

# A Comparative Assessment of Municipal Solid Waste –Cases of Cochin Corporation and Girinagar Housing Colony

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## Abstract:

The research aims to assess and provide strategies (qualitatively and quantitatively) for all municipal solid waste in a selected residential area in Kochi. To get an overview and an in-depth idea of research, an overall study of literature dates across the globe specifically on developed and developing countries was worked upon. Simultaneously the process of collecting, management, policies, and, practices in India was studied and listed.

Then the Kerala context was studied, and waste generation, quantification, and in-depth data of Kerala state policy, and operational guidelines were looked forth. Additionally, technical guidelines at the level like Suchitwa mission and Haritha Keralam strategies were glanced through.

As the study was intended to be focusing on a micro-level context; various methods of waste management methods were looked forth and finally the idea of a bottom-up-approach was used for the execution of the Ernakulum, being a commercial hub, and since the cochin corporation has the highest municipal solid waste generation, highly dense and highly populated, the cochin corporation would not afford to lose land for open dumping as it is currently openly dumped near the Brahmapuram plant. Therefore a central residential suitability analysis was carried out and the site was being scaled down to Girinagar Residential colony in Cochin Corporation.

The types of waste generated from the colony were quantified and bottom-up- up method was used to address and solve the issues regarding waste locally. Household-level surveys were conducted to know the education level, containers used for collection, etc which gave way to a better vision of proposal for the colony.

Thus, based on the methodology followed in the study; it is evident that each area has its own characteristics and solutions and conclusions can be obtained through micro-level analysis and studies.

**Keywords — Waste management; Kochi; Collection; Segregation etc**

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## INTRODUCTION

### **SOLID WASTE MANAGEMENT**

Solid waste is the unwanted or useless solid materials generated from human activities in

residential, industrial, or commercial areas. It may be categorized in three ways.

According to its:

Origin (domestic, industrial, commercial, construction or institutional)

Contents (organic material, glass, metal, plastic paper etc)

Hazard potential (toxic, non-toxin, flammable, radioactive, infectious etc).

Solid Waste Management reduces or eliminates the adverse impact on the environment & human health. A number of processes are involved in effectively managing waste for a municipality. These include monitoring, collection, transport, processing, recycling and disposal. The quantum of waste generated varies mainly due to different lifestyles, which is directly proportional to socio economic status of the urban population.

**Types of Solid Waste**

It can be classified into different types depending on their source:

**Municipal Solid Waste (MSW):** It consists of household waste, construction and demolition debris (CnD), sanitation residue, and waste from streets, generated mainly from residential and commercial complexes. As per the MoEF it includes commercial and residential waste generated in municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes;

**Industrial Solid Waste (ISW):** In a majority of cases, it is termed as hazardous waste as they may contain toxic substances, are corrosive, highly inflammable, or react when exposed to certain things e.g. gases.

**Biomedical waste or hospital waste:** It is usually infectious waste that may include waste like sharps, soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, etc., usually in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc. These can be a serious threat to human health if not managed in a scientific and discriminate manner. (India water portal)

**PRESENT GLOBAL SCENARIO**



Figure 1 Top municipal solid waste generators annually in the world

**India generates the most waste globally, says World bank (Waste, 2020)**

**IMPORTANCE OF SOLID WASTE MANAGEMENT IN INDIA**

Municipal solid waste (MSW) management is a big problem faced by developing countries like India. The major cities in India face the threat of increasing municipal solid waste generation and it has become a big burden on both the local bodies as well as the public. The present annual quantity of MSW generated in Indian cities has increased from 6 million tons in 1947 to 48 million tons in 1997 - an annual growth rate of 4.25%. (CPCB, 2004) It is expected to increase to 300 million tons by 2047. It is not an easy task to manage these wastes. There are different approaches to waste management followed in Indian cities. The most common type of waste management practice followed in Indian cities is the open dumping of waste. Open dumping is generally considered as the worst method of solid waste management due to its different ill effects of it. The main problems related to open dumping include problems related to human health parameters, drinking water contamination, soil

pollution etc. More than 90% of the waste generated in Indian cities is disposed of directly to the land in an unscientific manner (Das et al., 1998). Cochin is one of the main cities of India and is often considered the commercial and industrial capital of Kerala. Although many of the Indian cities are having enough land to follow the open dumping practices, the more congested and populated cities like Cochin cannot afford to lose a large area of land just for open dumping in the west. The problems related to the rapid increase of MSW generation in the city are mainly because of rapid urbanization and population growth. (Hridya K K1, 2016)

The above graph shows that the collection efficiency of MSW is the least in Kerala. Cochin is one of the main cities of India and is often considered as commercial and industrial capital of Kerala. Although many of the Indian cities are having enough land to follow the open dumping practices, the more congested and populated cities like Cochin cannot afford to lose a large area of land just for open dumping of the waste. The problems related to the rapid increase of MSW generation in the city are mainly because of the rapid urbanization and population growth.

**PRESENT SCENARIO IN KOCHI**

**MUNICIPAL SOLID WASTE MANAGEMENT**

Bottom 10 states			Top 10 states		
State	Daily waste generated (MT)	Waste Processed	State	Daily waste generated (MT)	Waste Processed
Arunachal	181	0%	Chhattisgarh	1,680	74%
D & N Haveli	35	0%	Telangana	7,371	67%
J & K	1,374	1%	Sikkim	89	66%
Jharkhand	2,327	2%	Goa	260	62%
Odisha	2,650	2%	Meghalaya	268	58%
Bihar	1,318	3%	Tripura	420	57%
Puducherry	350	3%	<b>Delhi</b>	<b>10,500</b>	<b>55%</b>
Mizoram	201	4%	Manipur	176	50%
West Bengal	7,700	5%	Kerala	1,463	45%
Haryana	4,514	6%	Maharashtra	22,570	39%
<b>All states</b>					
Daily waste generated (MT)		1,43,558			
Waste Processed		24.8%			

Figure 2 Municipal garbage statistic in India.

75 % of municipal garbage in India is dumped without processing (TOI) (TNN, 2018)

**PRESENT SCENARIO IN KERALA**

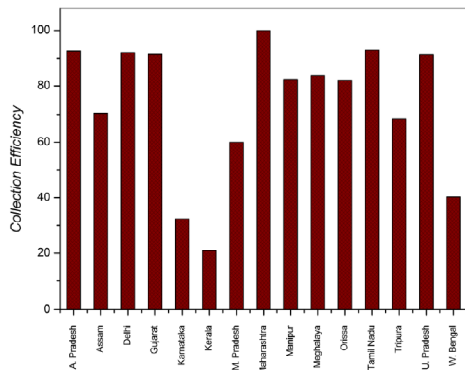


Figure 3 Collection efficiency of MSW of selected Indian states (CPCB, 2013)

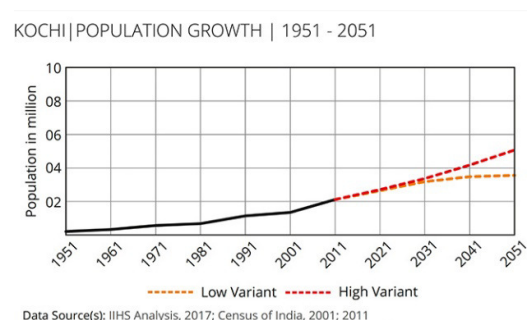


Figure 4 Projected population of Kochi

SL.No	Name of Municipality	Total Population	Total area (sq.km.)	Density (Persons/sq.km)
1	Perumbavoor	26547	13.605	1951.26
2	Muvattupuzha	29246	13.183	2218.46
3	Kothamangalam	37173	13.01	2857.26
4	Paravur	30059	9.02	3332.48
5	Thrippunithura	59884	18.69	3204.06
6	Kalamassery	63116	27.00	2337.62
7	Aluva	24110	7.18	3357.93
8	Angamaly	33409	28.24	1183.03
9	Kochi	595575	94.88	6277.13

(Source – Kerala State Statistics and Economics Department)

Table 1 Census of India (IHS Analysis; 2001, 2011)

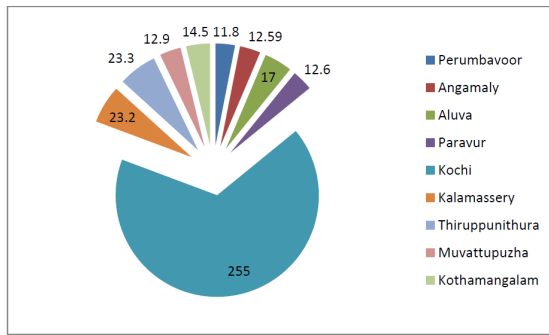


Figure 5 waste generation statistics

Name of Municipality/Corporation	Waste Generation in Tonnes
Perumbavoor	11.8
Angamaly	12.59
Aluva	17.0
Paravur	12.60
Kochi	255.0
Kalamassery	23.2
Thiruppunithura	23.3
Muvattupuzha	12.9
Kothamangalam	14.5
Total	382.89

Source: The Corporation and Municipalities

Table 2 Quantity of waste generated in ernakulam

### MSW MANAGEMENT IN COCHIN

Cochin is known as the queen of Arabian Sea. It is a major port city which is a part of Ernakulam district in the state of Kerala. It lies on the south west coast of India by the Arabian Sea. Population of Cochin is 603000 plus the floating population and metropolitan population is 2.1 million as per the census 2012. and vehicle procurement and maintenance. To treat 1 tonne of biodegradable waste, corporation is spending 550 rupees on an average.

Corporation collects 3 Rupees per Kg for biodegradable waste and 5 Rupees per Kg for Chicken and plastic waste from the residents and commercial establishments (Corporation of Cochin). The existing waste treatment practice followed by the city is shown in Figure.

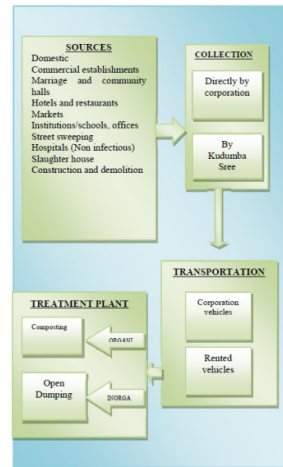


Figure 6 MSW management practices at Cochin city

### SOURCES AND QUANTITIES OF MSW

The major source of MSW in the city include

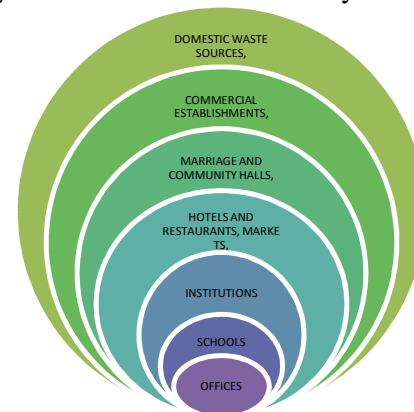


Figure 7 Sources from which waste is generated

domestic waste sources, commercial establishments, marriage and community halls, hotels and restaurants, markets, institutions, schools, offices, street sweepings, hospitals (Non-infectious), slaughter house, construction and demolition etc. The total daily production of MSW in city is 180-250 metric tonnes. The percapita waste generation is 482g/day/head.

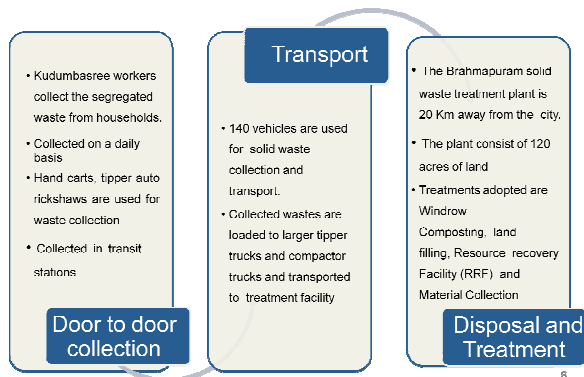
### COLLECTION AND SEGREGATION OF SOLID WASTE

Corporation of Cochin collects the solid waste in the city in a daily basis. The waste is being

collected from the households and commercial and other type of institutions by means of Kudumba Sree units and also by corporation directly. Almost 90% of collection is done by means of Kudumba Sree units.

Segregation of waste is being done at the collection point itself. There are 140 primary vehicles for collecting waste including tricycles.

### **PROCESS OF SOLID WASTE MANAGEMENT**



**Figure 8** Flow of collection to disposal of MSW in kochi



**Figure 9** Collection and segregation of MSW

MSW Generation sources	Quantity
Domestic sources	134.7
Commercial establishments	32.99
Marriage and community halls	4.75
Hotel and Restaurants	29.9
Markets	20.39
Institutions / Schools, offices	14.75
Street sweepings	31.3
Hospitals (Non infectious)	4.22
Slaughter house	5.26
Construction and Demolition	17
Total	295.26
Per capita generation(g/day/head)	482

**Table 3** Quantity of MSW in the city (KSUDP)



**Figure 10** A tricycle used for MSW

**PHYSICAL COMPOSITION OF MSW AT COLLECTION POINT AND DUMPING SITE (KSUDP)**

Type of MSW	Collection Point(%)	Dump site(%)
Paper	4.87	4.42
Plastic	4.83	4.1
Metals	0.35	1.03
Glass	1.06	2.04
Rubber and Leather	1.5	1.42
Inerts	1 74	1.81
Ash and fine earth	1.68	3.68
Compostable Organics	79.78	77.14
Domestic Hazardous	0.28	0.74

- Cochin corporation being a part of ernakulam has several residential divisions one being CA-06
- Kadavanthara area being the central area of various amenities in and around has 2 prominent colonies positioned in the best suitable areas for residential function.

**PRIMARY DATA COLLECTION**

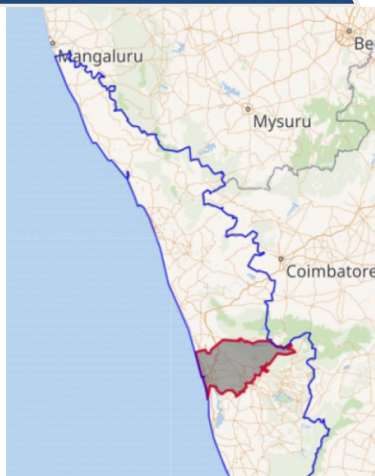
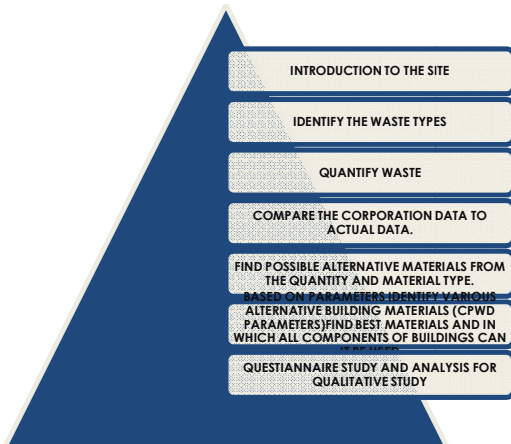


Figure 11 ernakulam boundary

- Ernakulam is a major financial and commercial hub of Kerala

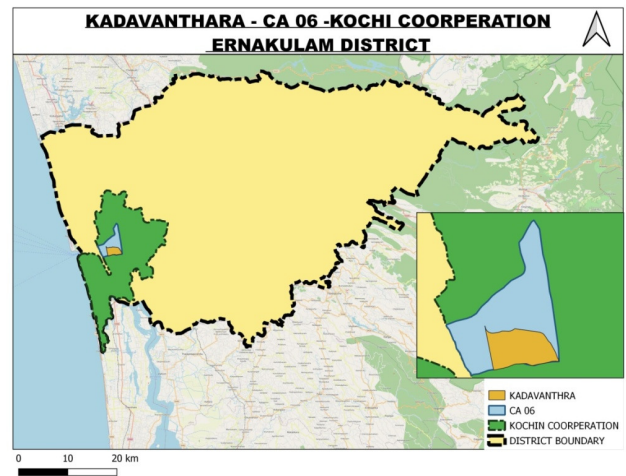


Figure 12 locating most favorable residential area - kadavanthara area

The map above represents the Ernakulam area and spots out cochin corporation and Kadavanthara area that is a residential area with all the amenities nearby for the households.

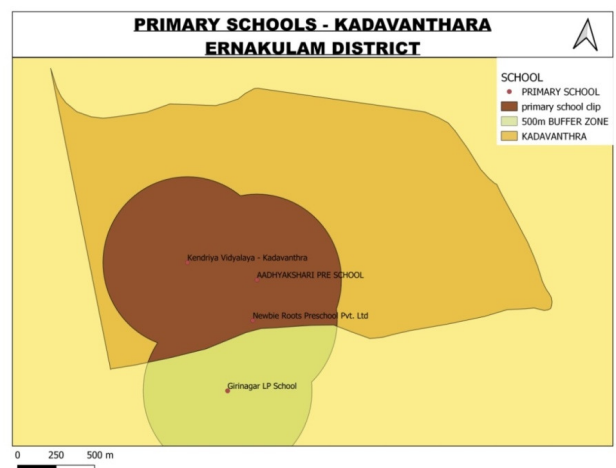


Figure 13 primary schools clip analysis

The map above represents the clip analysis primary schools in the Kadavanthara area as education facility is one of the basic amenities that have to be included.

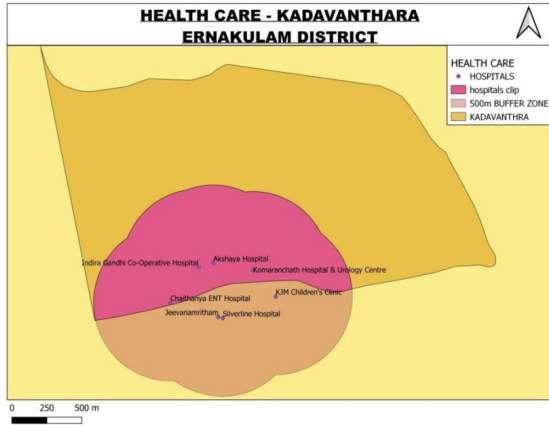


Figure 14 health care clip analysis

The map above represents the clip analysis for health care in the Kadavanthara area and as the image shows there are 7 amenities for healthcare in the region.

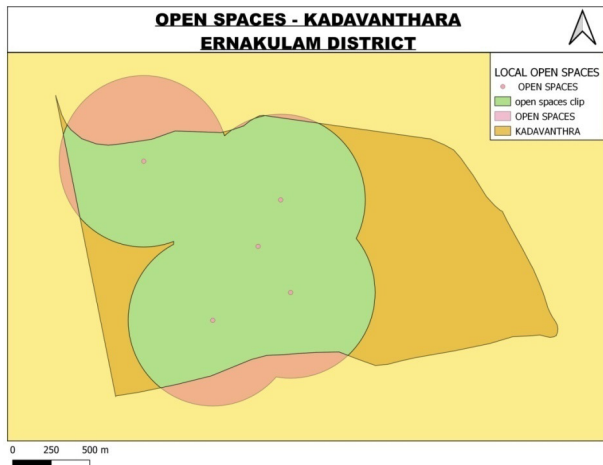


Figure 15 open spaces clip analysis

The map above represents the clip analysis for open spaces in the Kadavanthara area and this proves the coverage of open spaces in the area.

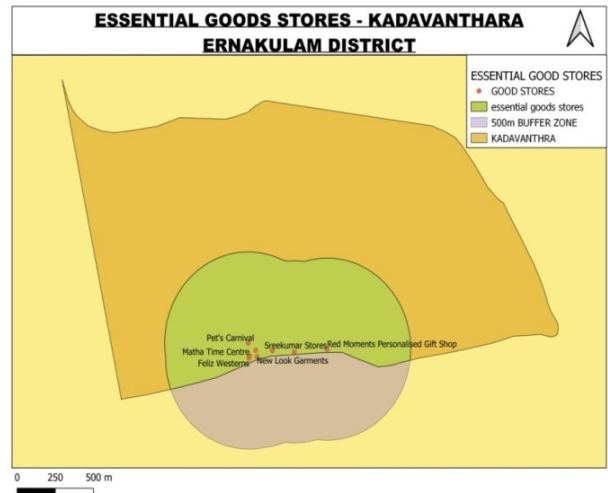


Figure 16 essential goods clip analysis

The map above represents the clip analysis for goods stores in the Kadavanthara area and this proves the coverage of open spaces in the area.

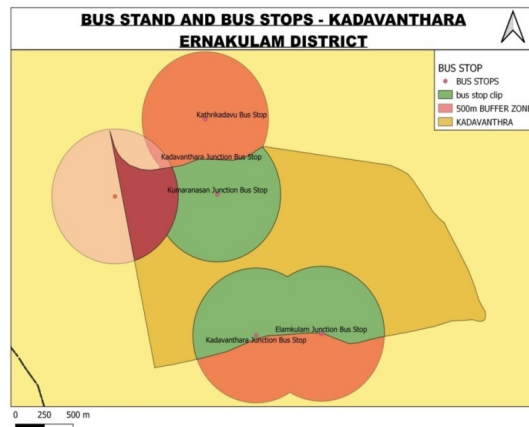


Figure 17 bus stand clip analysis

The map above represents the clip analysis for bus stand and bus stops in the Kadavanthara area and this proves the coverage of availability of public transport in the nearby area.

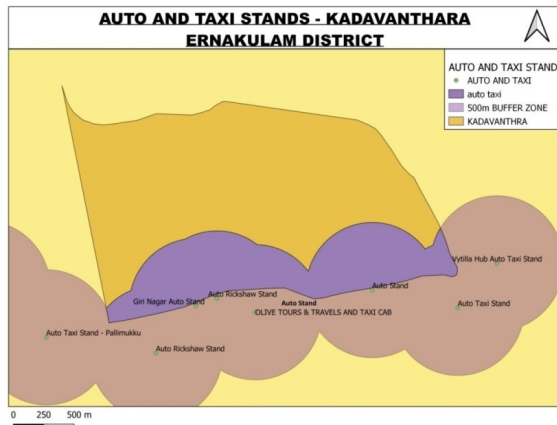


Figure 18 auto taxi stand clip analysis

The map above represents the clip analysis auto and taxi stand in the Kadavanthara area and this proves the coverage of availability of public transport in the nearby area.

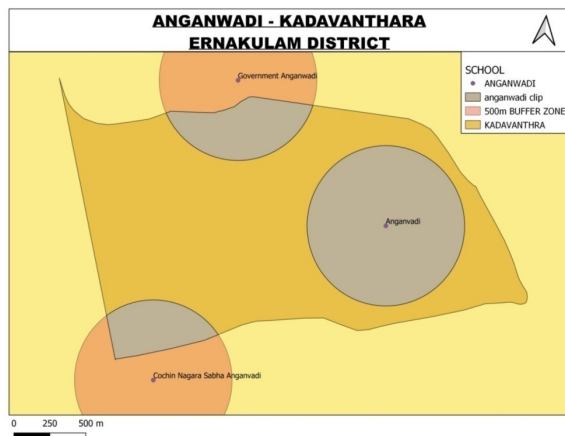


Figure 19 anganwadi clip analysis

The map above represents the clip analysis of anganwadi in the Kadavanthara area and this proves availability of educational facility nearby the area.

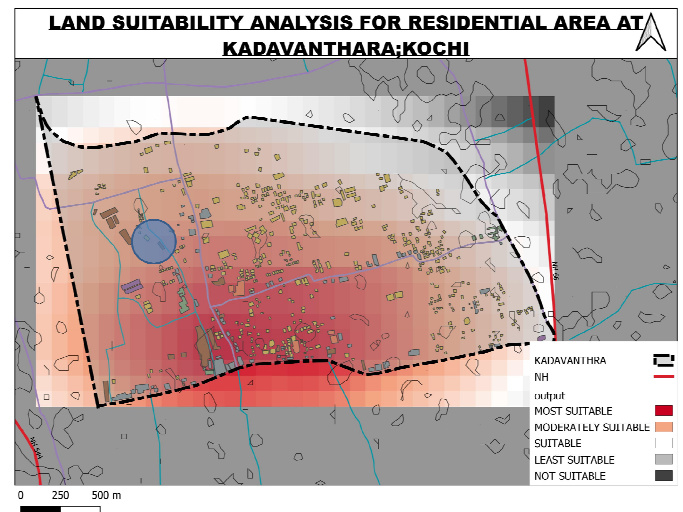
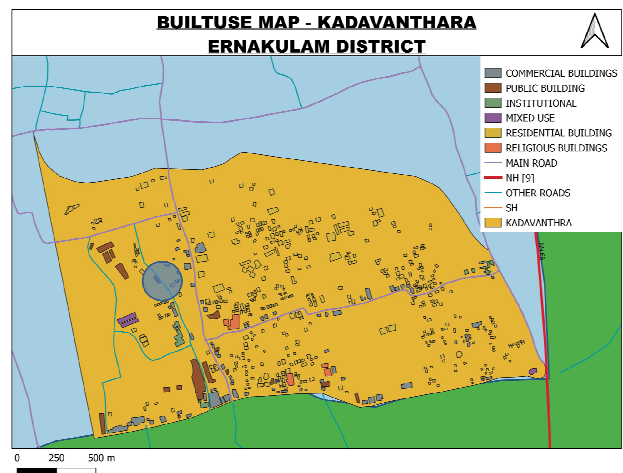


Figure 20 land suitability analysis



- From the above builtuse map shown; there are major of residential areas, commercial, institutional, mixed use, public buildings.
- The Girinagar residential colony being the first residential colony in Kadavanthara area.
- Major area of land is used for residential purposes

### INTRODUCTION TO THE SITE

Gandhi Nagar is one of the two earliest (the other being Panampilly Nagar) planned housing colonies



in Kadavanthra region of Kochi city in the state of Kerala, India. It was developed by the end of the 1970s by the Greater Cochin Development Authority, the statutory body overseeing the development of Kochi.

Gandhi Nagar was, in the 1970s, abandoned paddy fields, and wetlands. The land was developed by filling with earth from the hills of Kakkanad, and a planned housing colony was developed.

### The housing scheme based on 'income groups'

In the original plan of this colony, the housing regions were divided into three based on the income group of the potential occupants, and houses were built in these regions in four different formats, for four different income groups. It may be now perceived as quite unesthetic, or unpolitical, but these houses were, in fact, named to bear the category of these income groups. They were named: EWS (Economically Weak Section), LIG (Lower Income Group), MIG (Middle Income Group), and HIG (High Income Group). Although the expansions of these abbreviations are now forgotten, these houses still bear these abbreviations in their house numbers. The same scheme was followed in Panampilly Nagar and Changampuzha Nagar (KSHB) as well. Even though the same format of housing was replication in later projects of GDCA like the *South Commercial*, and in Kakkanad, the income group-based naming was not followed.

### AREA OF THE STUDY -GIRINAGAR RESIDENTS ASSOCIATION

Giri Nagar South: This was the golden project of the society. 278 plots were developed in an area of 33 Acres. The plot of Girinagar resident's colony consists of more than 80 houses all of them being categorized based on the sizes of residence.

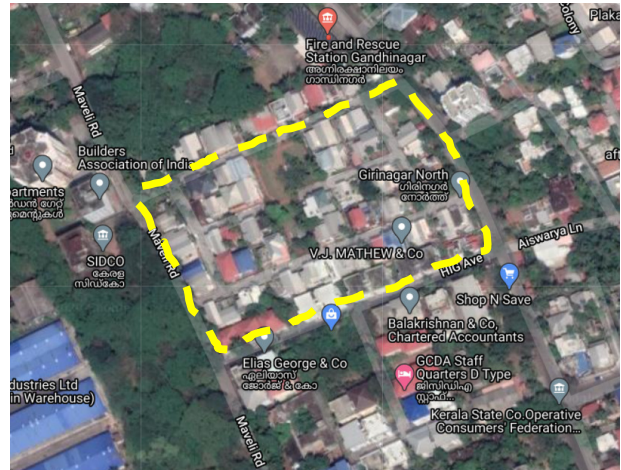


Figure 21 Girinagar residential area boundary



Figure 22 Street views of Girinagar Housing colony.

For the different wastes generated from the households; a pilot study regarding the residence were carried out.

Waste Type	Composition
Food/organic waste	food leftovers, vegetables, fruits, fruit skins, bones, bread and used <i>chai patti</i> etc.
Metal	tins, steel and iron utensils, wires, razor-blades cooking oil cans, soft-drink cans etc.
Plastic	packaging, plastic bags, pipe, utensils and items of daily use, bottles, etc.
Rubber	tires, tube, slippers and accessory parts of refrigerators and other electronics, etc.
Corrugated Boxes	In various sizes and with varying weight of packaging container i.e. milk pack carton, candy boxes etc.
Textile	rugs, torn clothes, cotton, socks, fur, etc.
Paper	books, note-books, magazines, newspaper, packaging paper etc.
Ash/Dust	Fine material from wood burning, home sweeping.
Glass/Ceramic	broken window glass, showpieces, cups, jugs, plates and other kitchen utensils made from these materials, beverages, vinegar, sauce, and medicine bottles.
Others	those waste materials which could not be distinctively classified in any of the above mentioned groups like disposal nappies/dippers or those items which are rarely produced or produced in very minute quantities, these include wood splinters, human hair, household hazardous substances, razors, batteries, paint, household chemicals, grass blades, electric and electronic waste.

Figure 23 pilot study of types of waste produced in colony

- The collection happens from door to door and is transported and dumped in Brahmapuram plant.
- Due to the lack of open space for the residents; the wastes generated are taken by the cochin corporation.
- Some of the household still practice burning waste within their compound

Random samples of 10 households were taken From the study it is evident that 90 percent of the waste is basically collected from the residential colony and disposed off at Brahmapuram plant which is currently not in functioning condition.

**Based on the categories of wastes literature studies have been conducted to finally quantify the alternative materials that can be obtained.**

### 1) SOLID WASTE MANAGEMENT IN THE CITY- BEST PRACTICES.

- Plastic shredding unit – plastic is collected from every source and shredded into fine particles and used for brick making and road construction.
- Segregation of waste – the segregation is done at source. Food waste and plastic waste collected separately.
- Composting – practiced in many households and also in the waste treatment plant

Bio methanation - practiced in many households

- The Kochi module reflects the best practices on source segregation of waste as exemplified by the Kochi Municipal Corporation (GOI).
- It shows how source segregation, composting, stringent legal system coupled with multi-stakeholder participation leads to effective waste management in urban places which are devoid of adequate landfill spaces.

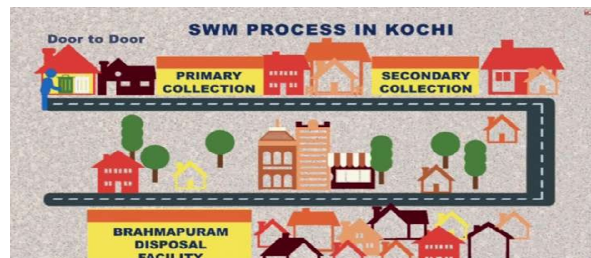


Figure 24 swm process currently followed

### IDENTIFY WASTE TYPES

- ORGANIC
- PAPER
- PLASTIC
- ASH
- RUBBER
- METAL
- GLASS
- OTHERS

**Land use map**



**Figure 25 landuse map**

- Total number of houses : 78 numbers
- Residences in the category of HIG.
- The roads are aligned straight and maximum area of the land is utilized for buildings.
- Drainage is aligned along the roads but the sizes are quite small. coverings for the drains are also not provided.
- One side of the colony faces ksrtc bus route which is more susceptible to noise pollution and burning of waste and illegal dumping of waste is frequent along this area.
- houses are designed such that each house shares a common wall with adjacent house making it a single module mirrored to each other in terms of planning

**WASTE GENERATING HOUSEHOLDS**



**Figure 26 waste generation mapping**

- The green-coloured houses provide organic, plastic, and paper waste separately to the kudumbasree waste collectors.
- The orange-colored households are unoccupied and wastes are not generated from them
- The red indicated household is an ayurvedic outlet.
- Wastes from the same are taken for treatment by the rented residents.
- The organic waste is collected in boxes from all the houses on all days except Sundays.
- The plastic and paper waste is collected on all days except Mondays, Fridays, and Sundays. usually collected in a cement sack.

**QUANTIFICATION OF WASTE TYPES  
- FOR 2 WEEKS**

**WASTE QUANTIFICATION-COMPARE  
THE CORPORATION DATA.**

DAY 1 - November 2 - Monday

WASTE TYPE	QUANTITY	WEIGHT (KG)	VOLUME (L)	PERCENTAGE
ORGANIC(KUDUM BASREE)	100	1000	1000	77%
METAL(COORPORATION)	10	100	100	8%
RUBBER(COORPORATION)	5	50	50	4%
ASH	10	100	100	8%
PLASTIC(KUDUMBASREE)	10	100	100	8%
PAPER(KUDUMBASREE)	10	100	100	8%
OTHER	10	100	100	8%

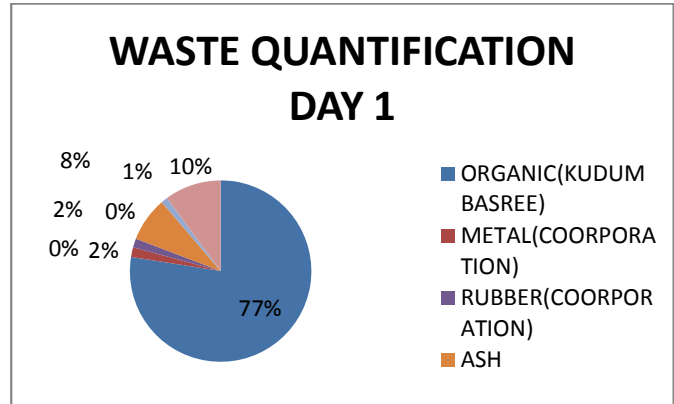


Figure 27 waste quantification day 1

DETAILED QUANTIFICATION IS ATTACHED AS AN APPENDIX AT THE REPORT END.

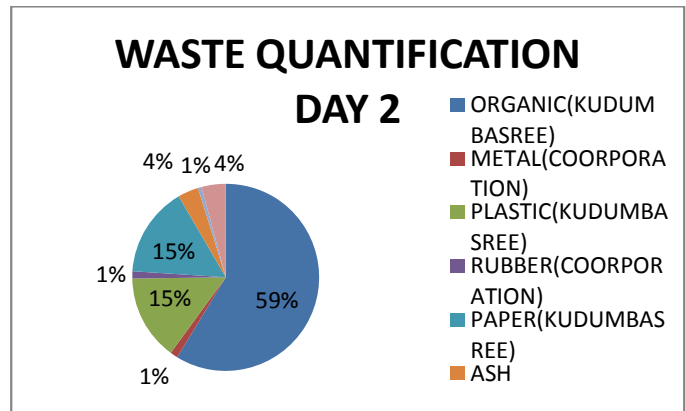


Figure 28 waste quantification day 2

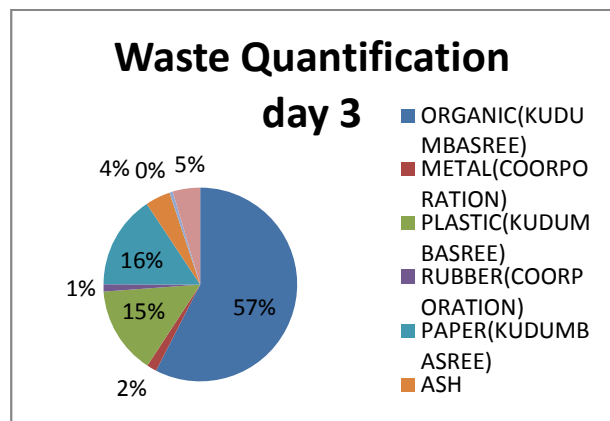


Figure 29 waste quantification day 3

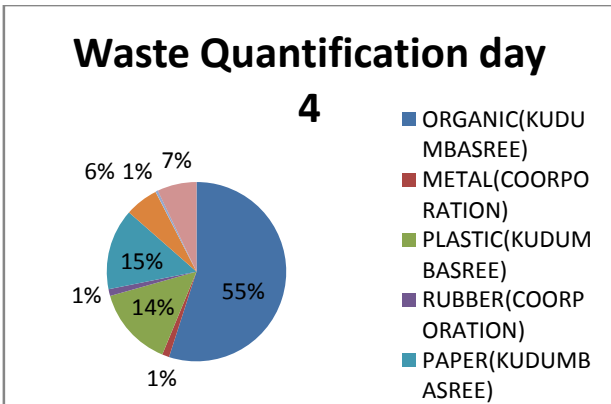


Figure 30 waste quantification day 4

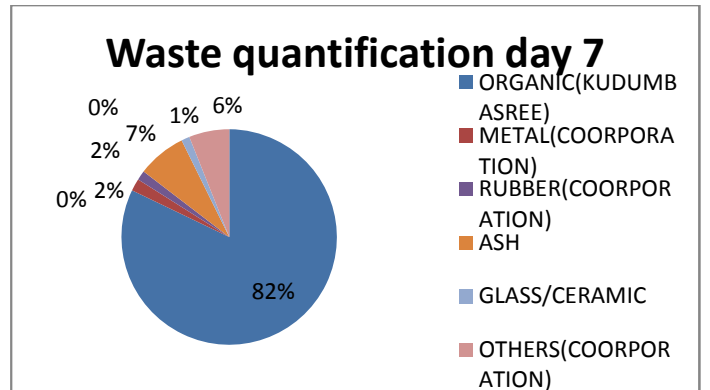


Figure 33 waste quantification day 7

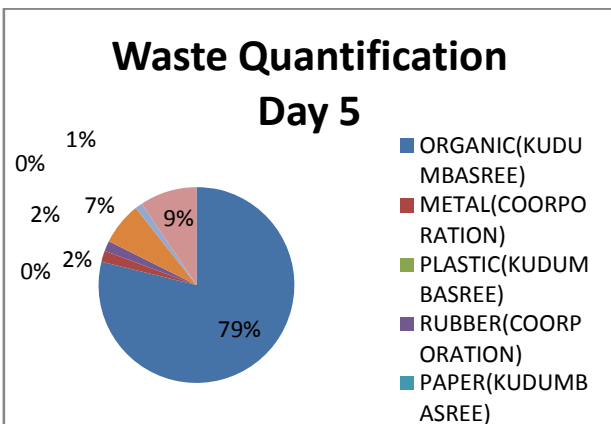


Figure 31 waste quantification day 5

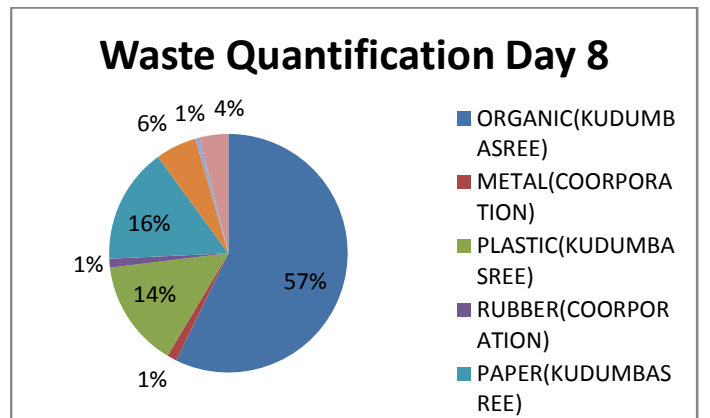


Figure 34 waste quantification day 8

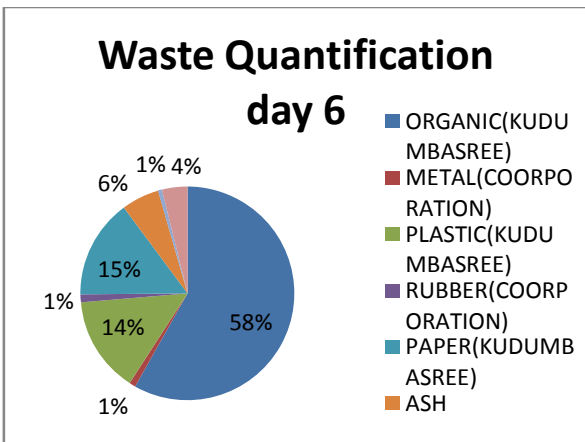


Figure 32 waste quantification day 6

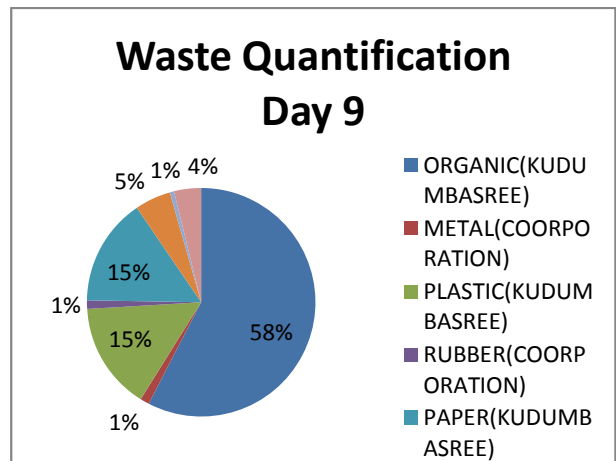


Figure 35 waste quantification day 9

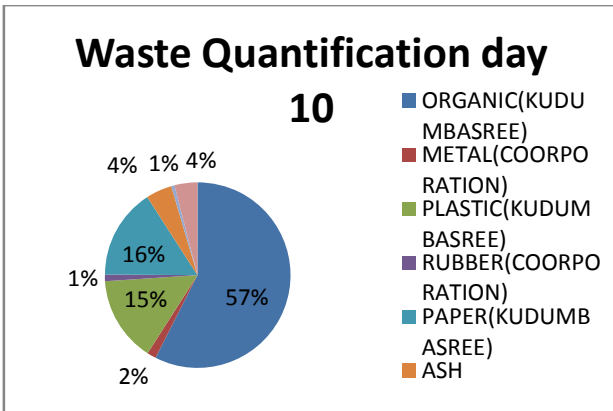


Figure 36 waste quantification day 10

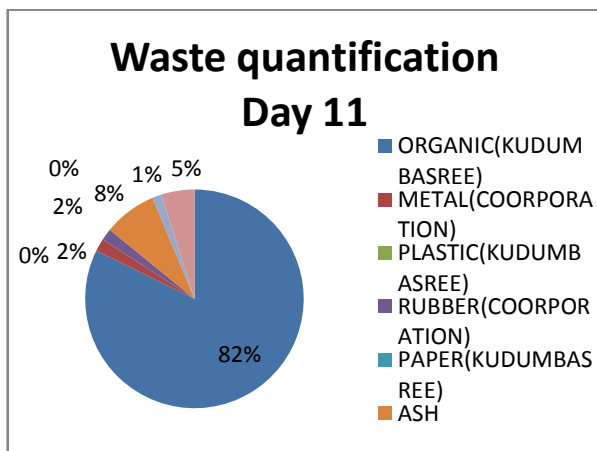


Figure 37 waste quantification day 11

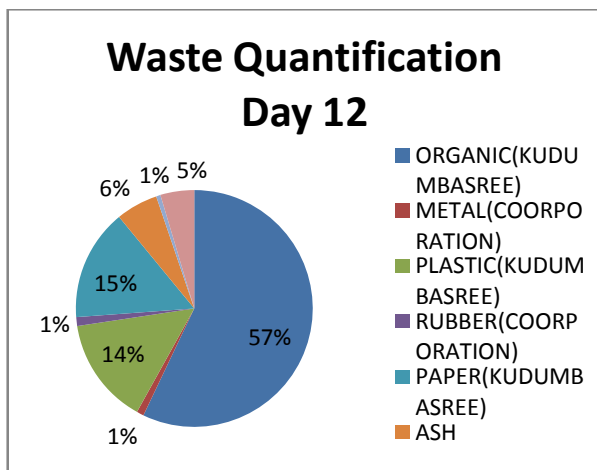


Figure 38 waste quantification day 12

HIGHLY GENERATED IS ORGANIC WASTE, THEN COMES PLASTIC AND PAPER WASTE

Day	ORGANIC (KUDUMBASREE)	METAL (COORPORATION)	PLASTIC (KUDUMBASREE)	RUBBER (COORPORATION)	PAPER (KUDUMBASREE)	ASH	GLASS/CERAMIC	OTHERS (COORPORATION)
1	18.13	0.4		0.375		1.859	0.28	2.351
2	17.88	0.4	4.5	0.375	4.747	1.1	0.19	1.269
3	17.83	0.5	4.528	0.385	4.829	1.303	0.17	1.422
4	17.35	0.4	4.543	0.405	4.6	1.899	0.15	2.231
5	17.26	0.4		0.375		1.533	0.26	2.068
6	18.07	0.3	4.511	0.375	4.659	1.776	0.19	1.191
7	18.24	0.4		0.325		1.623	0.28	1.338
8	17.84	0.4	4.533	0.375	4.886	1.744	0.19	1.207
9	17.66	0.4	4.651	0.375	4.669	1.556	0.19	1.168
10	17.58	0.48	4.534	0.365	4.803	1.391	0.19	1.221
11	17.62	0.4		0.375		1.683	0.042	0.02
12	17.64	0.3	4.5	0.375	4.701	1.772	0.19	1.427
total	213.1	4.78	36.3	4.48	37.89	19.23	2.322	16.91
289 days/187 days	61585.9	1381.42	6788.1	1294.72	7086.178	5560.071	671.058	4887.857

Table 4 Total waste generated from the colony

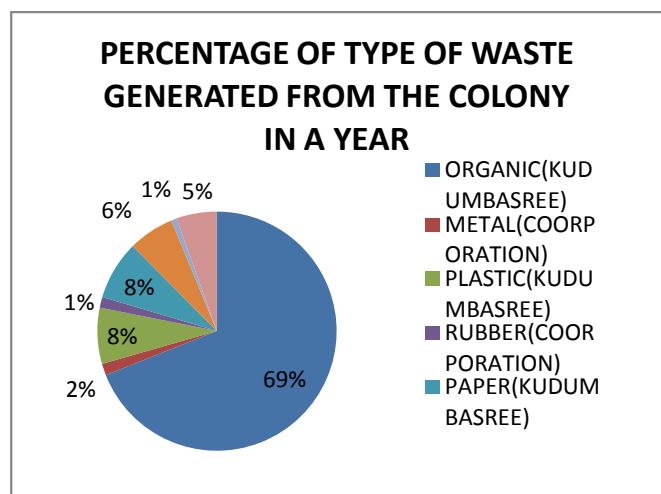


Figure 39 percentage of waste generated from the colony in a year

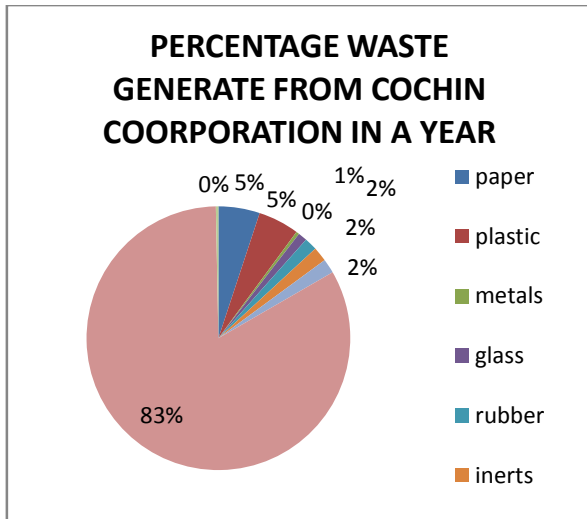


Figure 40 percentage of waste generated from the coorporation in a year

## FINDINGS

Compared to the percentage of waste generation the percentages widely varies for a colony.

TYPES	ALTERNATIVES POSSIBLE	WASTE IN A YEAR	APPLICATIONS
ORGANIC(KUDUMBASREE)		61585.9 KG	
METAL(COORPORATION)	SLURRY INFILTRATED CONCRETE	1381.42 KG	WALLS,FLOORS
PLASTIC(KUDUMBASREE)	1.5% BITUMENPOLYMER FOR ROAD CONSTRUCTION, PERFORATED POLYMER CONCRETE BINDING MATERIAL IN CEMENT	6788.1 KG	ROADS,WALLS,FLOORS
RUBBER(COORPORATION)	Crum Rubber Modified Bitumen (CR)	1294.72 KG	WALLS,ROADS
PAPER(KUDUMBASREE)	BOARDS FOR INTERIOR PARTITIONS	7086.178 KG	WALL
ASH	PPC cement or blended cement, which is almost 60% of the total cement produced.	5560.071 KG	WALLS,FLOOR
GLASS/CERAMIC	glass is properly crushed, concrete construction as fine or course aggregate.	671.058 KG	WALLS.CONCRETING ETC

Figure 41 FINDINGS

Thee wastes generated have the potential to be used as alternate materials

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