872	1,262,551	Maharashtra

Amongst all the mega cities of the country, Jaipur ranks 10th with a total population of 3.07 million. It is one of the fastest growing mega cities of the country with an annual average growth rate of 4.5% whereas the national urban growth rate is only 2%. With its current growth trend, it is likely to supercede many other cities. Jaipur is thus a vibrant city.

5.1.1.2 Population Density

The walled city has the highest population density in the city at 58207 persons/sq km. This is despite the fact that the density has declined from 1991 (74,000 persons per sq.km). The population density of JMC is higher in 2001 than 1991 and has increased by nearly 3000 persons sq. km in spite of expansion of municipal boundary. In 2011, the population density of JMC area is about 7860 persons/sq.km. The JDA area density in 2011 is about 1786 persons/sq km. It is evident that the JDA has the lowest density with JMC at the second place and the walled city with maximum concentration of population.

The densities in the JMC area range from 100 PPH nearly 1000 PPH. However, the density is high only in the walled city. In the rest of JMC area, the densities range from 100 PPH to 550 PPH.

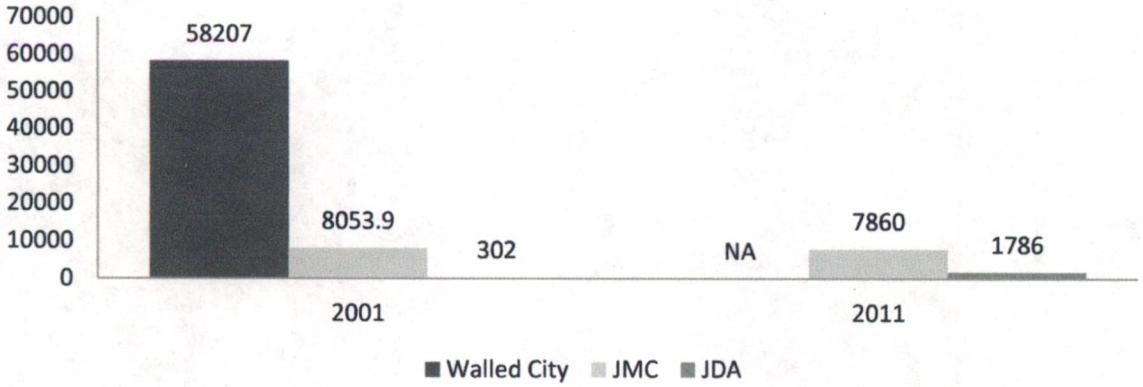


Figure 5.4: Population density, Jaipur

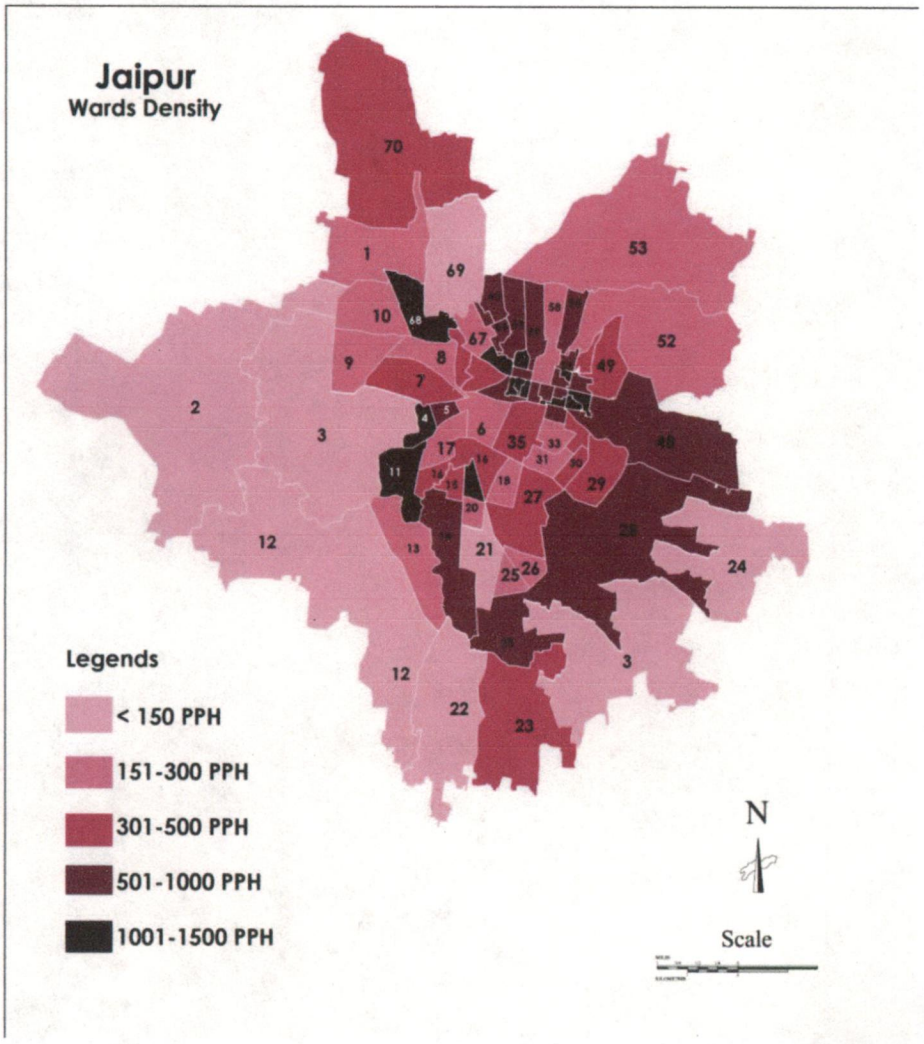


Figure 5.5: Population density of Jaipur (Author, 2012)

5.1.2 Literacy rate

The number of literates in the city has grown from 58.5% in 1991 to 66.2% in 2001 and 73.94% in 2011, which is almost the same of national average of 74%. The city level figures are higher than the corresponding state level data, which in 1991 was only 38.5% and 49% in 2001 and in 2011, it jumped to 67.06%.

The walled city has a lower rate of literacy than the rest of the JMC area. The literacy rate was only 51.65 in 1991 in the walled city whereas for rest of the city it was 55.3 %. The gap widened in 2001 when the literacy rate of walled city dipped to only 40% and in the rest of the city it rose to 75%.

Comparison of literacy among males and females show that more percent of male are literate than females and this holds true also for the state and the country as a whole. 2001 figures show that only 36.5% of females were literates in the walled city. Jaipur has higher female literacy than the state and the national average.

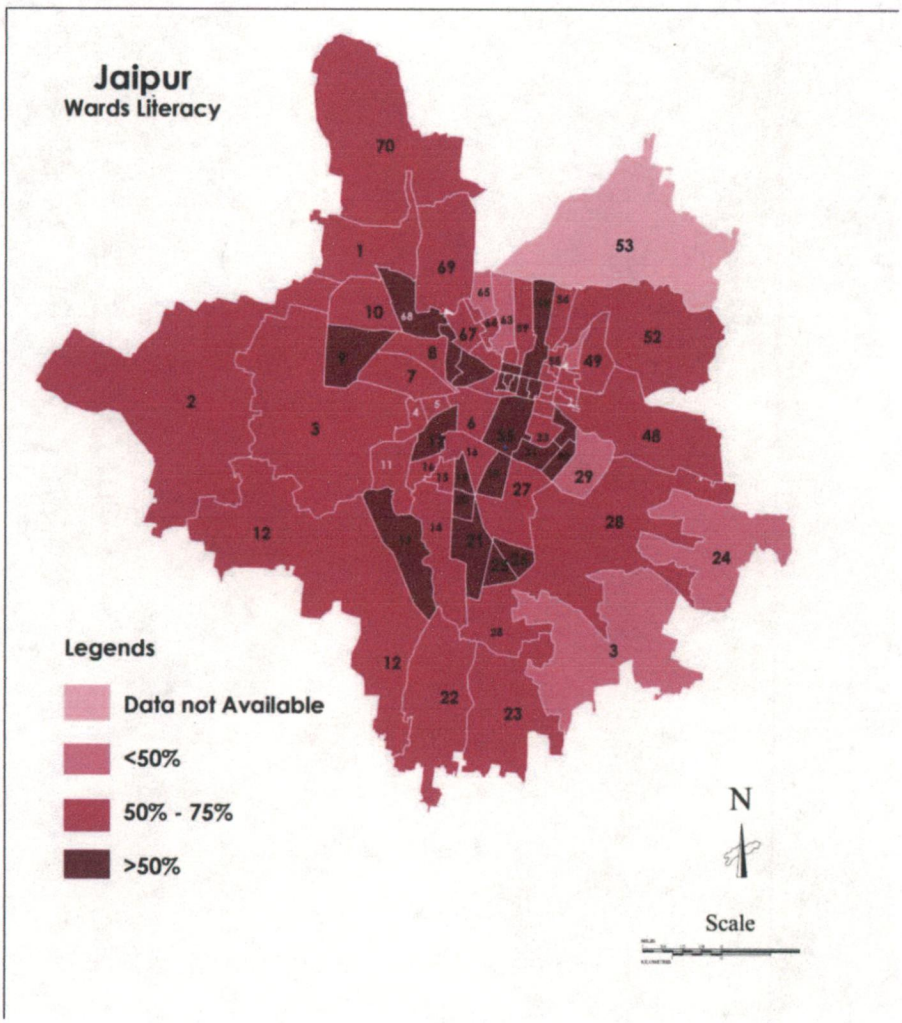


Figure 5.6: Literacy rate in various wards of Jaipur (Author, 2012)

5.1.3 Sex ratio

The sex ratio in Jaipur has been below 900 in the history of the city. The sex ratio in the walled city in 1991 and 2001 has been higher than the rest of the JMC area. In the JMC area the sex ratio shows an improvement from 868 females in 1991 to 876 females per 1000 men in 2001. The sex ratio of the city is lower than both the state (926) and national average (940). In 2011 it is slightly improved with sex ratio of 909.

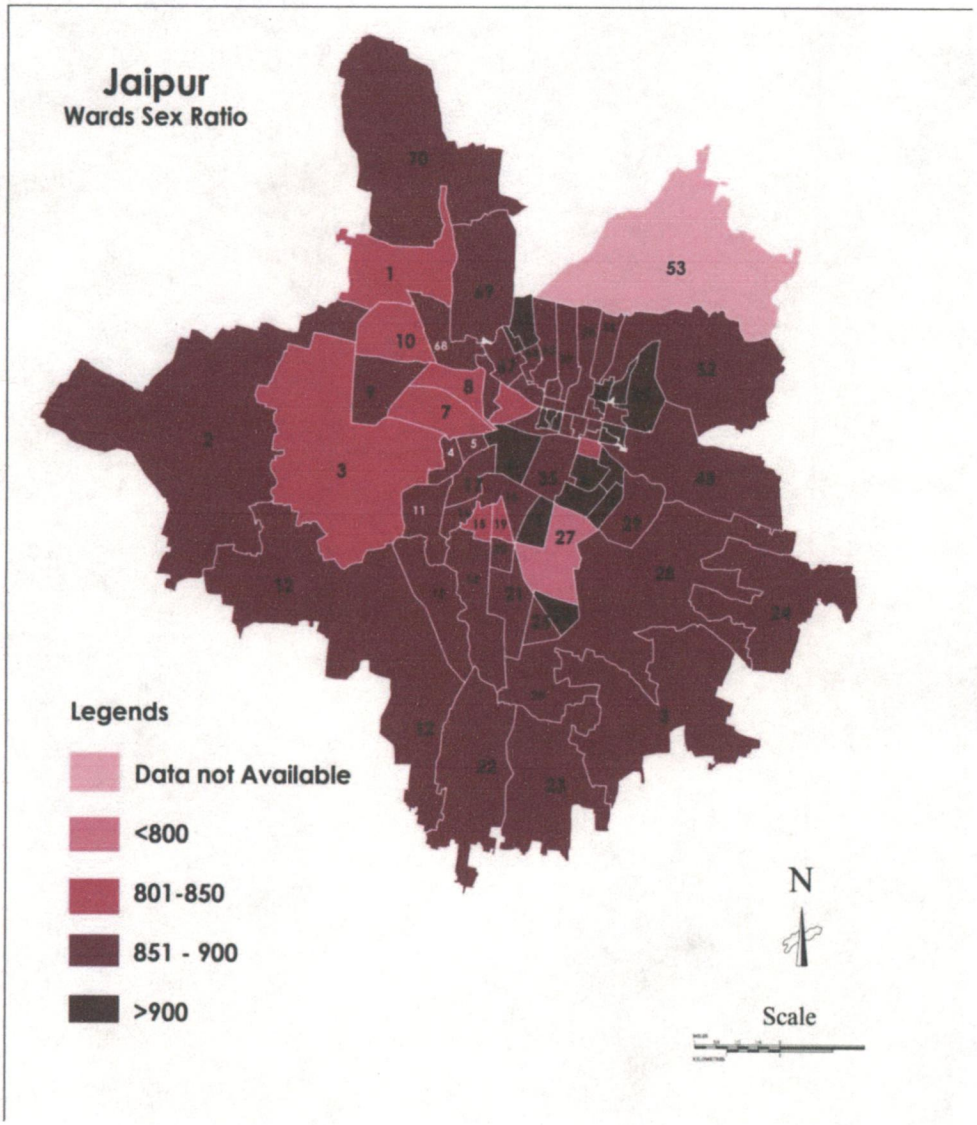


Figure 5.7: Sex ratio in various wards of Jaipur (Author, 2012)

5.1.4 Economy

Jaipur district is a centre for both traditional and modern industries. It is famous as largest exporter of gold, diamond and stone jewelery in Asia and the only city finishing blue diamond, or tanzanite, in the world. The main industrial products include: acetylene gas, ACSR (Aluminum Conductor Steel Reinforced) cable, all-purpose flour (maida), atta flour, ball bearings, bottling of LPG, ceramics,

pottery, cold roll strips, corrugated boxes, deoiled cakes, durries, dyeing and printing, edible oil, electronic items, engraving on brass items, ferrous and non-ferrous castings, gems and jewelry, general engineering and manufacturing, granite slabs and tiles, hand-made paper, handicraft items, halogen automobile headlamps, "hawai" chappals (sandals), household electrical appliances, HT steel strips, iodized salt, lamps, laminated springs for railways, marble statues, marble tiles & slabs, moulded plastic components for electronics, nitrochlorobenzene, oxygen gas, perfumes, pigments, plastic containers, P.P. multifilament yarn, PVC cables, PVC doors, PVC footwear, canvas shoes, Portland cement, ready made garments (clothing), re-roller products, semolina (suji), steel furniture, steel ingots, stone grits, synthetic leather, suits & shirts made of synthetic materials, tablets and capsules, two way radio and line, washing soap, wheat, woolen carpets, refined vegetable oil and vanaspati ghee heavy Steel fabrication, brass and lacquer work, enamel work, gems and jewelery, granite tiles, handlooms, printed cloth and textiles, ready made garments, woolen and silk carpets.

Jaipur has been ranked 31 among the 50 Emerging Global Outsourcing cities. Genpact and Infosys have their BPO already established and running successfully. In fact Genpact has the fastest growing location in Jaipur. Real Estate business is flourishing well from last 2–3 years. Some of the companies already present here include MICO, Coca Cola, IBM, Ericsson and NEI, popularly known as NBC Bearings.

Jaipur also has Reserve bank of India and many other prominent international banks. India's largest integrated IT SEZ Mahindra World City is located in Jaipur. Master planned by Jurong Constructions Singapore it covers nearly 3,000 acres (12 km2) of land off Ajmer highway and has already attracted major companies like Infosys, TCS, Wipro, Tech Mahindra, ISYS BPO Services, Truworth and Deutsche Bank. India's one of a kind World Trade Park is also under construction in Malaviya Nagar. It will be having a luxury hotel, business halls and many showrooms of international brands. In coming years it is projected to become a hub for modern business development in Jaipur.

5.1.4.1 Commercial Areas

5.1.4.1.1 Walled City

The walled city of Jaipur acts as a central business district for the city with over 60% of the commercial activities concentrated here. It is famous for its traditional handicrafts, gems and jewelry, textile, wooden furniture, leather bags etc. The walled city. As the walled city is the traditional bazaar of Jaipur, not only attracting the locals, but also the tourists, the area has witnessed an increase in the traffic. Thus the walled city needs to be treated carefully and sensitively in view of its high density and multiple use.

5.1.4.1.2 Planned Commercial Centers

The planned commercial centres in the Jaipur are:

(a) Lal Kothi District Centre

(b) Subhash Nagar District Centre

(b) Vidyadhar Nagar Central Spine

(c) Indira Place, JLN Marg

(d) Jagatpura Central Spine

5.1.4.2 Wholesale Trade

The Wholesale Trade sector comprises establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale like outputs of agriculture, mining, manufacturing, and certain information industries, such as publishing.

The major markets under wholesale trade are given below. Surajpole is the biggest grain market and handles nearly 47% of total income of food grains in the city. The other respective wholesale markets are listed below.

Table 5.5: Wholesale markets in Jaipur City

S.No.	Type of Market	Location Area
1	Grain Market	Surajpole Mahapura-Kukarkhera
2	Fruit And Vegetable Markets	Muhana Terminal Market
3	Building Material	Agra Road VKIA Kalwar road
4	Iron and Steel Hardware	Chaura Rasta, Sansarchandra Road, Loha Mandi and Machua
5	Lakkad pathar mandi	Admasaili, Delhi Bye Pass
6	Slaughter House	Chainpura, Ramgarh Road

5.1.4.3 Specialized Markets

Certain specialized markets exist which market only one type of product. These are generally non-perishable and non-daily usable goods markets like building materials, electronics, electrical, vehicle parts, etc.

Table 5.6: Specialized Markets in Jaipur

Sr. No	Name	Specialization
1	New Aatish market	Building materials
2	Jayanti Bazaar	Electronics
3	Delhi Bye-Pass	Truck and Bus body- building parts

5.1.5 Industry

5.1.5.1 Organized Industrial areas

There are 6 major industrial areas in the city namely V.K.I.A[1]., Jhotwara, Kanakpura and Bindayaka in the north west, Sitapura and Sanganer industrial areas towards the south of the city and Malviya industrial area towards south east.

5.1.5.2 Unorganized Industrial areas

A number of household industries are present in Jaipur, mostly in walled city and engaged in works such as stone cutting and polishing, blue pottery, lac work, gota sculptures etc. The household industries are acting as savior to the traditional art and craft for which Jaipur is famous. A total of 5.09 percent of workers are engaged in the household industry as per the census 2001.

5.1.6 Land Use Pattern

Table 5.7: Jaipur land use pattern

SN.	Land Use	Area (ha.)	% of developed area	% of total area
1	Residential	19072	68.02	
2	Commercial/Mixed	1978	7.05	
3	Industrial	2119	7.56	
4	Public/Semi Public	2029	7.24	
5	Army	1103	3.93	
6	Parks	543	1.94	
7	Circulation	1196	4.27	
8	Developed Area	28040	100	35.14
9	Agriculture	30708		38.14
10	Water bodies	322		0.40
11	Forest	7445		9.33
12	Open Spaces	13285		16.65
	Total area (8+9+10+11+12)			100

[1] *Vishwakarma Industrial Area*

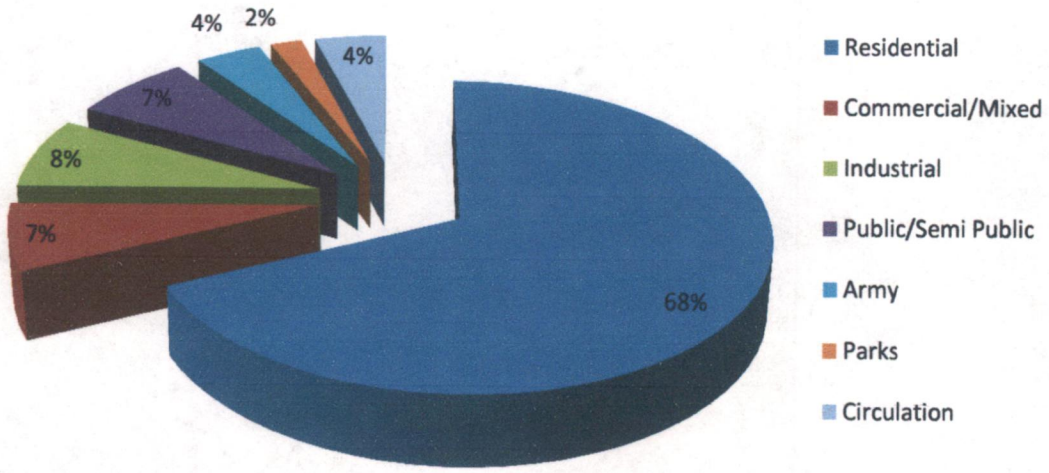


Figure 5.8: :Land Use breakup of Jaipur

5.1.7 Physical Infrastructure of Jaipur

5.1.7.1 Water supply

The Jaipur city covered with Municipal water supply. The city water supply is dependent on tube wells as well as the newly launched project, ***Bisalpur dam water supply***. There are many borewell fitted with power pumps which supplies water to the clear water reservoir (CWR). The water from tubewells fitted with power pumps are collected in CWRs before pumping to ESRs before distribution to system.

In 2005, the entire population was not dependant upon PHED[2] water supply. According to PHED estimates, about 23.80 lakhs population was being served by PHED water supply system, the rest 3.72 lakhs population was served through other systems eveloped and maintained by housing cooperative societies or from own sources. Thus in 2005, about 86.50 % populations were under PHED supply system.

The Jaipur water supply system is predominantly dependant upon ground water. The only surface source namely Ramgarh lake, which used to be the main source of supply more than 30 years back,

[2] PHED: Physical Health and Engineering Department

produces insignificant quantity. After the monsoon of 2005, not enough quantity was received in the lake and the present level is only about 29'. No water is being drawn from the lake at present and the current storage is being kept in reserve to meet the contingency situation during summer season. About 1 mld is being however drawn from the seepage from the dam. The 1340 tube wells scattered over various parts of the city, are responsible for the bulk of the total production (347 mld). In addition, there are about 1845 hand pumps installed at various locations, which help in meeting the demand of the weaker sections of the society.

5.1.7.2 Sewerage

Sewerage system in Jaipur was first laid more than 75 years ago. The city was confined to four walls at that time and sewer networks were provided within the old city. Topographically, Jaipur is divided in two sewerage zones, the north zone and the south zone. The line joining Chandpole and Surajpole gates lies along the ridgeline, which divides these zones.

Area north of the ridgeline drains towards a depression called as Man Sagar or Jal Mahal. Canals downstream of Man Sagar dam ultimately drain in to a seasonal river in the east, called Dhoond river, which flows in a north to south direction. The south zone is featured by existence of a valley situated in the heart of outer city, popularly known as Ganda nallah, also flowing in a north – south direction and ultimately joining Dhoond river in the extreme southeast. Thus the entire drainage of Jaipur takes place towards the east – southeastern direction.

Existing sewerage system of north zone was refurbished between 1977 and 1980 by PHED under a project. A sewage treatment plant of 27 mld capacity, based on extended aeration system was also installed under this project. The system after commissioning functioned satisfactorily for about 5 years and Jal Mahal lake during that period was a clear water lake. Due to poor upkeep of the plant subsequently however, resulted in lake again becoming polluted, which is the status today. Now under the RUIDP, refurbishment of this treatment plant is underway.

Sewer networks have been laid in a large number of colonies in the south zone prior to 1990. In the absence of southern outfall sewer, wastewaters from these colony networks were discharged into Ganda Nallah. Between 1997 and 2000, PHED laid a 17 kms long southern outfall sewer of diameter varying between 1200 and 1800 mm. This facilitated the collection of sewege at Delawas, where a 62.5 mld capacity treatment plant has been installed under the RUIDP, which is on the verge of commissioning.A large number of colonies have also been covered by sewer networks under the RUIDP. The present sewer networks comprise about 605 km of sewerlines.

The existing sewerage system covers about 65 % of total area of Jaipur. In the areas uncovered by sewerage system septic tanks are used to dispose night soil. According to the studies conducted by

Safage in 1998, the septic tanks cater to about 25 % of the population in Jaipur. Roughly about 1,20,600 septic tanks are in use in Jaipur. Basic sanitation facilities are absent in most of the slums and Katchi Bastis. Most of these places neither have sewerage system nor septic tanks. There are about 76 community latrines throughout Jaipur catering to the slums and public in general, which is much below the requirement. As a result most of the slum dwellers resort to open defecation along the roads and open drains polluting the surroundings and risking their health. This problem is also rampant in places like bus stands, bus stops and around community centers such as hospitals, Marriage gardens, etc.

5.1.7.3 Urban transportation

The road and the rail sector play a very significant role in Jaipur and the surrounding region. Transportation categorized in Regional linkages, city level road network, traffic characteristics, parking and public transportation system. Regional linkages describes the connectivity of Jaipur city to the other cities. City level road network identifies the main arterial roads inside the city and features related to it. Traffic characteristics details out the traffic volume, flow characteristics, modal split and vehicle growth in Jaipur city. The section on parking deals with the present parking scenario in the city mainly in commercial areas. Public transportation system section talks about the modes of public transport and other details associated with it. Regional linkages and connectivity is described in the ensuing section.

Regional Linkages

Jaipur is well linked to the rest of the country by roads, rail and air. National highway 8 and National highway 11 intersect at Jaipur and NH 12 leading to Jabalpur starts from Jaipur. NH-8 connects Bombay and Delhi while NH-11 connects Agra and Bikaner. NH-8 transects the city in North-South direction and NH-11 does so in an East-West direction. An estimated 38% of the vehicles enter the city from Ajmer Road, 18% from Delhi Road, 17% from Agra Road, 14% from Tonk road and the remaining 13% from Bikaner and Kalwar Roads. The city lies on Delhi- Ahmedabad rail route of Western Railways. It is well connected to Delhi, Agra, Ahmedabad, Calcutta, Jodhpur, Kanpur and Mumbai by more than 3 trains daily, the maximum being for Delhi with 9 trains. The Jaipur airport is situated in South of the Jaipur city at Sanganer. It presently caters to domestic flights but is proposed to be upgraded to an International Airport.

City level road network

The transport of Jaipur is mainly road based in the absence of an MRTS. The road network characteristic is very different for the walled city and the areas outside.

Walled city:

The walled city has a grid pattern of roads and most of the wholesale and retail trade activities are located in the walled city. The road network follows a hierarchy. The major East-West, Surajpol Chandpol road and North-South Roads which form the sector boundaries measure 33m wide. Following this there is a network of 16.5m wide roads which run North-South in each sector linking

The road condition is not good inside the walled city except the main roads. The by-lanes are Very narrow and pedestrian vehicle conflict chances are extremely high.internal areas of the sectors to the major activity spine formed by the major roads.

Outside the walled city:

Jaipur city has around 10 major arterial spines which criss-cross the entire city. Tonk road is a major arterial road that connects some of the major job centers like Sanganer, Durgapura and Lal Kothi. The section of the Tonk road from Gandhi Nagar to Ramniwas garden is known as Sawai Ramsingh Road. MI road runs from Ghat Gate to Railway Station Road connecting high job areas like Bani Park, Sindhi Camp and Transport Nagar. JLN marg runs straight from Jaipur circle to Ramniwas Garden and has many important sites like the Laxmi Narayan temple, Albert Hall, Rajasthan University and other institutions on its either side. Ajmer road connects Ajmer and Jaipur. It terminates in Jaipur at the intersection of MI Road and Sansar Chandra Road. Agra Road terminates at the beginning of MI Road. Khatipura Road starts from the railway station and runs towards Khatipura lying to the West of the city.

5.1.8 Social Infrastructure

5.1.8.1 Healthcare

Table 5.8: types and number of Health Care Facilities in Jaipur

SN.	Facility	No. of Service providers	No of Beds
1	Allopathic Hospital	29	5648
2	Allopathic Dispennsary	56	98
3	Ayurvedic and Unani Hospital	8	30
4	Ayurvedic and Unani Dispensary	30	
5	T.B. Hospital + Sanatorium	2	280
6	Mother and Child care Centre	17	592
7	Mental Hospital	1	332
8	Aids control Centre	2	
9	Leprosy Care Centre	3	30
10	Counselling & De-Addiction Centres	3	12

5.1.8.2 Educational

Table 5.9: Educational facilities in Jaipur

S. No.	Facility	Total Number
1	Universities	6
2	Medical Colleges	3
3	Engineering Colleges	13
4	Management Colleges	8
5	Polytechnics Colleges	3
6	I.T.T's	4
7	B.Ed. Colleges	14
8	Gen. Colleges	22
9	Sr. Sec. & Sec. Schools	845
10	High Schools	2414
11	Primary Schools	2952
12	Anganwaris	613
13	Adult Education Centres	176

5.1.8.3 Recreational

Table 5.10: Recreational and Socio Cultural Facilities in Jaipur

S. No.	Facility	Number
1	Auditorium	2
2	Planetarium	1
3	Convention Centre	3
4	Observatory	1
5	Science / Traffic Park	1
6	Technology Park	1
7	Cultural Centre	2
8	Museums	5
9	Art Galleries	40
10	Exhibition / Fair Grounds	6
11	Sport Complexes	5
12	Amusement Parks	3
13	Resort and Clubs	25
14	Movie Theatres	22
15	Discotheques	6
16	Café / Coffee Shops	12
17	Gymnasiums	10
18	Florists	25
19	Polo Club	1
20	Flying Clubs	1
21	Shooting Range	1
22	Archery	1
23	Forts	4
24	Public Gardens	4
25	Kite flying clubs	1

Chapter 6. NATIONAL URBAN SANITATION POLICY & JAIPUR

The National Urban Sanitation Policy (NUSP) launched during 2008 envisages "All Indian cities and towns become totally sanitized, healthy and livable and ensure and sustain good public health and environmental outcomes for all their citizens with a special focus on hygienic and affordable sanitation facilities for the urban poor and women."

6.1 National Rating Scheme for Sanitation

In order to rapidly promote sanitation in urban areas of the country as envisaged in the NUSP 2008 and to recognize excellent performance in this area, the Ministry of Urban Development (MoUD), Government of India (GoI), has instituted an annual rating and award scheme for cities. The award (Nirmal Shahar Puraskar) is based on the premise that improved public health and environmental standards are two key outcomes that cities must seek to ensure on for their citizens. In doing so, governments in states and cities will need a plan and implement holistic citywide sanitation plans, thereby putting in place processes that help achieving outputs pertaining to safe collection, confinement and disposal of solid and liquid wastes.

The first rating of cities with regard to their performance in sanitation improvements, based on set of objective indicators of outputs, processes and outcomes and uniformly methodology, was carried out in 2010 across the 423 cities to set the baseline ranking. Brief details of city sanitation ranking indicators are given below:

6.1.1 Three Categories of Indicators

The rating exercise will involve three categories of indicators:

1. **Output Indicators:** pertain to the city having achieved certain results or outputs in different dimensions of sanitation ranging from behavioural aspects and provision, to safe collection, treatment and disposal without harm to the city's environment. There are nine main output- indicators accounting for 50 points of the total of 100 points.

2. **Process Related:** indicators pertain to systems and procedures that exist and are practiced by the city agencies to ensure sustained sanitation. There are seven main process-indicators accounting for 30 points of the total of 100 points.

3. **Outcome Related:** indicators include the quality of drinking water and that of water in water-bodies of city, as also the extent of reduction in sanitation-related and

water-borne diseases in the city over a time period. There are three main outcome-indicators accounting for 20 points of a total of 100 points.

Cities are expected to undertake an objective self-assessment from time to time. Jaipur city ranked 230 out of 423 with 33.67/100 points (see table below) and falls in the red category in the baseline survey. The following chart shows the total and secured points for the Jaipur city for different indicators:

Table 6.1: Rating chart for Sanitation of Jaipur city (NUSP, 2008)

RATING CHART FOR SANITATION IN JAIPUR CITY			
NO	**INDICATORS**	**TOTAL POINTS***	**POINTS SECURED**
1	**OUTPUT RELATED**	**50**	**10.29**
A	No open defecation sub-total	**16**	**6.7**
I	Access and use of toilets by urban poor and other un-served households (including slums) - individual and community sanitation facilities	4	**0**
II	Access and use of toilets for floating and institutional populations - sufficient public sanitation facilities	4	**2.1**
III	No open defecation visible	4	**1.7**
IV	Eliminate Manual Scavenging and provide personnel protection equipment to sanitary workers	4	**4.0**
B	Proportion of total human excreta generation that is safely collected (6 points for 100%)	6	**1.5**
C	Proportion of total black waste water generation that is treated and safely disposed of (6 points for 100%)	6	**0**
D	Proportion of total grey waste water generation that is treated and safely disposed of (3 points for 100%)	3	**0**
E	Proportion of treated wastewater that is recycled and reused for non potable applications	3	**0**
F	Proportion of total storm-water and drainage that is efficiently and safely Managed (3 points for 100%)	3	**1.0**
G	Proportion of total solid waste generation that is regularly collected (4 points for 100%)	4	**0.0**
H	Proportion of total solid waste generation that is treated and safely disposed of (4 points for 100%)	4	**0.0**
I	City wastes cause no adverse impacts on surrounding areas outside city Limits (5 points for 100%)	5	**0.0**
2	**PROCESS RELATED**	**30**	**15.39**
A	M&E systems are in place to track incidences of open defecation	4	**0**
B	All sewerage systems in the city are working properly and there is no exfiltration (Not applicable for cities without sewerage systems)	5	**4.0**
C	Septage / sludge is regularly cleaned, safely transported and disposed	5	**4**

	after treatment, from on-site systems in the city (Maximum 10 marks for cities without sewerage systems)		
D	Underground and Surface drainage systems are functioning and are well maintained	4	**2**
E	Solid waste management (collection and treatment) systems are efficient (and are in conformity with the MSW Rules, 2000)	5	**1.87**
F	There is clear institutional responsibility assigned; and there are documented operational systems in practice for b)/c) to e) above	4	**1**
G	Sanctions for deviance on part of polluters and institutions is clearly laid out and followed in practice	3	**2.5**
3	**OUTCOME RELATED**	**20**	**8.0**
A	Quality of drinking water in city compared to baseline	7	**7**
B	Water quality in water bodies in and around city compared to baseline	7	**0**
C	Reduction in water-borne disease incidence amongst city population compared to baseline	6	**1**
	TOTAL	**100**	**33.67**

Total score for the city (with colour code)	**33.67 (Red)**
1. OUTPUT RELATED INDICATORS	10.29 / 50
2. PROCESS RELATED INDICATORS	15.38 / 30
3. OUTCOME RELATED INDICATORS	8.00 / 20
Contribution of Solid Waste related indicators	**1.87 / 18**

6.1.2 Colour Coding in Sanitation Ranking

Table 6.2: Colour coding in sanitation ranking (NUSP, 2008)

No.	Category	Description	Points
1	RED	Cities on the brink of public health and environment 'emergency' and needing immediate remedial action.	<33
2	BLACK	Needing considerable improvement	<34<=66
3	BLUE	Recovering but still diseased	<67<=90
4	GREEN	Healthy and clean city	<91<=100

6.1.3 Overall Ranking of Jaipur city

Table 6.3: Position of Jaipur city in Sanitation Ranking (NUSP, 2008)

Rank	City	State	TOTAL Points Scored
1	Chandigarh	CHANDIGARH	73.48
2	Mysore	KARNATAKA	70.65
3	Surat	GUJARAT	69.08
4	N.D.M.C.	DELHI	68.265
5	Delhi Cantt.	DELHI	61.367
6	Tiruchirapalli	TAMIL NADU	59.02
7	Jamshedpur J	HARKHAND	57.96
8	Mangalore	KARNATAKA	57.34
9	Rajkot	GUJARAT	56.118
10	Kanpur	UTTAR PRADESH	55.34
230	Jaipur	RAJASTHAN	33.676
231	Bahadurgarh	HARYANA	33.657
232	Jabalpur	MADHYA PRADESH	33.627

National Urban Sanitation policy indicates that Jaipur is one of the worst cities in terms of sanitation condition. The solid waste indicators show the story very clearly that Jaipur is one of the least managed cities in terms of Municipal Solid waste management in our country. Total solid waste related indicators are 18 out of 100 and Jaipur scored only 1.87 out of these 18 points which is a shame on the authority of Jaipur as well as on Jaipur Municipal Corporation. So there is a huge potential of improvement in solid waste management in Jaipur, which require policy planning, financial assistant, public participation and general awareness.

Chapter 7. SITUATIONAL ANALYSIS OF CURRENT MSWM IN JAIPUR

7.1 Current status of Municipal solid Waste Management

The city was founded in 1727 by Maharaja Sawai Jai Singh for the population of approx 50000 and now it accommodates more than 3 million people. According to National Urban Sanitation Policy-2008, Jaipur is ranked at 230th position out of total 423 cities surveyed in sanitation condition. The worst affected urban service in the city is the solid waste management. Solid waste management is one of the major headaches for any municipal corporation in India and Jaipur is also one of the examples of most neglected waste management system. The waste generation in Jaipur city is around 1200 MTpd and the collection efficiency is about 80% (JMC), which is projected to rise 3643 MTpd by 2021 (CDP, Draft City development Plan, Jaipur, 2005) . Development research group also figured out the waste generation around 1740 MTpd and collection efficiency to only 50%. There is one treatment plant also, with private sector partnership (Grasim Industries) a new refuse derived fuel paletization unit has been set up Lengriyawas sanitary landfill site with 500mtpd capacity. Due to poor collection of MSW and several operational problems, this plant is not able to run its full capacity. Most of the waste is disposed in three uncontrolled open landfills sites at the outskirts of the city. In absence of proper sanitary landfill sites, these landfills are a major source of groundwater contamination and air pollution.

Waste generation rate of Jaipur is 0.75 kg per capita daily waste which amounts to total waste at ***1740 MT/ day*** in Jaipur, however only ***975 MT*** of solid waste gets collected with an efficiency of about 50% only (According to Development Research Group Study). The Jaipur Municipal Corporation has identified 2868 collection sites, out of which only 230 have collection bins. Thus 90% sites in the city are open dump sites posing serious sanitation and health problems. Transportation is done through open tractors, JCB, Dumpers, loader etc. Jaipur Municipal Corporation has developed 3 waste disposal sites which are around 6 to 17 km. from the city. These sites are open dump sites, not sanitary landfills.

7.1.1 Jaipur's Waste Management Hierarchy

At the political level, the mayor is at the top, accompanied by a health and sanitation committee, made of up five elected and three nominated members. The administrative hierarchy is headed by a CEO, under whom is a health commissioner, garage commissioner, and a chief engineer (CE) (Chart.1). Jaipur is divided into 77 wards grouped into eight zones.

7.1.1.1 Political Hierarchy

- Mayor
- Health and Sanitation Committee (Includes 5 elected and 3 nominated members.)

7.1.1.2 Administrative Hierarchy

In administrative hierarchy, the top position is acquired by Ceif Executive Ofiicer. There are three positions under CEO, namely Commissioner (Health), Commissioner (Garage) and Chief Engineer (CE).

Garage commissioner section oversees vehicles and transportation CE section oversees development of landfill sites, processing plants, and civil development for SWM.

Chart of entire administrative hierarchy has been given in annexure –1

7.2 Waste Generation

According to JMC, the total waste generation in Jaipur city is 1040 MTpd and the same is 1239 as per Rajasthan Urban Infrastructure Development Project (RUIDP). The collection efficiency is around 80% of the waste generated. While the estimated quantity of waste generated in 2001 was around 1100 TPD (source, JMC) (As estimated by JNN, 1040 metric tones per day of solid waste was generated in 2001-02 while RUIDP estimated it to be 1239 mtpd, and 80% of that waste was being transported each day which comprised fresh as well as old waste of backlog. Hence from 2001 to 2010 the total municipal solid waste generated has increased by 16%. Table 6 below shows the waste generation from various sources as per the JNN data, RUIDP data and Development research group data. DRG estimated the total waste generation to about 1740 MTpd and collection efficiency to only 50%.

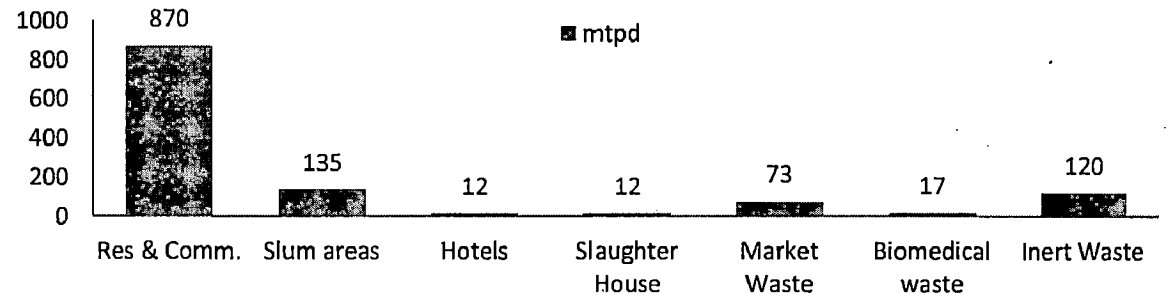


Figure 7.1: Waste generation estimated by RUIDP as on 2001-2002

Table 7.1: Waste generation estimated by RUIDP and JNN as on 2001-2002

Type of waste generation as estimated	Quantity of waste (mtpd) as per RUIDP	Quantity of waste (mtpd)as per JNN	Quantity of waste (mtpd) as per DRG[3]
Residential and commercial sources	870	-	-
Slum areas	135	-	-
Hotels	12	-	-
Slaughter House Waste	12	-	-
Market Waste	73	-	-
Total MSW	1102	1040	1740
Biomedical waste	17		
Industrial Waste	NA	NA	
Construction and Demolition waste	120		
Total Waste Generated	1239	1040 (only MSW)	1740

Table 7.2: Zone wise population and waste generated in 2010 ((JMC)

	Zone wise population			
Zone	2001	2010	Waste Collected in 2010 (TPD)	Waste Generated in 2010 (TPD)
Hawa Mahal (East)	324152	414299	145	181
Hawa Mahal (West)	185528	237183	83	104
Moti Dungri zone	256228	327485	115	145
Civil Line zone	402278	514152	180	225
Vidyadhar Nagar zone	528012	674852	236	295
Sanganer zone	228688	292286	102	127
Mansarovar zone	246375	314892	110	137
Amer zone	117811	150574	53	66
Total	2289072	2925723	1024	1280

From the above table the population of the city has increased by 28% in 2001 to 2010 while the total municipal solid waste generated has increased by 16%. Table 8 below shows the trend of waste

generation in Jaipur as in Kg per capita per day in 2001, 2004 and 2010. In table 9, the projection of waste generation has been calculated and it is estimated that by 2021, total waste generation in Jaipur city will be 3643 MTpd.

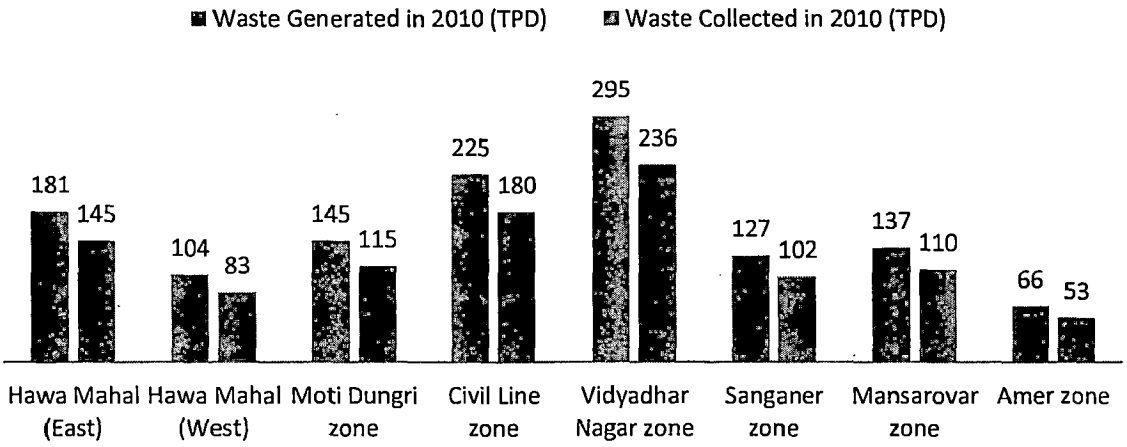


Figure 7.2: Waste generated and collected (JMC)

Table 7.3: Waste generation rate (kg/c/day)

S. No		Waste generation rate (kg/c/day)	Source
1	2001	0.48	JMC, 2001
2	2004	0.39	CPCB, 2004
3	2010	0.44	JMC, 2011

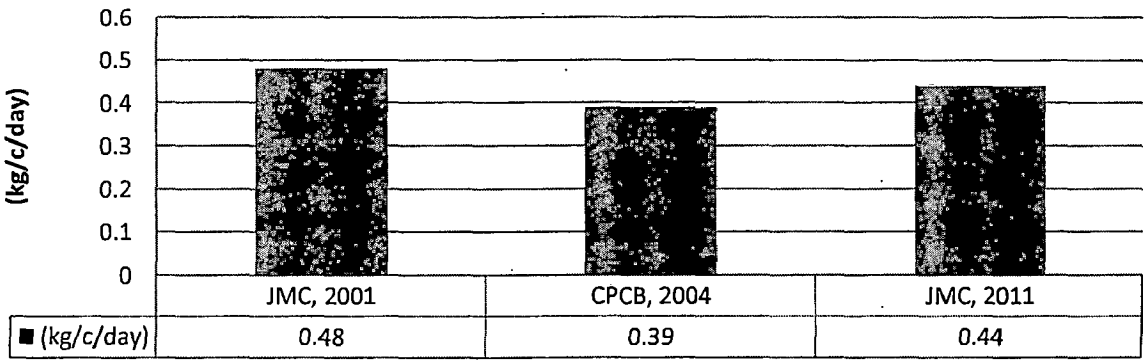


Figure 7.3: Waste generation rate in Jaipur city (kg/c/day)

Table 7.4: Waste Generation (mtpd) Projections for JNN (CDP, Draft City development Plan, Jaipur, 2005)

Years	2001	2010	2016	2021
Population (High Growth Based)	2322575	2925723	4607674	5880690
Waste Generation (mtpd)	1040	1280	2649	3643

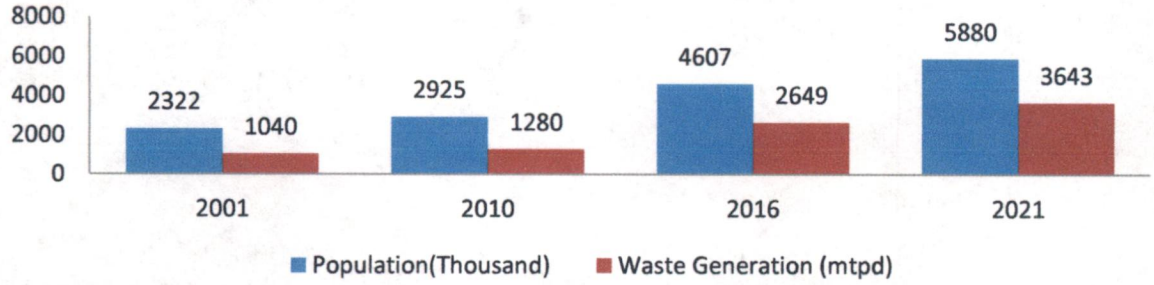


Figure 7.4: Waste Generation (mtpd) Projections for JNN

Figure 7.5: Solid waste at Gaurav tower and inert waste near World Trade Parkin Jaipur (Primary_Survey, 2012)

Figure 7.6: Waste dumped in plot near Rajasthan University and on railway track (Primary_Survey, 2012)

Below table show the physical composition of MSW in Jaipur city and there is a 42% of waste is compostable matter which is almost half of the total waste generated. The plastic content is very low, but as the data is very old so there is high increase in the plastic content till the date. Jaipur is also one of the fasted developing city in India and there are lots of construction works going on, so the inert waste content is also very high.

Table 7.5: Physical characteristics of MSW in Jaipur (% by weight) (CPCB, 2000)

City	Paper	Textile	Plastic	Glass	Ash, fine earth and others	Compostable matter
Jaipur	6.0	2.0	1.0	2.0	47.0	42.0

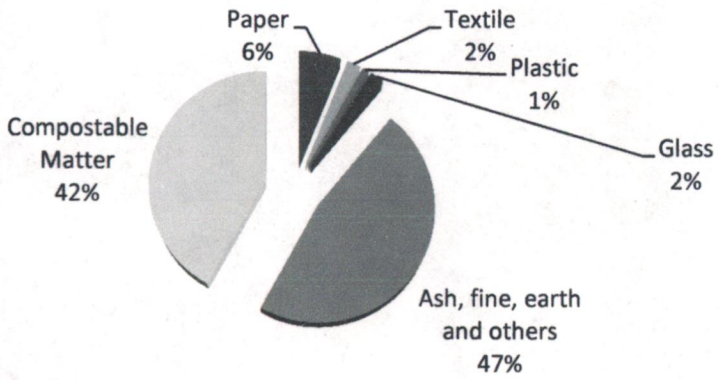


Figure 7.7: Physical characteristics of MSW in Jaipur (% by weight) (CPCB, 2000)

7.3 Waste Segregation

Waste segregation is one of the major steps in the municipal solid waste management but there is no procedure of waste segregation takes place at the source in the whole city because of which it is very difficult to separate them later.

Figure 7.8: Waste segregated by ragpickers (Primary_Survey, 2012)

7.4 Waste Storage and Collection

Storage of MSW at the source is lacking in most of the places in the city. The waste is collected by different methods in the city. The solid waste management activity in Jaipur consists of citizens throwing the waste into the cubic community bins provided by the JNN with different carrying capacity which is common for both decomposable and non-decomposable waste without any segregation process. The main system of primary collection of waste is street sweeping, generally the sweepers sweep the road and drain andcollect the waste into small heaps on the road or into the bins. A sweeper who sweeps the roads put the road wastes into a wheelbarrow, and then transfers the waste to dustbins or collection points.

The house-to house waste collection system does not involve segregation of biodegradable from the nonbiodegradable. Waste is collected and stored in containers or left at road corners for JNN workers to collect and transport it from there. This creates a lot nuisance with stray cattle and dogs spreading the waste. Waste management is absent in slum and kacchi basti areas where waste is dumped into nallahs(drainage).

This problem is mainly occurring in the old city, where there is no single collection bin has been placed. The sweeps generally sweeps the street and make a heap whenever they find the large waste or else they generally sweeps it to the nallahs. The old city area is the one of the worst managed area in terms of solid waste management in Jaipur.

7.4.1 Solid waste management in walled city

Waste is collected in traditional tricycles in the walled city. This is deposited in temporary bulk storage at open sites, round cement concrete bins and masonry bins. The waste from these sites is transported via motorized vehicles. There is often spilling of waste on these sites. Bullock carts, three-wheelers, tractors and trucks are used to transport waste. Transportation within the walled city becomes difficult due to the narrow width of the inner roads.

There are total 5644 permanent and 1392 temporary street sweepers in the city for cleaning the waste. They are engaged to sweep the total road length. Some roads are sweeps daily and some on alternate dad or once in a week. Door-to-door collection of waste is not adopted in the city. The main system of collection in most of the places in the city is through community bins placed at various points along the roads and many times MSW generated remains uncollected on the streets.

The Jaipur city has been divided in 8 zones and 77 wards for the better management of MSW. Total 8090 persons in public health section manage the MSW in the city.

Table 7.6: Zones and Ward no.

Sr. No.	JNN Zones	Ward No.
1	Civil Lines	2,3,7,11,4,5,17,6,16,19,15,20,21,38
2	Motidungri	35,34,33,18,31,30,29,32,27,26,28
3	Vidyadharnagar	1,9,10,68,69,70,65,63,67,66,64,8,36,37,62
4	Hawamahal (East)	52,55,51,56,57,44,45,46,47,49,50,48
5	Hawamahal(West)	53,54,58,59,60,61,40,42,43,41,39
6	Sanganer	12,13,14,22,23,25,24
7.	Amer	NA
8.	Mansarovar	NA

Table 7.7: SWM Team in the public health section of JNN

Sl. No.	Staff	Total Strength
1.	Zonal commissioners	6
2.	Chief Health officer	1
3.	Health Officer	2
4.	Chief Sanitary Inspectors	4
5.	Sanitary Inspectors	70
6.	Sanitary supervisors/Jamadars	250
7	Sweepers & vistis	7757
	Total	8090

Figure 7.9: Communal bin of carrying capacity 1.1 cum and 7 cum (Primary_Survey, 2012)

Table 7.8: Number of containers of different capacity in different wards (JMC)

JNN Zones	Number of containers provided by JNN
Motidungri Zone	190
Vidyadhanagar Zone	
Civil Lines zone	150
Sanganer zone	
Pratap Nagar	20
Total	460
Total working containers	375

JMC has placed 460 communal bins of different carrying capacity 1.1cum, 3cum. and 7cum. From the above table it can be seen that the communal bins have been placed only in 5 zones out of total 8 zones. The totally neglected zones include Hawamal East and Hawamahal West zones. The entire walled city comes under the Hawamahal zone. In these zones there are open depot where there is no garbage container is placed.

7.5 Waste Transportation

JMC use 159 vehicles for the transportation of the municipal solid waste from the communal bins to the disposal sites. Table below shows the types of vehicles used for the collection and transportation of MSW from various points.

Table 7.9: Types of Vehicles and its number used for the collection and transportation of MSW

S. No	Type of Vehicles	Number
1	Dozer	2
2	X Loader J.C.B	6
3	F.E. Loader	9
4	Dumper	15
5	Truck	10
6	Sewer Jetting Machine	13
7	Auto Jet Machine	12
8	Dumper Placer	43
9	Compactor	20
10	Road Sweeper	4
11	Tractor	16
12	Mobile Toilet	9
Total		159

Dumper Placer and Compactor play a major role in transportation. A dumper placer is used to carry waste materials, there are basically two types of dumper placer; one can carry a single container of carrying capacity 7cum while another one can carry two containers of carrying capacity 2.5cum each. Compactor is the next important vehicle which generally loads the waste from community bins of 1.1 cum carrying capacity and is load waste automatically by hydraulic lift system. It has capacity is of 14cum and can carry waste up to 9 tons.

The waste transported from small vehicles is collected at the transfer stations, In the current scenario, only one transfer station is working in Lal Dungri, on Delhi bypass whose carrying capacity is around 200 TPD and another transfer station is under construction at Jhalana Dungri whose carrying capacity is also around 200 TPD. Lal Dungri transfer station carries the MSW of Hawa Mahal East and West zone, Amer zone, 48, 47 and 51 ward of Moti Dungri zone and 41, 42, 19, 20, 21 ward of Civil line zone. The Jhalana Dungri zone which is under construction will cover the Sanganer zone, Civil line zone and Moti Dungri zone. In other zones, the waste collected from source is directly go to the disposal sites.

Because there is only one transfer station is in working condisiton, the vehicles have to carry and transport the MSW in many number of times. 1 compactor perform 2 round in the morning and 1 round in the evening in Moti Dungri zone, and in generally each transport vehicle perform 2-3 rounds in a day to transfer MSW from source to the disposal sites. The trucks used for transportation except compactor, are generally of an open body type and are usually kept uncovered; thus during transportation, the waste tend to spill onto the road resulting in unhygienic conditions.

Figure 7.10: A compactor collecting MSW (Primary_Survey, 2012)

Figure 7.11: At Mathuradaspura site (Primary_Survey, 2012)

Figure 7.12: Trackter carrying waste from old city (Primary_Survey, 2012)

Figure 7.13: Compactor driver on its way to Mathuradaspura site (Primary_Survey, 2012)

7.6 Disposal of wastes

The Jaipur city has a total 530.65 acres area for waste disposal sites (CPCB). There are three main sites for waste disposal and they are at Mathuradaspura, Sewapura and Langadiawas areas. The

total areas of the sites are 108.7, 123.5 and 298 acres. (The area has been given in Bighas, and in Rajasthan, one Bigha is equall to 2500 sq.m, so the area was 176, 200 and 483 bighas respectively). All he waste generated in the city is being depositing at these three disposal sites.

All the three sites are open sump sites and no scientific method of waste disposal was adopted at these sites. All the waste is disposed at the landfill site by just openely dumping it. One MSW processing plant has been established at village Langadiawas site, by M/s Grasim Industries to process municipal solid waste received from Jaipur Municipal Corporation. The processing plant designed to handle about 400-500 TPD of MSW and generation of 130-140 TPD Refuse Derived Fuel (RDF) in the form of fluff. The basic principal included in the processing of MSW is separation of different categories of waste, according to different densities. The composition of waste is expected to contain moisture 25%, inert material 20% and the balance RDF of 30%. Final product, RDF contains mostly cotton fibre, plastic pouches and other light density materials. The RDF produced at Jaipur plant transported to M/s Vikram Cement, Neemuch, M.P. where it is used as a industrial fuel in the kiln to substitute the coal requirement to a maximum extent 10-15% in the (CPCB).

A brief detail of these three dumping sites are given below:

Mathuradaspura site: The site is located in the east direction of the city. This is the oldest site and about 17 Km from the main city. It has capacity of about 400-500 TPD and approximately, 300 to 400 TPD of garbage is being dumped every day at this site.

Langadiyawas site: This site is also located in the east direction of the city, 3 to 4 Km downside from the Mathuradaspura. It has total area of 298 acres. The JMC has allotted 25 acres land from this site to M/s Grasim Industries Ltd to install processing plant to process the municipal solid waste to produce RDF, which is further used as an alternative fuel in the cement industries. From the remaining site a land of 67 acres is allotted for the sanitary landfill facility (SLF). Due to poor collection of MSW, RDF plant operated by M/s Grasim Industry is not able to run its full capacity.

Sewapura site: This site is located at 20 Km from the main city Jaipur in North direction on Jaipur-Delhi road. Its total area is 123 acres. MSW of 17 wards of the Vidyadhar Nagar zone and 5 to 6 wards of Civil Line zone which comprised of half of the total Civil Line zone dumped to this site. Approximately, 200 to 300 TPD of garbage was being gone every day to this site.

The location map of disposal site has been given in figure 7.14.

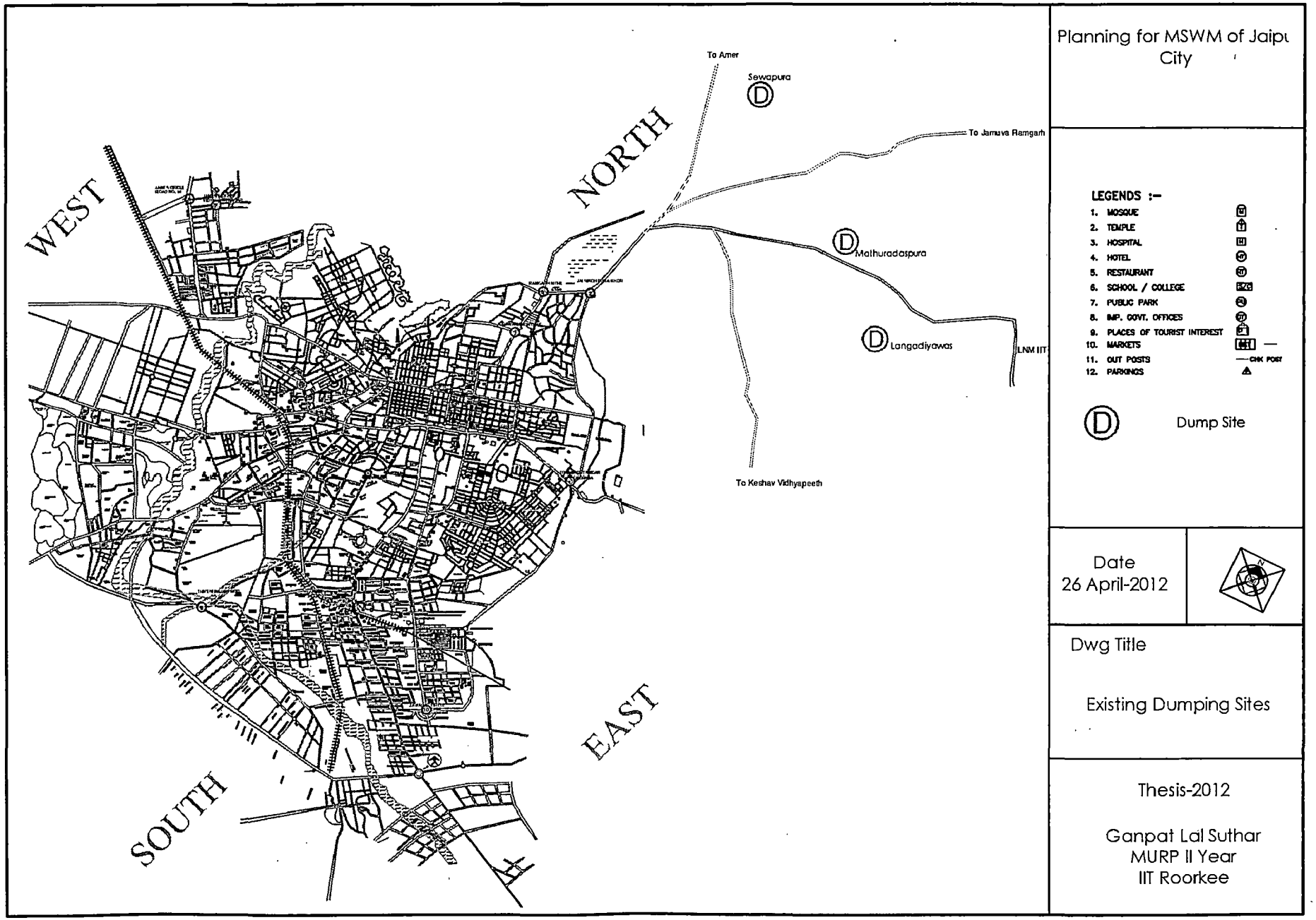


Figure 7.14: Location of disposal sites in Jaipur

Table 7.10: Amount of MSW disposed at Langadiyawas, Mathuradaspura and Sewapura site and number of trips (JMC)

	Langadiyawas		Mathuradaspura		Sewapura	
Date	Net Wgt	Trips	Net Wgt	Trips	Net Wgt	Trips
01-11-2008	216315	25	282275	32	205695	32
02-11-2008	88850	11	343145	40	17035	12
03-11-2008	131100	16	379180	43	27085	29
04-11-2008	176115	21	431340	47	185210	27
05-11-2008	211230	23	363689	37	209621	29
06-11-2008	170570	18	424565	46	173302	32
07-11-2008	252447	28	326685	37	236205	28
08-11-2008	119495	14	424664	46	198350	29
09-11-2008	50235	5	496705	51	110735	12
10-11-2008	0	0	468655	52	187953	26
11-11-2008	233510	26	350727	38	157476	31
12-11-2008	7185	1	460240	54	132250	34
13-11-2008	114475	12	303336	37	22870	23
14-11-2008	0	0	457375	52	170920	28
15-11-2008	0	0	499055	55	260212	31
16-11-2008	0	0	445905	52	17710	14
17-11-2008	201705	24	297525	34	230585	33
18-11-2008	156570	17	304035	35	283430	34
19-11-2008	102210	11	385845	43	311780	34
20-11-2008	10150	1	574460	63	285945	31
21-11-2008	0	0	413420	48	305890	35
22-11-2008	35845	4	385445	44	240808	37
23-11-2008	104240	12	347095	40	77135	10
24-11-2008	39805	4	416945	46	24655	31
25-11-2008	168330	19	319330	35	67260	38
26-11-2008	0	0	597500	65	365085	34
27-11-2008	0	0	585965	65	290793	35
28-11-2008	0	0	604830	67	283860	36
Total	2590382	292	11689936	1304	5079855	805

Table 7.11: Total amount of MSW disposed at Langadiyawas, Mathuradaspura and Sewapura site and number of trips taken by the transportation vehicles to these sites in a particular time period (JMC)

Date	Net Wgt(KG)	Trips
01-11-2008	704285	89
02-11-2008	449030	63
03-11-2008	537365	88
04-11-2008	792665	95
05-11-2008	784540	89
06-11-2008	768437	96
07-11-2008	815337	93
08-11-2008	742509	89
09-11-2008	657675	68
10-11-2008	656608	78
11-11-2008	741713	95
12-11-2008	599675	89
13-11-2008	440681	72
14-11-2008	628295	80
15-11-2008	759267	86
16-11-2008	463615	66
17-11-2008	729815	91
18-11-2008	744035	86
19-11-2008	799835	88
20-11-2008	870555	95
21-11-2008	719310	83
22-11-2008	662098	85
23-11-2008	528470	62
24-11-2008	481405	81
25-11-2008	554920	92
26-11-2008	962585	99
27-11-2008	876758	100
28-11-2008	888690	103
Total	**19360173**	**2401**
Average	**691434.75**	**85.75**

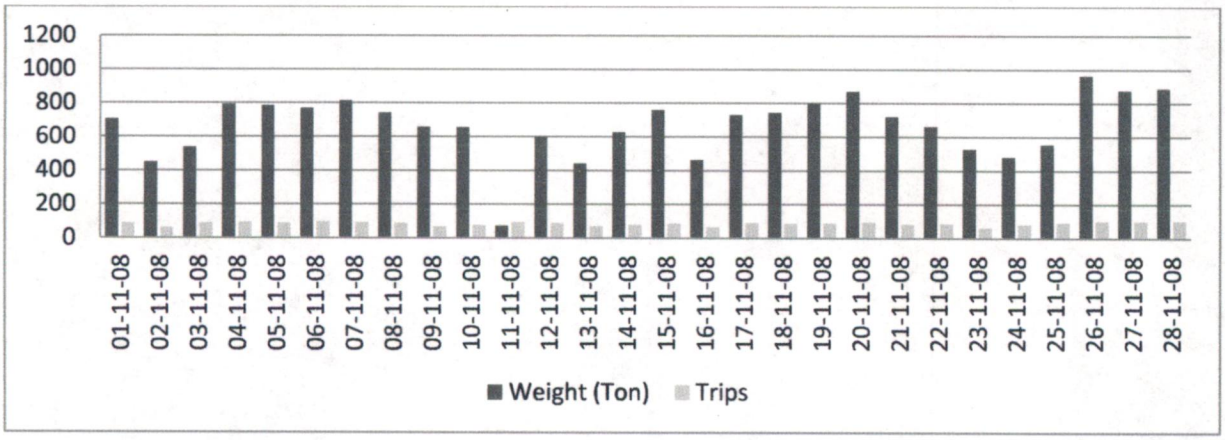


Figure 7.15: Tabular representation of total amount of MSW dumping in these 3 dumping sites and vehicles taking number of trips to these sites in a particular time period

Figure 7.16: Open dump site at Mathuradaspura (Primary_Survey, 2012)

Figure 7.17: Compactor dumping waste at Mathuradaspura site (Primary_Survey, 2012)

7.6.1 Recycling

In Jaipuc city, like other urban areas of India, recycling of MSW is a widely prevalent activity involving both the formal and informal sectors. The informal recycling sector refers to the waste collection by

Corporation in informal sector recycling. The informal sector of any Indian cities where rage-pickers perform the task has a hierarchical structure constituting recyclers (rage-pickers) at the bottom, dealers (small, medium and large) and finally the recycling units. Rage pickers collect the waste from either the storage level or from the disposal sites. Storage level includes the households, commercial establishments, streets, dhaloas.

In the Jaipur city the majority of rage-pickers carries a sack and relies on their back and a smaller fraction rents the vehicles according to the requirements of the area. Generally what they do, they collect the recyclable waste from the storage level and pack it in a jute or plastic bag, and then they carry it on pushable lorry. Some rage-pickers s go from door to door at shops and restaurant for collecting sorted dry recyclable materials on an instant payment basis and collect a relatively large amount of waste, generally the collects waste newspapers, magazines, plastics, glass bottles, metals etc. (Author, 2012), on other hands some rage pickers are more active in collecting waste thrown away in public places such as streets, parks and landfills within a 4–5 km vicinity of their residence. The average income of rage-pickers varies according to the collected waste. Generally, a rage-picker earns Rs. 100-200 daily. (i.e., approx. the same amount payable to an employee as per the Indian labor Law). On other hand, a waste collector who collects the waste from rage-pickers earns about Rs. 200-300 per day (Author, 2012).

Mostly waste pickers and collectors are the migrants from the poor states of India, mainly from West Bengal, Uttar Pardesh and Bihar and from home state Rajasthan also. Some Bangladeshis refugees also working here as rage-pickers. Most of the rage-pickers are 25 years and above age, but large numbers of childrens are also working as the same. Most of the rage-pickers are illiterates. Most of the rage-pickers live in temporary shelters or slums. The working conditions are unhygienic; safety equipment such as gloves and boots are unaffordable for waste pickers.

One thing observed from rage-pickers that they have better knowledge about waste and its value. They are more aware about the waste and its market value. It will be interesting any beneficiary for the municipal corporations if they appoint these rage-pickers as their contract basis employee, then they will definitely perform better than permanent employees of the Municipal corporations.

7.7 Survey findings

People's opinion for the MSWM system in any city provides better information to understand the current scenario of the waste management. To make this possible, a detailed primary survey has been carried out to understand the local public's opinion in Jaipur city. Survey has been carried out in two area of the city, one is inside the walled city which is one of the most neglected areas in terms of solid waste management and other is outside the walled city that was Malaviya Nagar which is better socially connected and the solid waste management service is better here. Survey sample map has been given in figure 7.18. Survey Performa is enclosed in annexure-2.

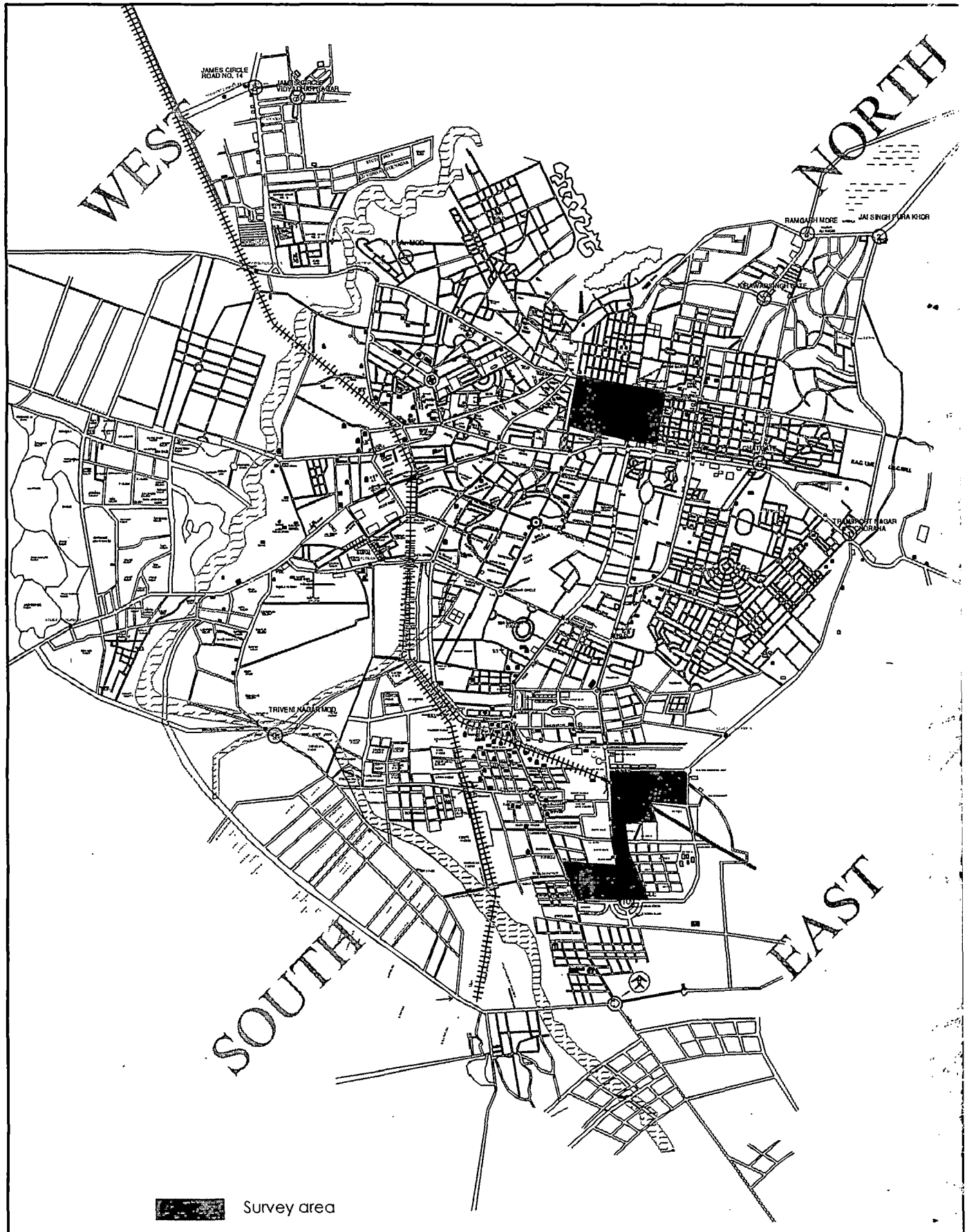


Figure 7.18: Survey samples map

7.7.2 Satisfaction level of people towards MSWM

People's opinion about how much they are satisfied with the current situation of the MSWM is different in the two areas. In Malviya Nagar people are satisfied while on the other hand in old city they are highly unsatisfied with the current way of handling the MSW.

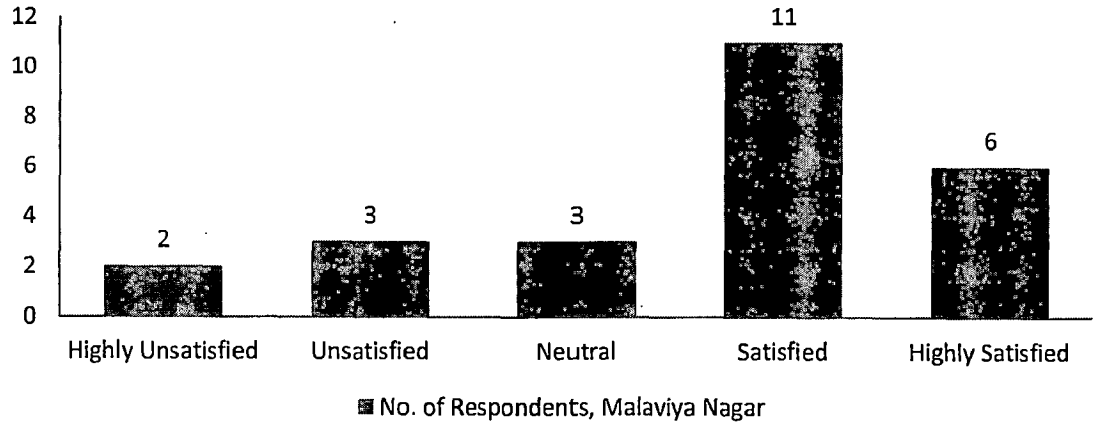


Figure 7.17: Are you satisfied with the current way of handling Municipal Solid Waste?, Malaviya Nagar

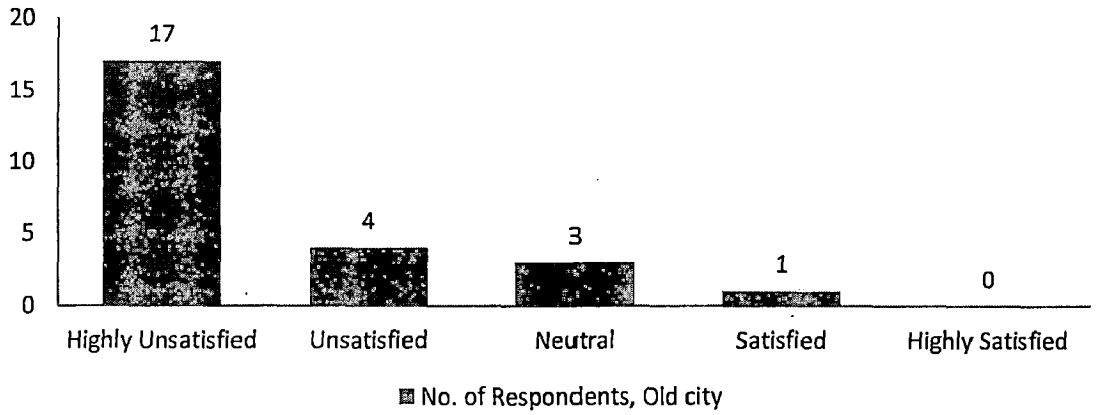


Figure 7.18: Are you satisfied with the current way of handling Municipal Solid Waste?, Old city

As it can be easily seen from the above two figure that households peoples of Old city are more tend to unsatisfied or highly unsatisfied as compare to the peoples of Malviya Nagar. Since Malviya nagar is more socially connected hence JMC does pretty well over there. In Malviya Nagar almost in every locality they have placed communal bins but on the other hand in Old city it is very hard to find a single bin, or we can say that there are no collection bins in the old city area. Hotels and schools have also almost the same opinion as the peoples of households in both the areas.

Figure 7.21: Clean Road at Malaviya Nagarand dirty road at old city (Primary_Survey, 2012)

7.7.2 People's opinion on the status of waste collection

JMC performs much better way in Malviya Nagar than they do so in Old city. As per people's opinion of Malviya Nagar sweeper almost daily collects the scattered waste from the streets and through wheel barrow they put it in the communal bins and daily that waste carried away and transported to the disposal sites. While on the other hand people's opinion of the old city is not good since in the complete absence of the community bins people throw the wastes near their houses and sweeper also comes only in few days in a week, and if sweeper comes, he sweeps the street and normally push the waste in Nalis rather than collecting it to collection bin which leads to wastes remains untouched there and after sometimes it starts. Old city area is one of the most ignored are in terms of waste collection.

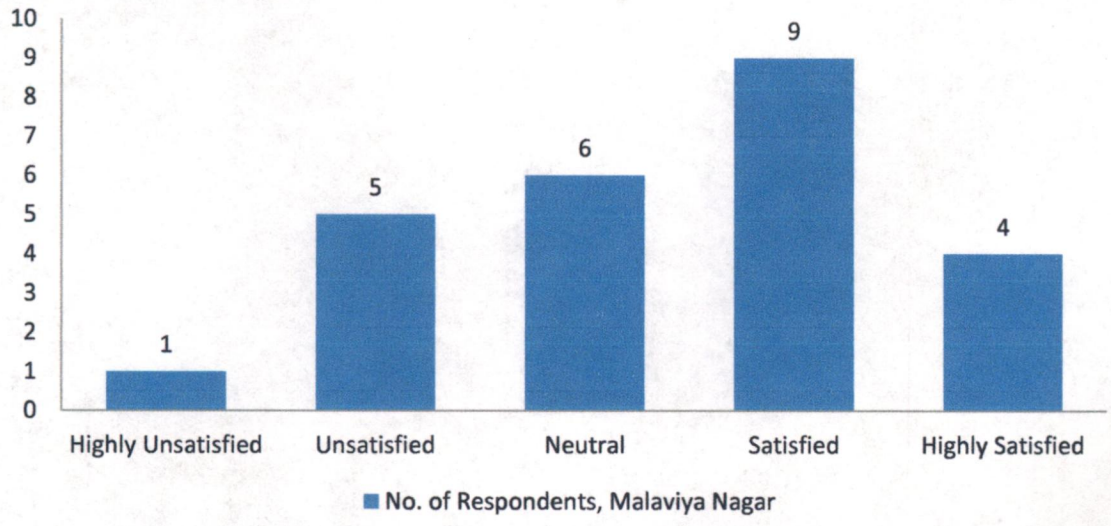


Figure 7.22: Does the community bin in your locality have sufficient capacity to carry waste in a day? Malaviya Nagar

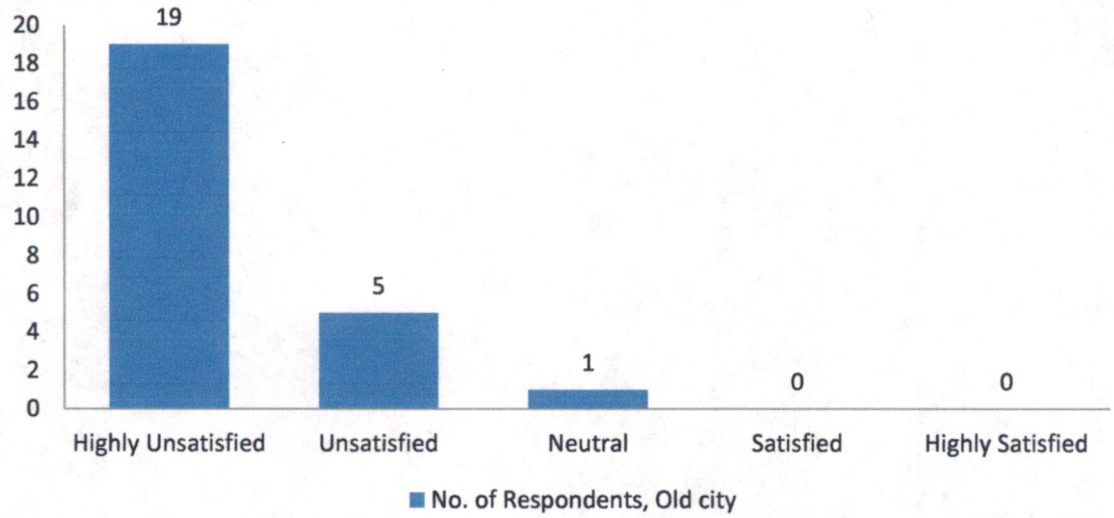


Figure 7.23: Does the community bin in your locality have sufficient capacity to carry waste in a day? Old city

Figure 7.24: Overflow Community bin at Malaviya Nagar and waste lying on road at old city

7.7.3 Opinion about daily collection

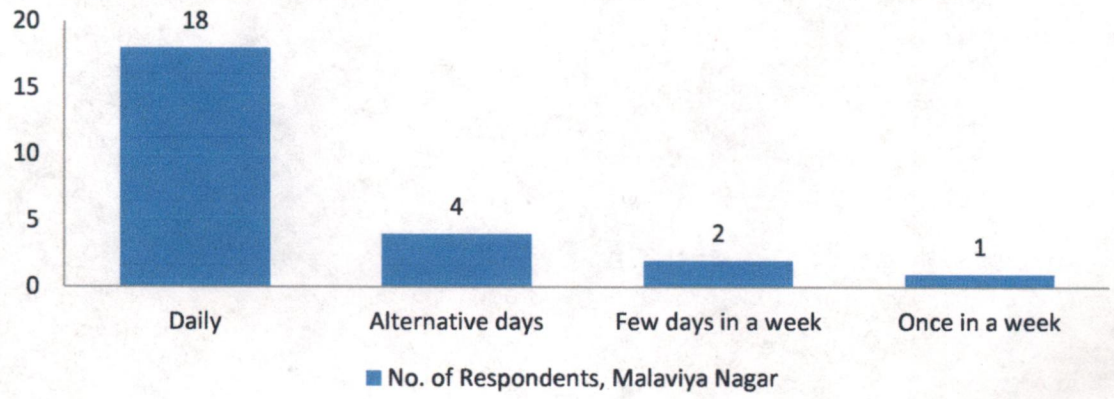


Figure 7.25: Does any person come daily in your locality to collect the wastes scattered on the streets? Malaviya Nagar

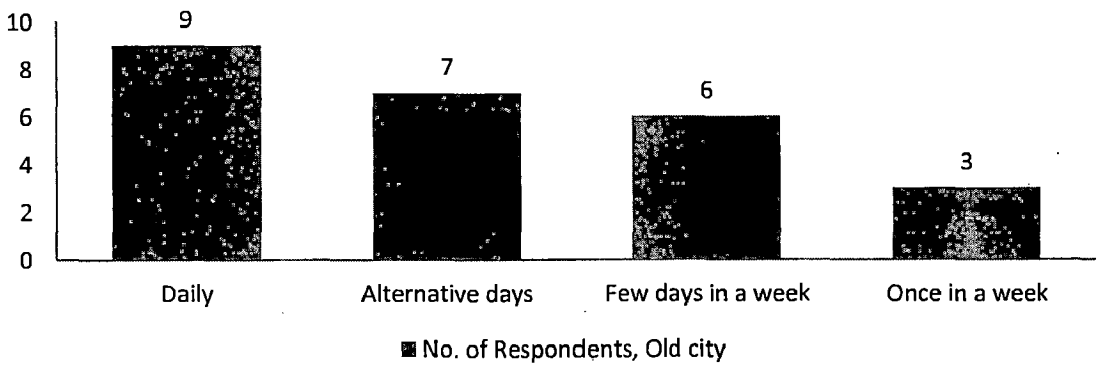


Figure 7.24: Does any person come daily in your locality to collect the wastes scattered on the streets? Old City

7.7.5 Opinion about the cleaning of collection bin

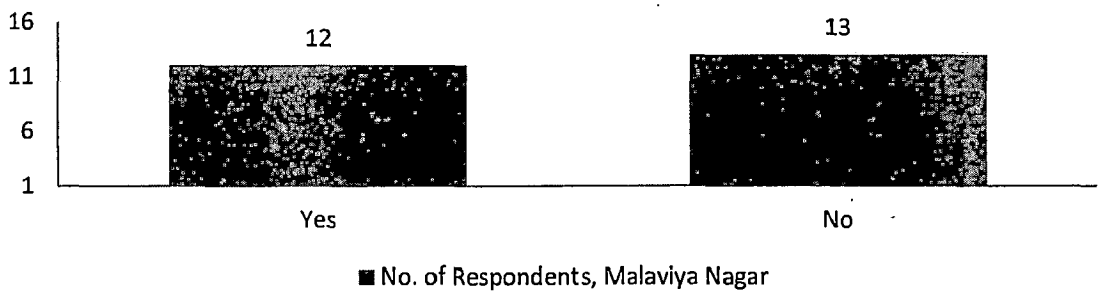


Figure 7.25: Does the waste collector come and clean the bin before it get overflow? Malaviya Nagar

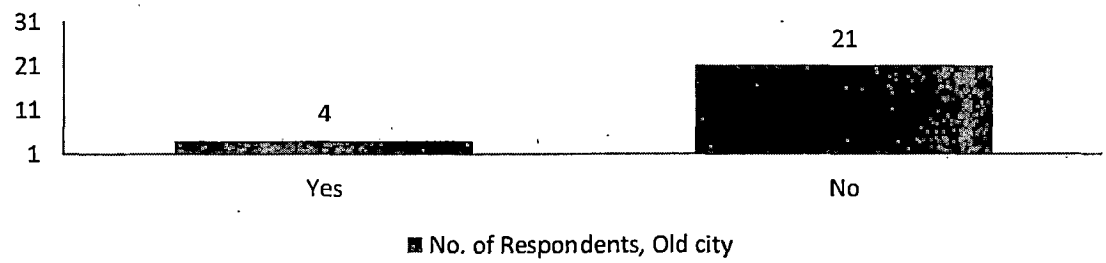


Figure 7.26: Does the waste collector come and clean the bin before it get overflow? Old city

Generally we have seen that all the collection bin remained over flow before it get transported. As we found that there is no collection bin placed in the old city area so all waste remained scattered on the streets. While in the Malaviya Nagar area, the sufficient amount of collection bins have been placed and vehicle come to clean it on daily basis or alternate days but at some area, the over flowed collection bin has also been found.

Figure 7.29: collection bin at Malaviya Nagar

7.7.5 Satisfaction level about transportation of waste

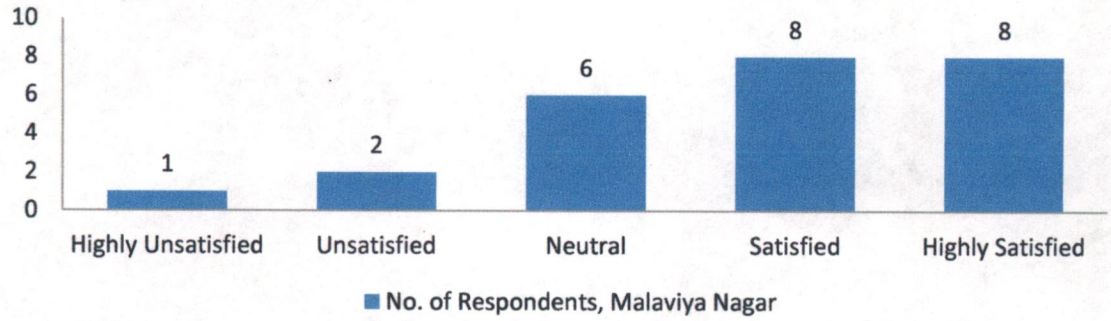


Figure 7.30: Are you satisfied with the way waste get transported through vehicles? Malaviya Nagar

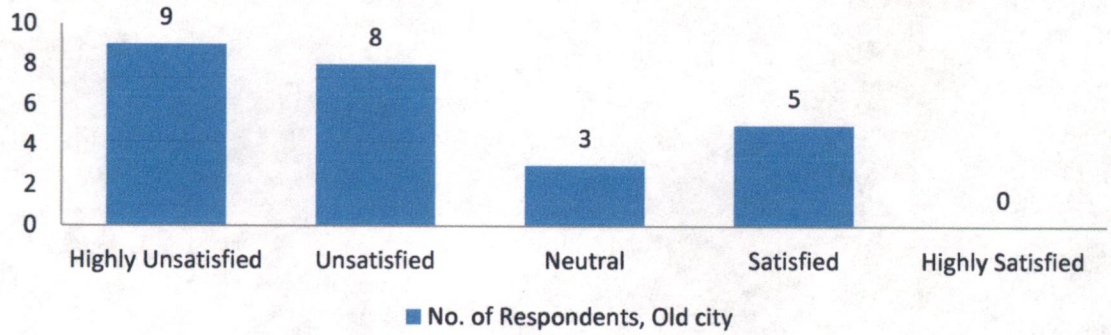


Figure 7.31: Are you satisfied with the way waste get transported through vehicles? Old city

With the above survey charts, we found that in Malaviya nagar are, people are satisfied with the way of waste get transported using dumper placer vehicles. But in old city area, peoples are highly unsatisfied. In old city area, sweepers sweeps the waste and collect it in one place then a hand card man comes and carry it and make a large heap at some place from where tracker carry it to the depot. Depot is a place where waste comes from tracker and then is transported to the dumping site with the help of truck and JCB.

7.7.7 Willingness to give a part of their earning for better MSWM

Since the way of handling the Municipal Solid Wastes in old city is not up to the mark as compared to the Malviya Nagar, hence people in old city are more prone to give part of their earning as compared to the peoples of Malviya Nagar. Below chart shows that when the peoples of Malviya Nagar were asked whether they are willing to give a part of their earning to have better way of handling the MSW then most of them responses that what is the need of giving money if they are already doing good job and hence most of them were disagree to pay money. While on the other hand when the same question was asked to the peoples of old city, then surprisingly they were any how ready to pay just to have a clean and hygienic locality as shown in next chart.

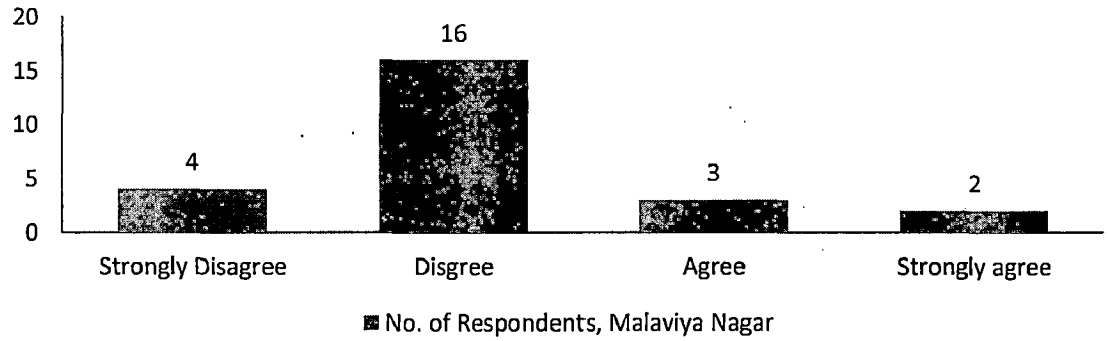


Figure 7.30: Would you like to give a part of your income to have a better management of Solid Waste? Malaviya Nagar

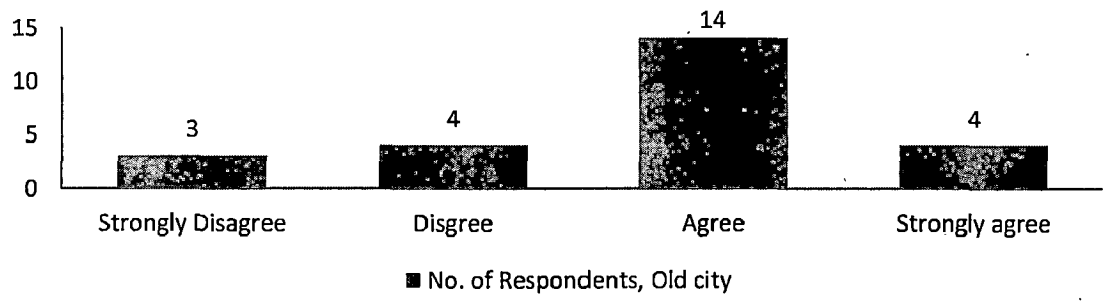


Figure 7.31: Would you like to give a part of your income to have a better management of Solid Waste? Old city

7.7.8 Awareness among people about the disposal of MSW

Communities are the major stake holders of the MSWM and they should know about the condition and disposal of the waste generated by them. Peoples are not aware about where does the waste goes at the end. In the survey when peoples of both the areas were asked whether they know about where the MSW goes at the end then almost 90% people responded that they don't know and never thought about it as shown in charts below.

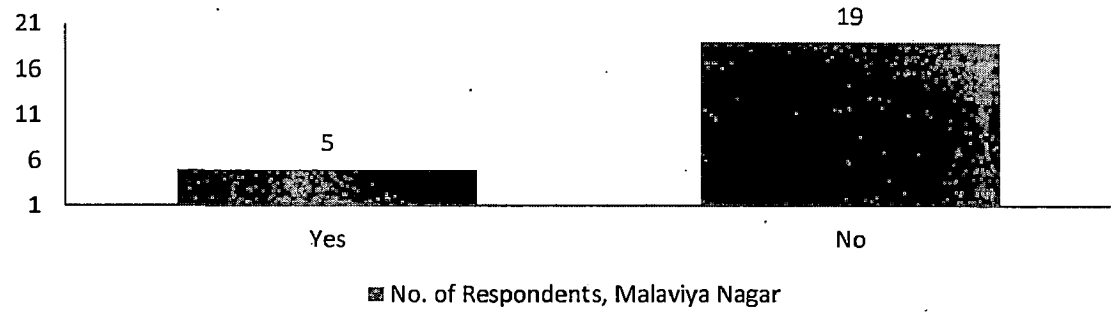


Chart 1: Do you know where does the solid waste go at the end? Malaviya Nagar

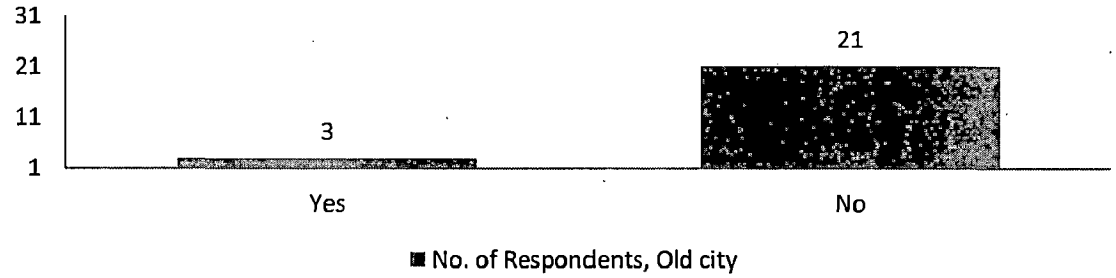


Chart 2: Do you know where does the solid waste go at the end? Old city

7.7.9 Local rules by communities

For better waste management of any city, the participation of communities is a prime requirement. Local people must be aware of the waste management and they have to participate equally for the same. Sone people make local rules in their areas for the proper management of solid waste and it play a major role in the safe waste management in the city. Now if we consider the surveyed are in Jaipur city, then majority people of both the area don't have such a local rules for waste management. As shown in the charts below, only 15% people have such a rule but only half the people bother to follow these rules.

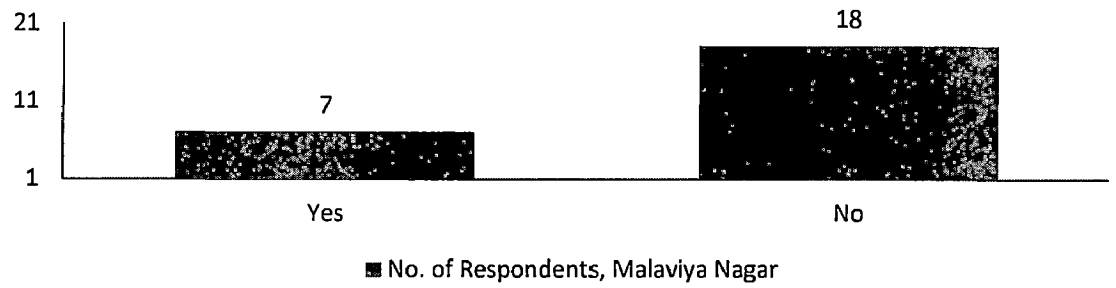


Figure 7.32: Have you made some local rules or set norms to prevent waste material scattered in your locality? Malaviya Nagar

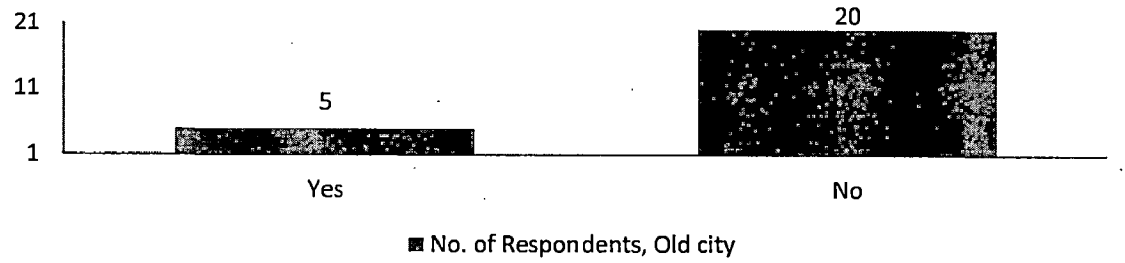


Figure 7.33: Have you made some local rules or set norms to prevent waste material scattered in your locality? Old city

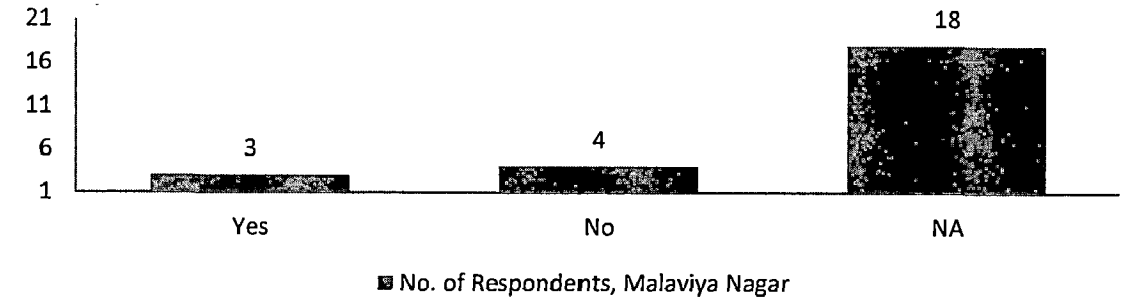


Figure 7.34: Do you regularly monitor the enforcement of those local rules? Malaviya Nagar

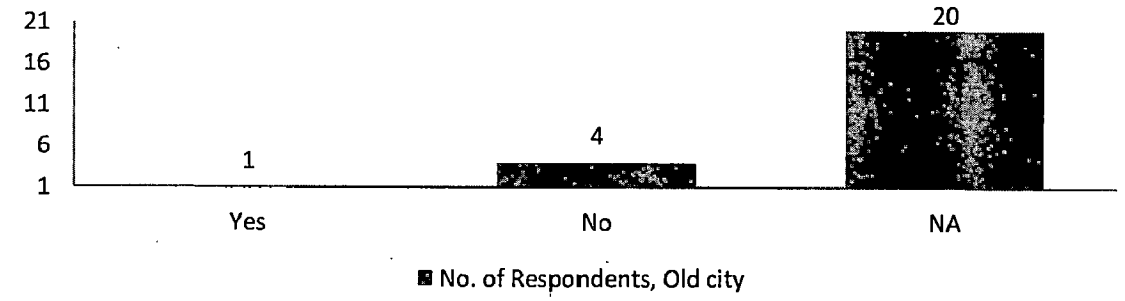


Figure 7.35: Do you regularly monitor the enforcement of those local rules? Old city

So after studying above data, we can find the conclusion that there is a huge lack of public awareness about the solid waste management in the city. We can't implement safe solid waste management system without public awareness. The responsibility of making public aware about the waste management is generally better suit to the politicians, like ward members etc. and generally we noticed that even elected ward members also don't have awareness about the safe waste management.

Chapter 8. PROPOSALS FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN JAIPUR CITY

With growing economy of the urban regions and the state population, generation of municipal solid waste is also on high rise. The plastics usage is despoiling the landscape, affecting health of animals and blocking drainage systems. There is a need to ensure proper segregation, collection, processing and disposal of solid waste. There is a strong demand to develop and implement viable public private partnership models for setting-up and operating composting plants, secure landfills, waste to energy projects and other appropriate techniques for MSW treatment. Segregation of municipal solid waste needs to be enhanced to improve level of efficiencies at the processing levels. Segregation and recycling of construction and demolition wastes should be implemented. The Supply of compost produced via composting of municipal solid waste to be mandated with the sale of agricultural inputs. Informal sector system which is very important for collection and recycling of various materials needs to be strengthened by giving them employment and enhancing their access to institutional finance and relevant technologies. There is a strong need to review the various municipal laws and policies to enable the process of registration of societies of recyclers to operate within the framework of law. Local municipal bodies have to play an important role in proper implementation of the important law about plastics "Recycled Plastics Manufacture and Usage Rules". Municipal bodies need to create a general public awareness for reusing, reducing, and recycling of the wastes.

Municipal Solid Wastes (Management and Handling) Rules 2000 was notified by the Ministry of Environment and Forests In October 2000, which has the procedures and guidelines for segregation, collection, storage, transportation, processing, and disposal of municipal solid waste. The rules envisage that all cities in the country should set up suitable waste treatment and disposal facilities. The rules also specify standards for leachate control and management, compost quality, and closure of landfill sites.

However, it is the prime duty of the Urban Local Bodies to address the issue of solid waste management, tight budgets, inefficient organization, etc. has rendered a situation that has little hope for alleviation in the near future.

According to the Rajasthan State Environment Policy 2010, table below shows the ways of improving municipal solid waste management

Table 8.1: Ways of improving SWM (GoR, 2010)

Priority Area		Timeframe (start year)	Responsible Agency	Existing policy/schemes/sources of financing
Municipal Solid Waste	Develop and implement viable PPP models for setting-up and operating secure landfills, composting plants, waste to energy projects and other appropriate techniques for MSW treatment.	2012	Local bodies and UDH	JNNURM, RUIDP1 The cost (capital and O&M) of solid waste management to be recovered through House tax.
	Strengthening of informal collection and recycling sector by reviewing the municipal laws and policies to enable registration of societies of recyclers to operate within the framework of law	2010	Local bodies	access to institutional finance and relevant technologies
	Proper implementation of "Recycled Plastics Manufacture and Usage Rules, 1999 and amended 2003"	2010	Municipal Corporations, RSPCB	XIth and XIIth Plan Funds

According to JMC, about 1140 Tonne of municipal solid waste is generated per day in the Jaipur city, which is not being disposed off in a scientific manner and dumped in open disposal sites. There is an continuous trend in the increasing usage of plastics, which is non-biodegradable in nature, plastic materials discarded as waste are causing blockage of drainage systems, degradation of land, , various health effects on animals and overall environmental degradation.

1.1 Stakeholders Participation

Community participation in solid waste management is the key to a sustainable and integrated management. Try to get as many local actors as possible to participate and actively contribute to the waste management system. Most importantly, it will create a feeling of own ownership for the waste management system among the citizens, whose waste is managed and whose local environment is improved by the proper waste management system.

8.1 Employees

Hundreds of thousands of people in country like India find livelihood opportunities in the area of waste, like "rag pickers" (known as kabadiwalas in Hindi). A solid waste management project must hence be understood in this informal yet organised setting. In order not to ignore these individuals, they will be prioritized in the job process and offered continuous job in the solid waste management system.

8.2 The Public

It important that the public, that is ordinary citizens as well as private and public institutions, whose discarded waste is managed and whose environment is improved, should be actively and regularly involved in the system. An important step to engage the public and motivate them is via continuous public awareness campaigns based on an Information, Education, and Communication (IEC) technology. In addition, a special feeling of ownership should be created as each household will contribute to the waste management with at least a monthly fee of INR 20-30.

8.3 Volunteers

Motivate individuals such as doctors, headmasters, religious leaders etc., from the concerned communities which will engage as volunteers and help convey the strong message to the public as well as they can function as role-model citizens.

8.4 NGOs, CBOs, and Local Associations

Community based organizations, Local nongovernmental organizations, and other local associations such as Resident Welfare Associations and Women's Associations should be offered training in solid waste management.

8.5 Youth Groups and Eco-Clubs

Via continuous school intervention programmers, youth groups and eco-clubs at schools should be engaged in the waste management system.

8.6 Private Corporations

Municipal authorities should seek the partnership of local and foreign companies for financial support as well as donations for scientific recycling of inorganic wastes. Private corporations can also be able to sponsor the various waste management projects and receive marketing in return.

8.7 Training Program for employees

All employees engaged in waste management should undergo extensive training in solid waste management, including the linkage between a deteriorating environment, human health, the treatment and management of waste, principles behind composting and recycling, health and hygiene, occupational hazards, collection and transportation procedures etc.

8.8 Proposals for Generation and Segregation of waste

It is the responsibility of households to segregate the waste at source into biodegradable waste and non-biodegradable waste. The non-biodegradable (dry) waste will thereafter be segregated into recyclables, non-recyclables, and domestic hazardous waste. Each household should be provided at least three buckets for the storage of waste in different colours free of charge for the biodegradable, non-biodegradable and the recyclable waste respectively.

In the proposals for walled city, three community bins for collection of biodegradable, non-biodegradable and recyclable wastes have been placed within the 400m distances, see figures 8.1 to 8.8.

Local resident welfare committees and samitis which exist everywhere at jhuggies (slums) to middle class housing. They should be actively participating in segregation and collection of waste at the local level and community level. It is very important to have a public participation. These committees should be given the collective responsibility of implementing various running schemes of the solid waste management in their areas as a part of the formal system. A core group should be formed and responsible contact persons should be identified. The Municipal Authority may offer various incentives to such communities and can coordinate with them.

It is very important to know about the generation of municipal solid waste before implementing any policy or Method. Where it is important to know that:

1. What is being generated in the city?
2. How much waste is generated?
3. Where it is being generated in the city?

It is the responsibility of JMC to know the quantity of waste generation in the city with its composition in ward wise and of entire city also. Jaipur Municipal Corporation should also need to more concentrate on the public awareness campaign about the municipal solid waste and educate them to minimize the generation of waste. They can run few awareness programs either by television network or through print media. They can take the advantage of like Earth Day or

Environment Day to run programs and make the people more educate about municipal solid waste. Segregation of the municipal solid waste into organic waste, recyclable waste and inert. The most important step should be taken at the time of generation of waste. There is no alternative of the source segregation. The segregation of solid wastes should be worked out by the active engagement of local civic bodies with waste generators and an area where other organizations, such as NGOs could assist. To make this process smooth and hygienic, JMC should ensure these points:

- Organize various public awareness programmes.
- Promote reuse and recycling of segregated waste.
- Undertake phased programmes for community participation, like regular meetings with local welfare associations and NGOs at quarterly.
- In order to ensure that hazardous waste is not going to be dumped into municipal bins, the door to door collection from households and establishments must be implemented.
- Other waste generators, whose waste must follow other rules, should be made aware of these by awareness program.
- Peer pressure must be engaged for segregation of the waste.
- Various Incentives should be offered to associations or communities or organizations for segregation waste.
- A simple segregation routine involves three categories of municipal solid waste: Biodegradable, recyclable and others, in green, white and black bins respectively.
- Educate and create awareness in citizens, waste collectors and waste contractors on proper waste management.

It is very important to have an economic stake of every stakeholder in municipal solid waste management; only at that condition the stakeholders will give their best to improve the municipal solid waste management. Like citizens should get a kind of benefit of segregating their own waste at their household then they will be willing to do some more efforts to segregate their waste. On the other hand JMC need to place three community bin of different colour for various types of waste so that public can drop the waste accordingly. Initially there may be a chance of mixing all kind of waste despite having community bins of different colour, but gradually people will become aware about the use of bins of different colour.

8.9 Proposals for better collection system

There are two types of collection system, door to door collection and community bin collection. For both the system, some important steps must be taken, like;

8.9.1 Door to door collection

Selection of the vehicle kind should be based on width of road (generally useful for the old city area where at presently only hand card is used for waste collection in internal area.

- Create public awareness for waste management system.
- It will reduce the number of community collection bins.
- If the project is on contract basis, then concession period of the project should be at least Seven years keeping in mind the useful life of vehicle.
- All the garbage collection vehicles should be provided with proper alarm system and should go to every door step regularly at scheduled time. The arrival of waste collectors should be announced through ringing an alarm bell on vehicle.
- There should be two shift of waste collection from residential zones and commercial zones. From commercial zones, it should be in evening time and for residential zones, collection timing should be in the morning time.
- Creating Public Awareness through campaign should be the part of contractor's scope of work if the project is on contract basis else it should be of JMC's.
- Should have centralized complaint management system with modern communication facilities and local language speakers must be employed.
- Should have better provision for segregated waste collection.
- Waste e must be picked up from every doorstep in an organized manner.
- Waste must be collected at pre-informed timings so public can remain aware about the arrival of vehicles.
- Waste can be kept inside the house or outside the house for the convenience of the citizens.
- Sometimes, garbage can be hung up on a hook to avoid animals from tipping it over. At other times, the collector rings the doorbell so that even the most freshly generated waste can be disposed off to the collector.

- Different types of bins with different colours for different varieties of wastes must be kept so that each category of waste will follow a different path.

It has been observed during the study that Jaipur Municipal Corporation do not give priority to those areas which are not much socially connected in comparison to those which are well socially connected. Hence to have a better municipal solid waste management it is very important to give equal priority to each and every part of the city whether they are socially well connected or not.

8.9.2 Community bins

In Jaipur city some places does not have community bins even where no procedure of door to door collection takes place like the old city areas. So the community bins must be places at every places wherever it is possible and at a central point so that they are accessible to every citizen. These bins:

- Should be fully covered and leakage free so that any kind of bacterial infection can be prevented.
- Must be in at least three colors, with biodegradable, non-biodegradable and recyclable waste collection facility.
- Must be placed at walking distance distances, most preferably within the 400 mts, so that every person can reach easily to the bins.
- Everybody should be aware about the community bins and the color coding on it, can be achieved by public awareness campaign.

Jaipur Municipal Corporation should follow the procedure of door to door collection in the whole city like Surat municipal corporations' best practice on door to door collection, but they also need to place the community bins wherever it is possible. They also need to do better arrangements at places near the marriage hall from where large amount of municipal solid waste generate in a single day. They have to place two bins of bigger size for biodegradable and non-biodegradable waste, near the marriage halls and Jaipur Municipal Corporation also need to collect money from all the marriage halls per marriage. It should be mandatory to take permission from Jaipur Municipal Corporation for any marriage with submitting required amount of fee so that they can put more efforts near those places. Rag pickers play a vital role in the collection of municipal solid waste. During the primary survey, it has been found that this sector is the most vulnerable sector from the effect of municipal solid waste. Without proper training and knowledge, their life is in greater risk while handling the municipal solid waste through their naked hands. To resolve the conflicts between the rag pickers and waste collectors, there should be a single governing body which can

control both rag pickers and middlemen and also need to have a control on those waste collectors who does not come under the provisions and law of the association and getting more profit used to sells the collected wastes to the factories who uses bad practices to recycle the waste. Rag-pickers much be given advantages to have a part of Jaipur Municipal Corporations collection team and they will do better in this field.

Walled city is one of the most ignored are and there is no single community bin so a detailed plan of proposed community bin locations and the vehicle routes to collect the waste from these community bins has been given in figure 8.1 to figure 8.8.

Three community bins for each marked location has been proposed with different colour codes for collection of biodegradable, non-biodegradable and recyclable materials.

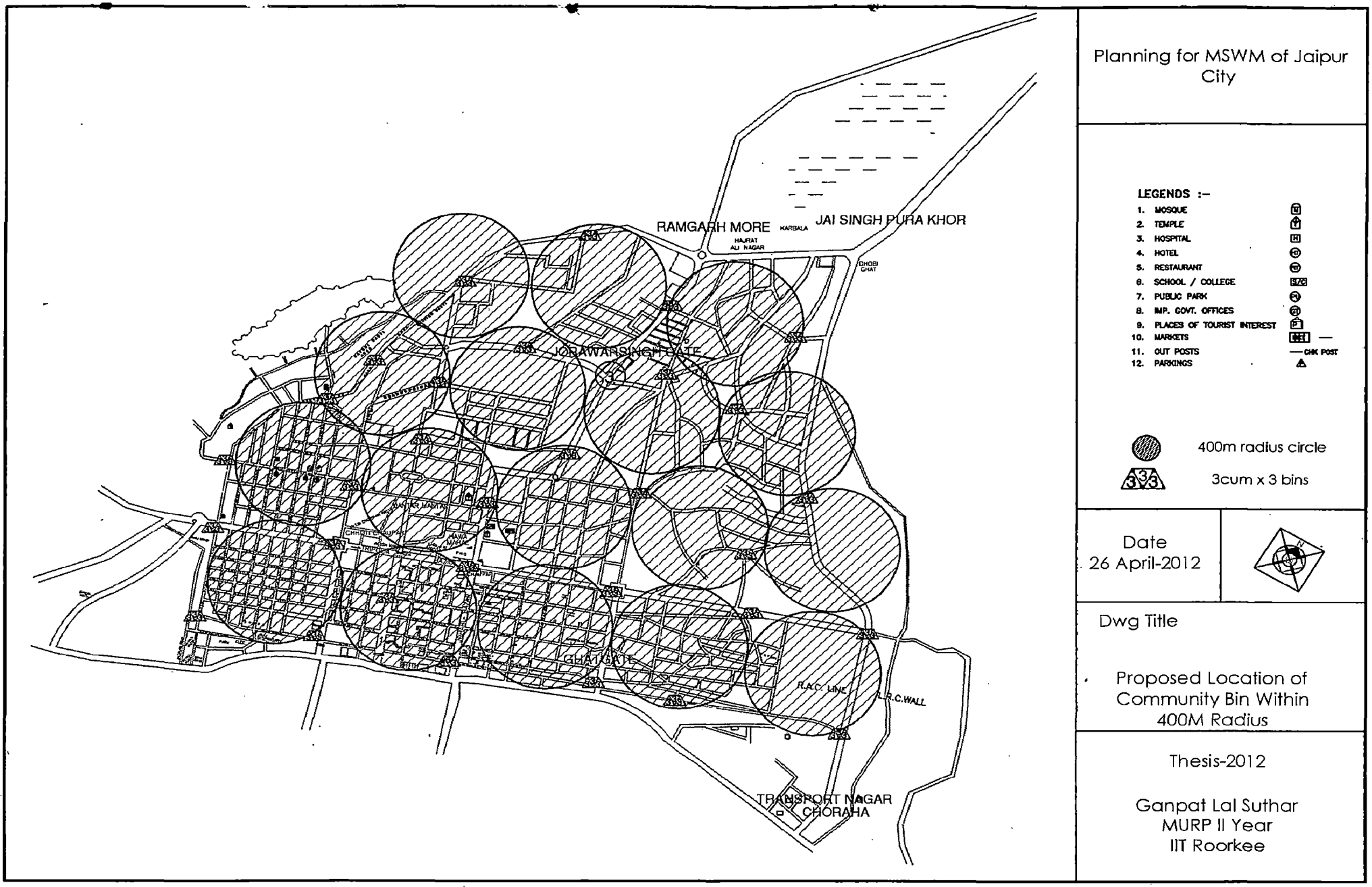


Figure 8.1: 400m radius coverage of old city

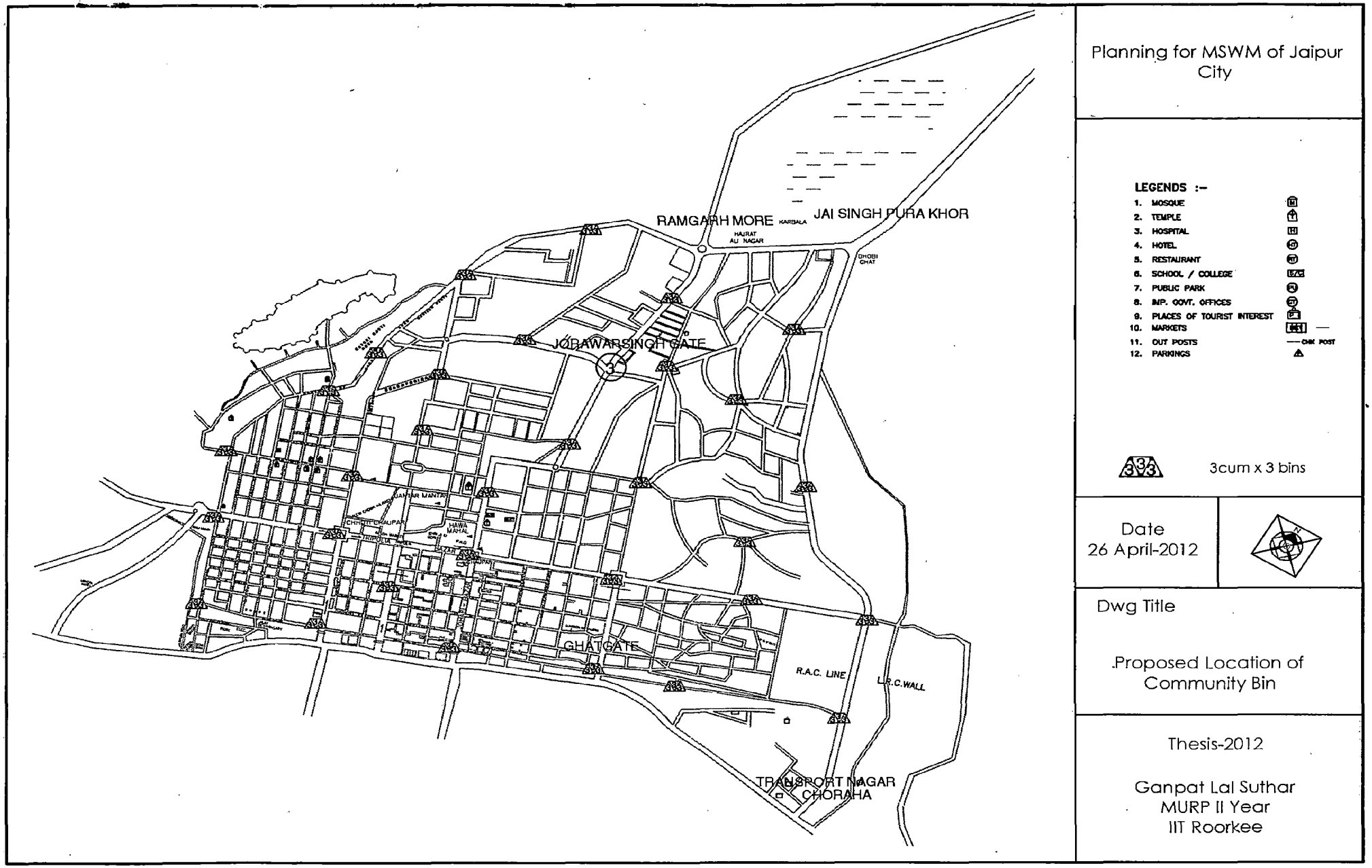


Figure 8.2: Location of proposed community bins with three colour codes

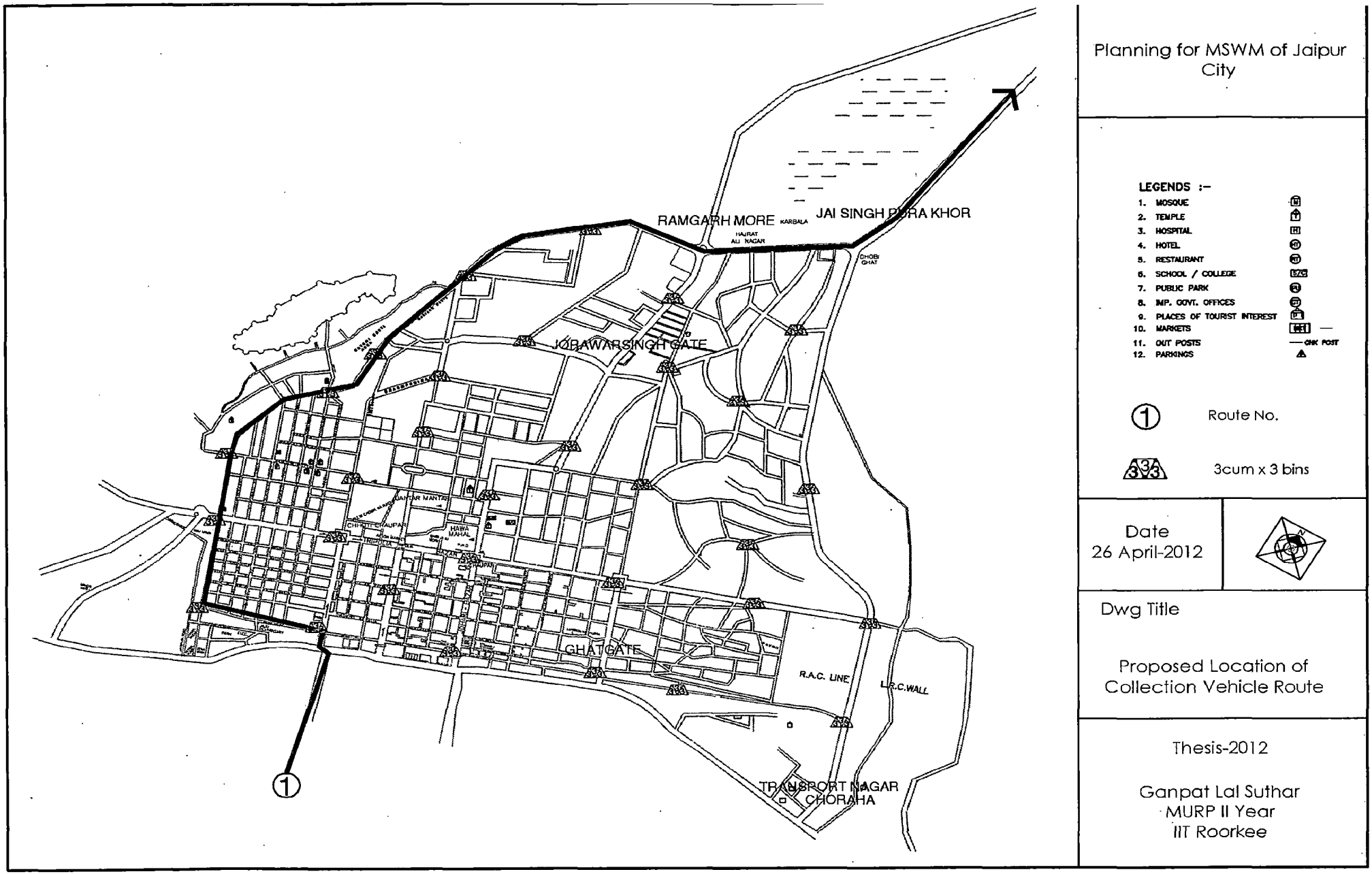


Figure 8.3: Proposed route no. 1 for collection vehicle

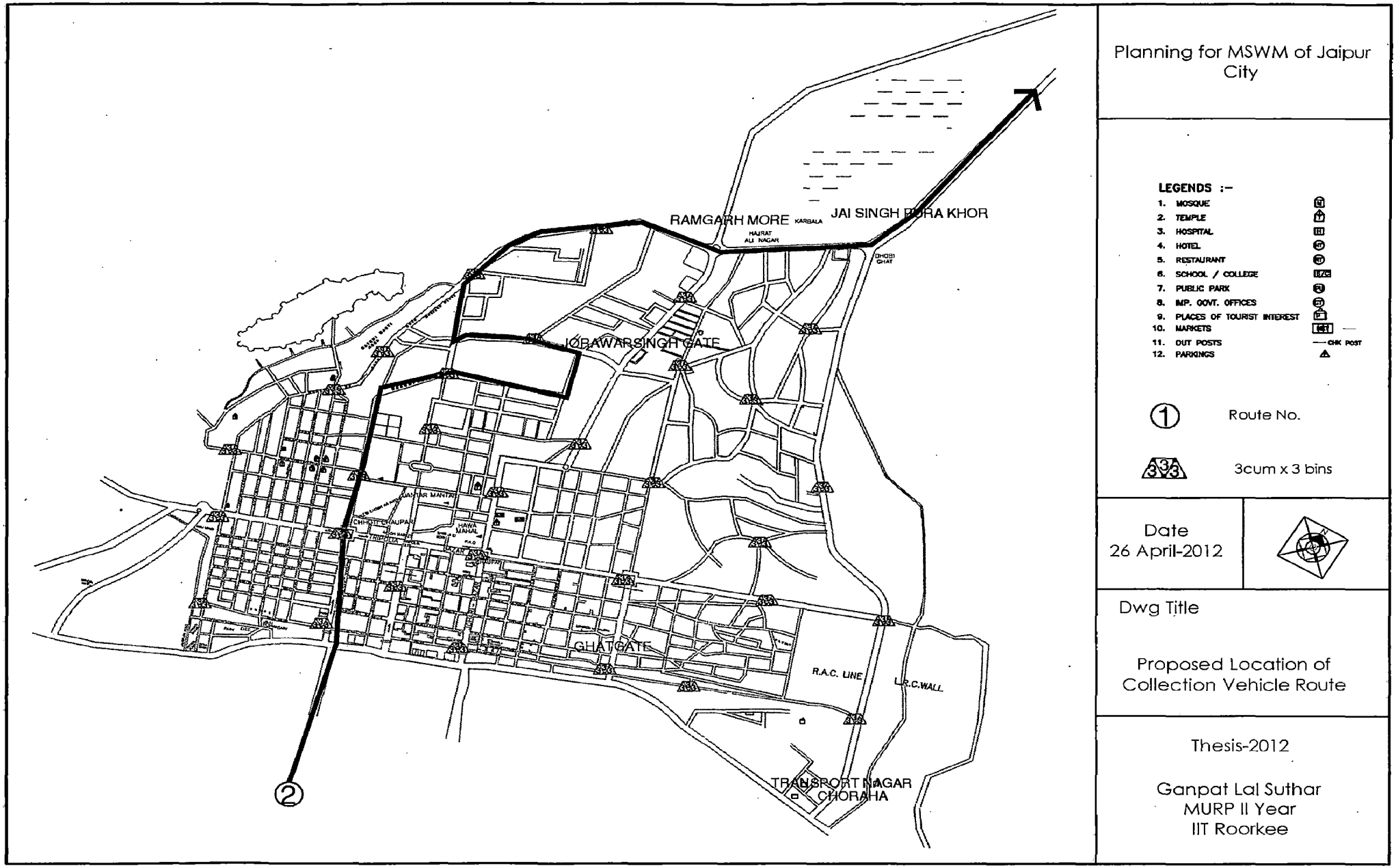
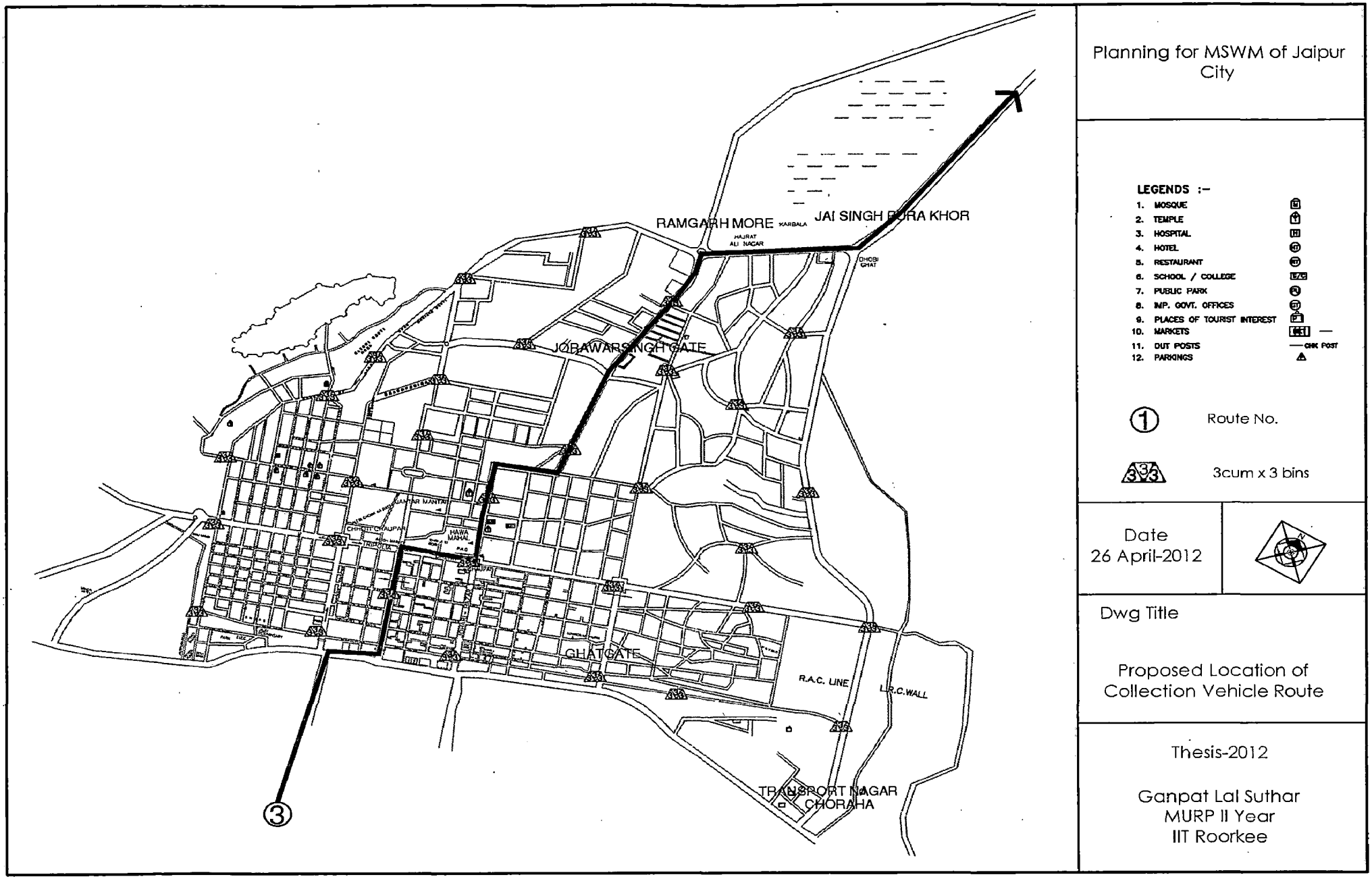


Figure 8.14 Proposed route no. 2 for collection vehicle



Planning for MSWM of Jaipur City

LEGENDS :–

1. MOSQUE
2. TEMPLE
3. HOSPITAL
4. HOTEL
5. RESTAURANT
6. SCHOOL / COLLEGE
7. PUBLIC PARK
8. IMP. GOVT. OFFICES
9. PLACES OF TOURIST INTEREST
10. MARKETS
11. DUT POSTS — CHK POST
12. PARKINGS

① Route No.

3cum x 3 bins

Date
26 April-2012

Dwg Title

Proposed Location of Collection Vehicle Route

Thesis-2012

Ganpat Lal Suthar
MURP II Year
IIT Roorkee

Figure 8.3: Proposed route no. 3 for collection vehicle

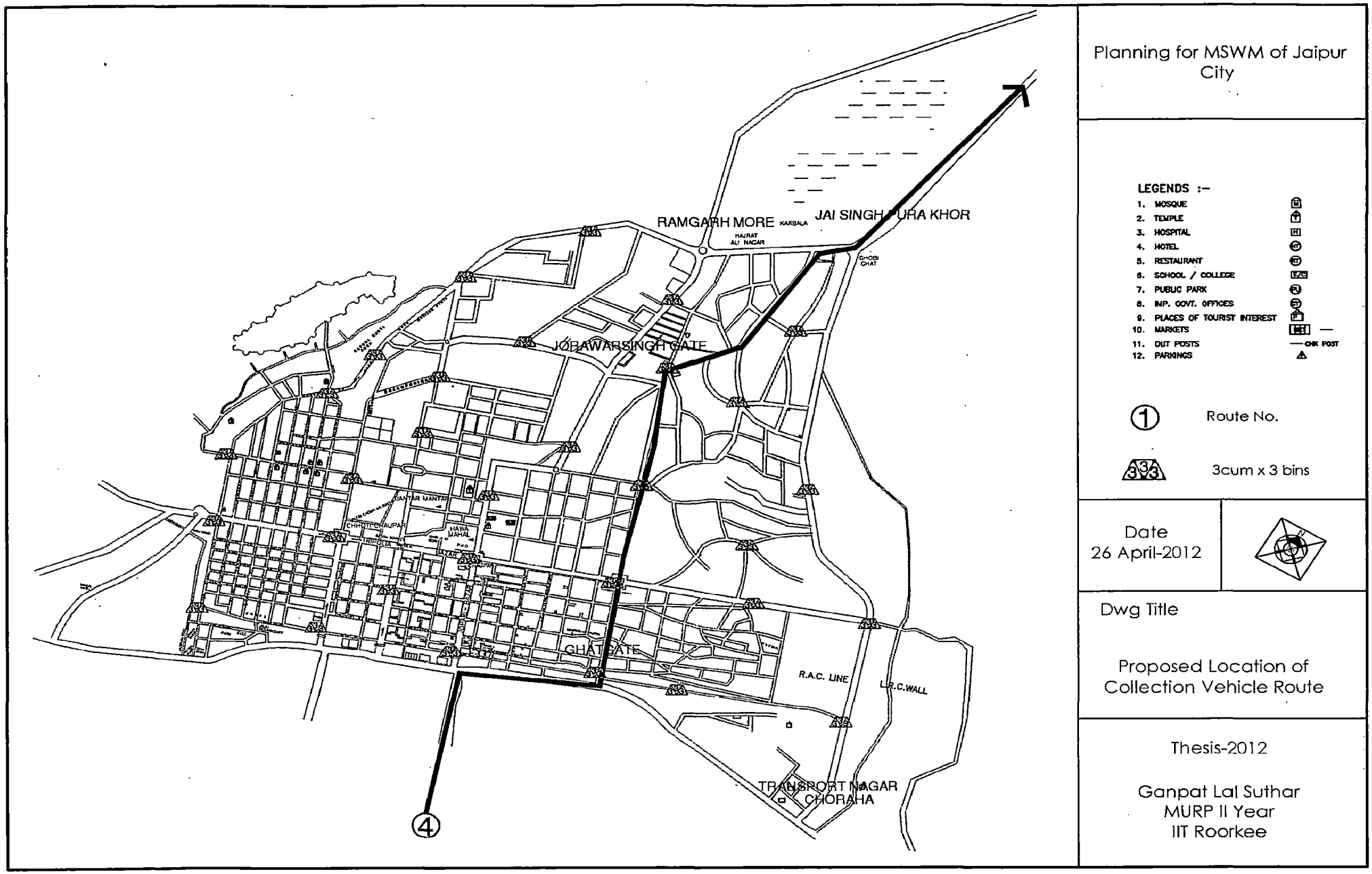


Figure 8.8: Proposed route no. 4 for collection vehicle

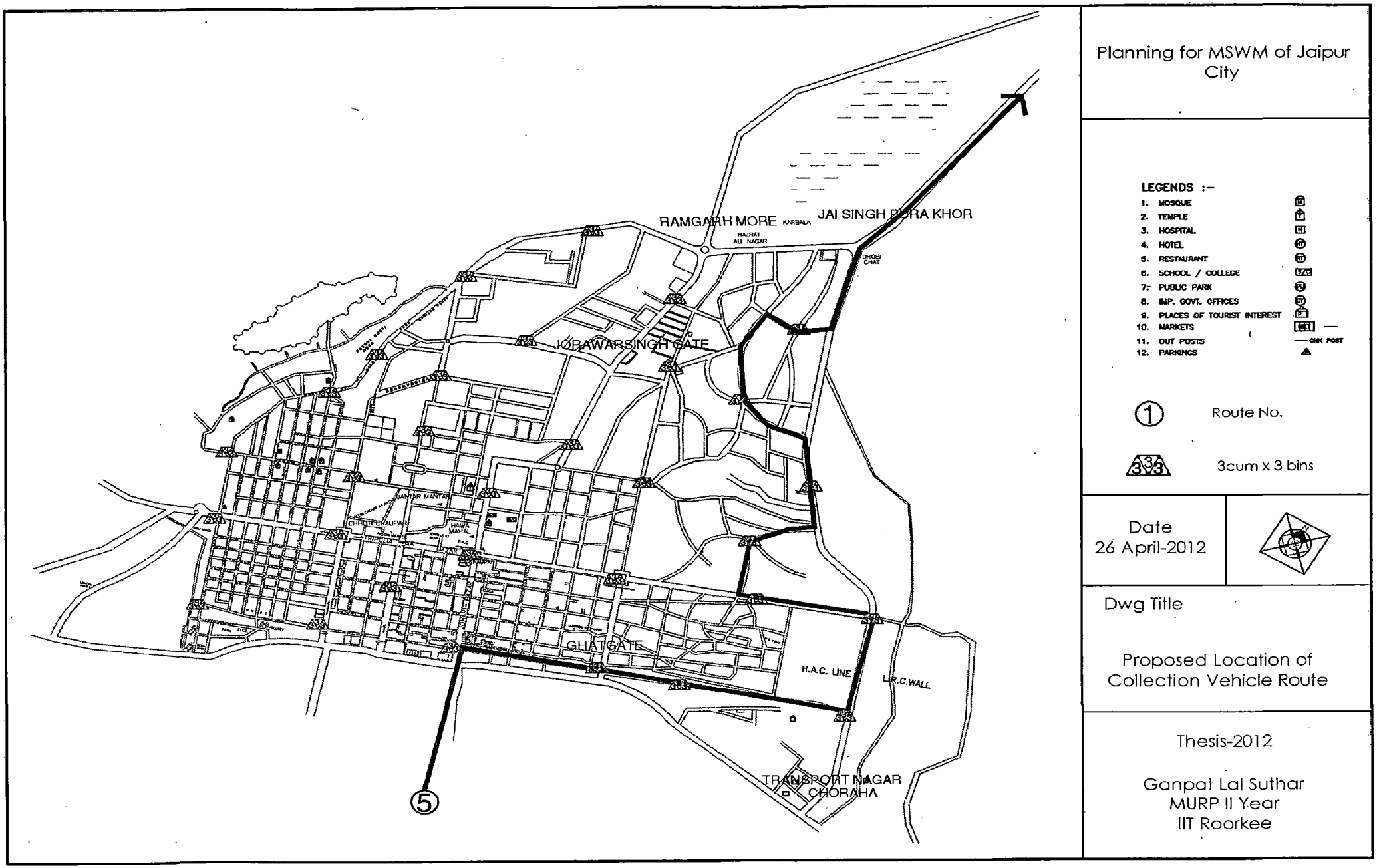


Figure 8.3: Proposed route no. 5 for collection vehicle

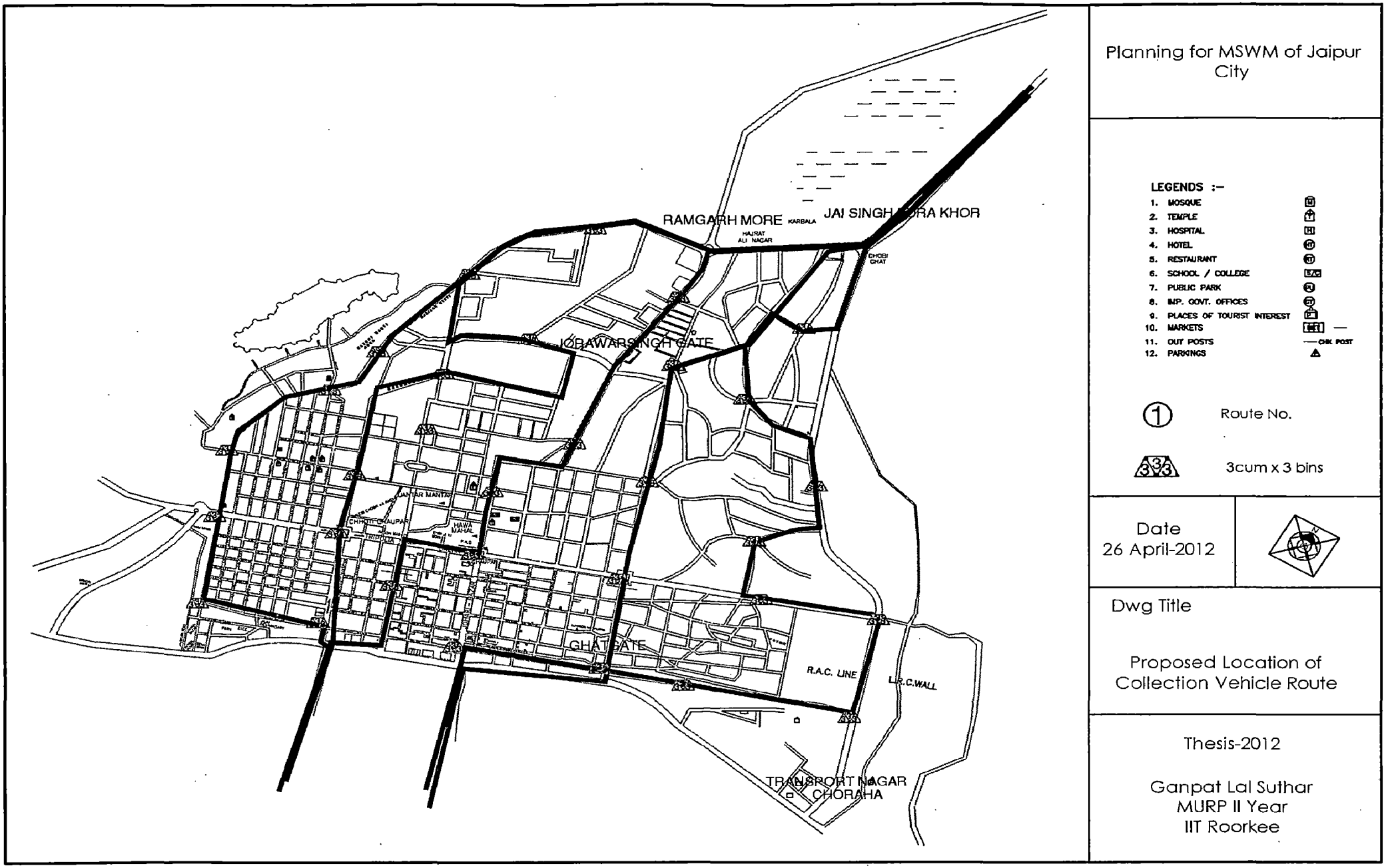


Figure 8.8: Proposed all routes for collection vehicle

8.11 Proposals for improvement of storage of municipal solid waste

It is generally observed that waste collected from old city and some other areas is going to waste collection depot, which is an open waste storage site from where the waste is transported to the various open dump site. Jaipur Municipal Corporation needs to dispense with open waste storage depots which are inefficient and unhygienic, with neat and covered containers. They have to identify suitable locations from the existing locations of waste storage depots in the city, where large containers ranging from three cubic meters to seven cubic meters could be placed for secondary storage of solid waste. The waste is being segregated at its source, at least two bins required: one for biodegradable waste and the other for recyclables..

Waste storage depots are not recommended, because it cause double operation cost for waste handling and transportation, as to transport it to depot and then unload it, after that again load it to other vehicle and transport it to open dump site, which require lots of input cost and manpower. The better idea is to keep large collection bin at regular interval at various places, in which hand cart man can dispose off the waste in it then it can directly be transported to the dump site.

In cities like Jaipur where the treatment and disposal site is more than 15 kilometers away from the city, transfer stations might be required. Waste which is transferred from small vehicles to larger container trucks so that waste can be transported more efficiently at long distances.

Some points might be considered:

- To minimize the cost of loading and unloading of waste from transfer station to vehicles, the transfer stations have to be designed such a kind so that waste can directly be transferred into a large vehicle or container.
- Vehicles or containers with a total carrying capacity of 20 to 30 cubic meters are typically used for long-distance waste transportation.
- The design and capacity of transfer stations and storage containers completely depends on the waste quantity and on vehicles used for primary and secondary waste collection and transportation.

Jaipur Municipal Corporation should very carefully select the site of transfer station to reduce the operating cost. More than one transfer stations in each city can facilitate optimum use of the fleet of small vehicles and can take possible benifits of large hauling vehicles for bulk transport of waste. Transfer stations must be decentralized within the city, allocated to an enclosed area, and situated itowards the general direction of the main landfill site. The direct transfer of waste from a small vehicle to a large vehicle is inconvenient, the JMC could also plan a transfer station at which waste is

initially deposited in a large bunker and later can be moved using special equipment such as a JCB machine.

8.12 Proposals for better transportation of municipal solid waste

The transportation of waste has to be more efficient and cost effective. Jaipur's transport system is bound by lengthy loading times (mostly manual loading) from storage areas. Additionally, long distances of the disposal sites limit vehicle crews to one or two trips per day, which can be inefficient if the transport capacity is small. If the distance to the landfill site is longer, the more volume should be transported with each load. In case of long distances to the disposal sites, transfer stations are found to be most efficient. Vehicles should be selected according to carrying capacity, capital costs, life expectancy, local spare part availability, loading speed, speed, fuel consumption, and maintenance costs.

Some general considerations for improvement could be followed:

- Under the Municipal Solid Waste Management and Handling rules-2000, the transport vehicle must be covered. In the beginning, therefore, municipal authorities can provide a cover for existing vehicles. Later, those vehicles should be replaced with a new covered vehicle to prevent waste from falling out.
- The transport of waste can be monitored and managed centrally or through a large decentralized arrangement. In either case, it is responsibility of municipal officers to ensure the efficiency of the arrangement.
- The whole transportation can be contracted out to private operators.
- The transport system must be harmonized with the beginning of secondary storage system of waste to prevent manual and multiple handling of waste.
- Transport capacity of vehicles must be sufficient to ensure a frequent evacuation of secondary waste storage containers. Otherwise containers will overflow.

Traditional manual loading operation is cost effective but the loaders cannot clean waste storage depots fully, besides loading vehicles damage the flooring and screen walls very often needs frequent repairs. The damaged flooring becomes a source of nuisance, if repairs are not carried out on time,

So there should be fully equipped automatic loading system from depot. It can be achieved by providing large storage bins at the storage depot which directly can be transferred to the disposal site or the waste from it can be loaded to the large vehicles easily.

Jaipur city generally has limited fleet (generally 2 fleets daliy) of vehicles and most of them are old and outdated necessitating frequent repairs with the result the waste transportation does not take place regularly. Solid waste in the city is generally seen lying in heaps or scattered at the unscientifically designed collection bins giving unsightly appearance besides causing nuisance and unhygienic conditions. So required amount of covered vehicles should be purchased to overcome this problem.

The route for lifting containers may be worked out avoiding zigzag movement of vehicles to the extent possible Depending on the containers to be cleared daily.

To ensure the full utilization of the fleet of vehicles and to reduce the requirement of new vehicles, all the vehicles may be utilized in two shifts to carry containers.

In the commercial area where there is serious traffic congestion during the day, transportation of waste during night time may be done in old city specially whereas it hampers solid waste management operations in day time. Night time operations will increase the productivity and reduce the cost of such service.

For the transportation of solid waste from walled city, the proposed routes have been marked with feasible way of transportation see in ~~appendixes 5 to 12~~. Figure 8.3 to 8.8

8.13 Guidelines for improvement of disposal of municipal solid waste

8.13.1 Recycling Options for Solid Waste

This is an important step was made mandatory under the *Municipal Solid Waste Management and Handling Rules 2000.* The Jaipur Municipal Corporation must treat the organic fraction of waste before disposal. Jaipur Municipal Corporation is expected to implement a plant for composting waste or to adopt waste-to-energy technology. Currently, private entrepreneurs are advising on several technologies for the processing and treatment of organic municipal solid waste. Some of the technologies have been used in India in the past, such as vermin-composting and microbial composting, whereas some are based on applications used in other developed countries that have yet to be tried in India or that didn't success in India. Such applications are like incineration for power generation. More often, municipal authorities fail to assess the suitability of new technology pertain to Indian conditions. They may be attracted to technologies which are successfully used in industrial countries without evaluating in Indian conditions, as a result, they may meet failure later.

It is very important to keep away this mistake and to properly address the issue of suitability to Indian conditions, including operation capacity, local technical knowledge and cost of maintenance.

8.13.2 Treatment of Organic Wastes

Waste form households can contain 40 or 50 percent of organic waste. Waste from urban fruit and vegetable markets may contain even higher amounts of this. Organic waste which causes major environmental and hygienic problems in cities and at landfills, the *Municipal Solid Waste Management and Handling Rules* 2000 mandate improved management and treatment of this fraction before dumping it to final disposal site.

Various treatment options for organic waste are available now like,

- *Composting*
- *Anaerobic digestion*
- *Incineration and other technologies*
- *Pyrolysis*
- *Bio-chemical conversion*
- *Landfill gas recovery*
- *Biogasification*

Composting: In the 2000 rules, composting is defined as a controlled process which involves microbial decomposition of organic matter under aerobic conditions. Biodegradable waste is converted to a soil like substance which is called compost, and considered as valuable soil amendment and fertilizer. In India there is a well-established composting community with a wealth of experience in composting. However, only a very few municipalities in India have adopted composting as a treatment option in their solid waste management strategy. Many composting projects are not formally linked to the official system and, therefore, struggle with financial, organizational, and institutional problems. Sustainable composting is only possible with the financial and organizational support of municipal authorities.

Anaerobic digestion: This is a process to produces biogas from decomposed waste. This biogas can be used to power electricity generators and to produce heat. This process drastically reduces the volume of organic matter from the waste stream, therefore needs less space to be put in a landfill or incinerated.

Incineration and other technologies: Developing countries like India have a waste of low calorific value between 700 and 1,000 kcal; therefore, it is not suitable for incineration process. Any technology for incineration requires a waste of very high calorific value. JMC should be very careful in assessing this option for disposal of waste.

8.13.3 Treatment of Inorganic Waste

The inorganic waste from municipal household can be divided into two categories, recyclable materials and non-recyclable materials. The recyclable materials which are segregated from the solid waste stream, the higher their value and very easier for further processing. The appropriate treatment option for inorganic waste completely depends on its physical and chemical characteristics. In India, the most suitable treatment option for in organic waste is recycling through the various informal sectors. This method has the potential to recycle nearly 20 percent of such waste. Experiences with the incineration are less promising. The recycling sector is very well established in India; however, much is still have to do regarding working conditions and environmental protection.

8.13.4 Improve Final Disposal of Waste by Landfills

Open dumping of waste can cause non-reparable damage to the environment by polluting water, land, and air; vastly affecting human health; and reducing people's quality of life. The *Municipal Solid Waste Management and Handling Rules 2000*, therefore, restrict open dumps and require municipal authorities to safely dispose of solid waste in fully engineered landfills. The rules further make it mandatory to treatment of the organic fraction of solid waste before final disposal to the landfill sites. Thus, only rejects, degraded and non-biodegradable waste can be placed in landfills. All Indian cities and towns are, therefore, under an obligation to stop open dumping of waste and to instead identify suitable lands for the construction of fully engineered.

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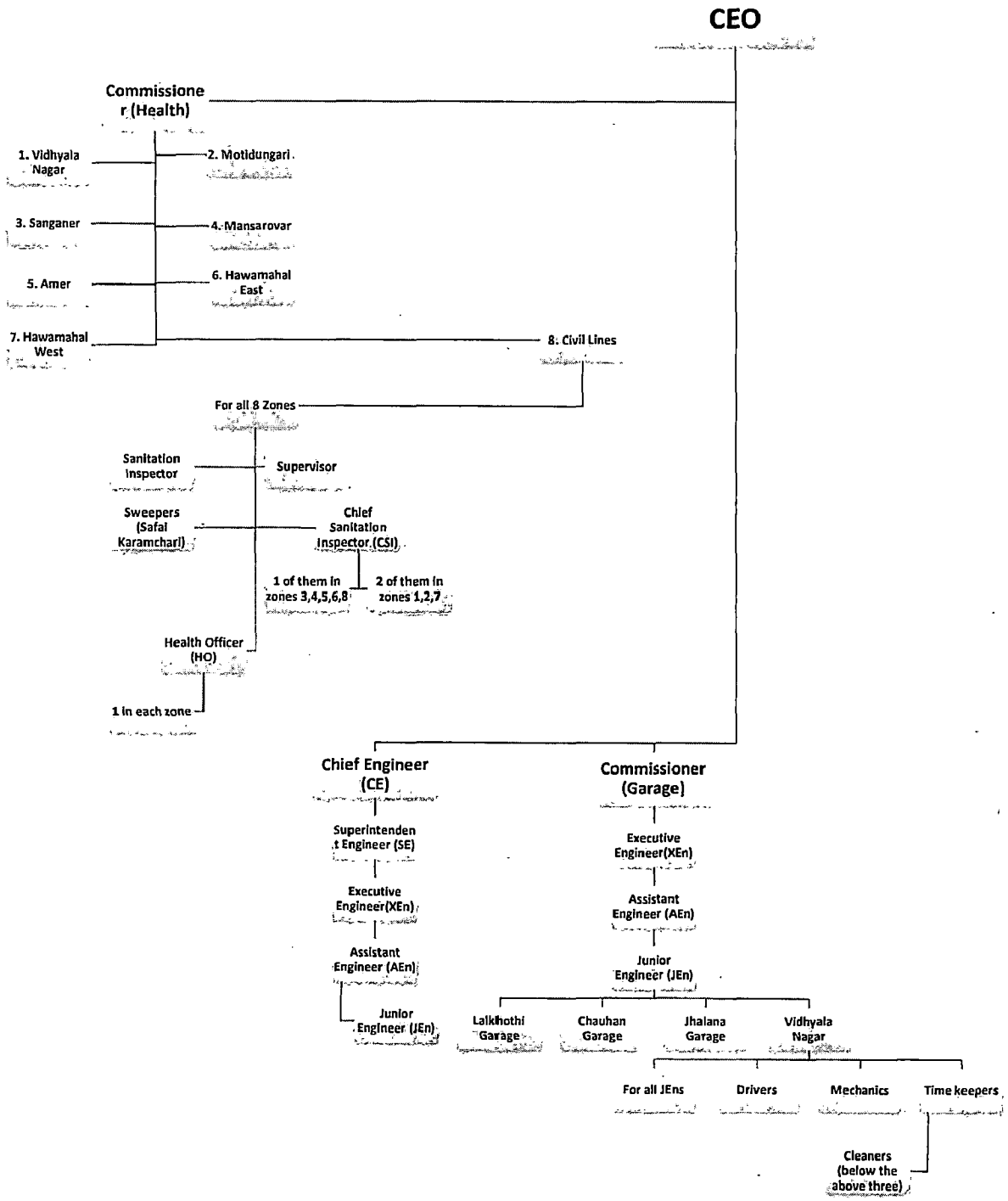
Annexure-1

Waste management hierarchy of Jaipur



Annexure -2

Questionnaire for Communities

Name: _____

Address: _____

Age: _____ Sex: Male ☐ Female ☐

Occupation: _____

1. Are you satisfied with the current way of handling Solid Waste?	1. Highly Unsatisfied 2. Unsatisfied 3. Neutral 4. Satisfied 5. Highly Satisfied	Comment:
2. Does the community bin in your locality have sufficient capacity to carry waste in a day?	1. Highly Unsatisfied 2. Unsatisfied 3. Neutral 4. Satisfied 5. Highly Satisfied	Comment:
3. Does any person come daily in your locality to collect the wastes scattered on the streets.	1. Daily 2. Alternative days 3. Few days in a week 4. Once in a week	Comment:
4. Does the waste collector come and clean the bin before it get overflow.	1. Yes 2. No	Comment:
5. Are you satisfied with the way waste get transported through vehicles?	1. Highly Unsatisfied 2. Unsatisfied 3. Neutral 4. Satisfied 5. Highly Satisfied	Comment:
6. Would you like to give a part of your income to have a better management of Solid Waste?	1. Strongly Disagree 2. Disagree 3. Agree 4. Strongly Agree	Comment:
7. Do you know where does the solid waste go at the end?	1. Yes 2. No	Comment:
8. Have you made some local rules or set norms to prevent waste material scattered in your locality.	1. Yes 2. No	Comment:
9. What kind of effort you are making to enforce those rules?		Comment:
10. Do you regularly monitor the enforcement of those local rules?	1. Yes 2. No	Comment:

Any Other problem: -

_____

_____

_____