CP303: Capstone Project 2

Project: MSW management of Ropar city; Main focus on RDF facility and route optimization.

Project Guide:

Dr. Indramani Dhada
Assistant Professor
Department of Civil Engineering
Indian Institute of Technology
Ropar

Submitted by:

Manisha (2018ceb1013)
Mohit Kasaniya (2018ceb1014)
Pratima Singh (2018ceb1021)
Sagarika Sharma (2018ceb1026)

Municipal Solid Waste (MSW)

- Municipal Solid Waste (MSW)— more commonly known as 'trash' or 'garbage' .

- It mainly consists of everyday items we use and then throw away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. This comes from our homes, schools, hospitals, and businesses.

```
[Source Storage and Segregation] → [Collection and Transportation] → [Dump Sites] → [Waste Transportation] → [Disposal to Landfills]
                                                                          ↓                    ↓
                                                          [Recyclables Materials Separated]   [Processing for Energy Recovering]
```
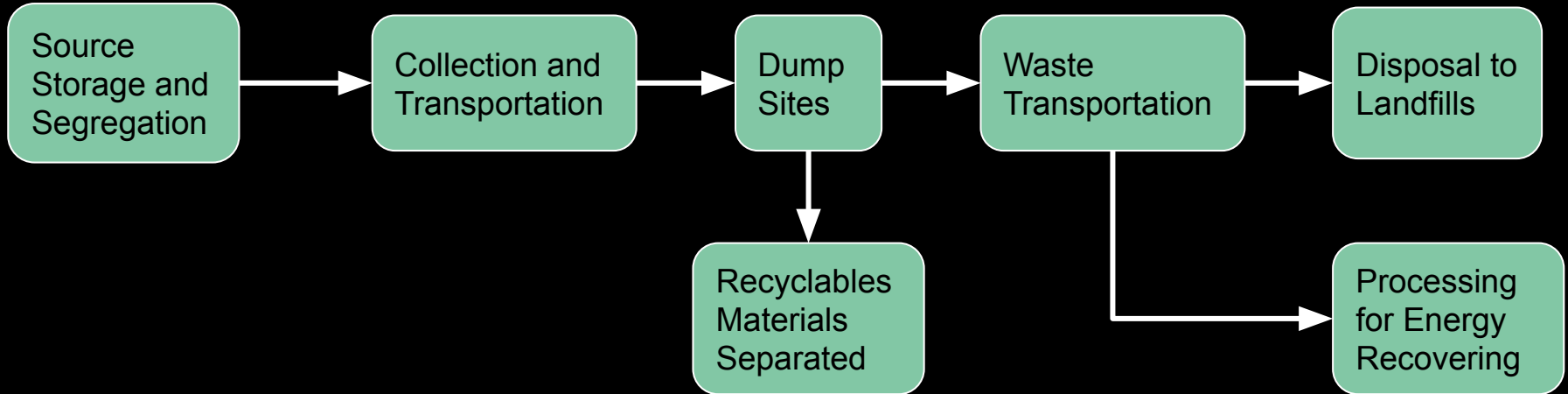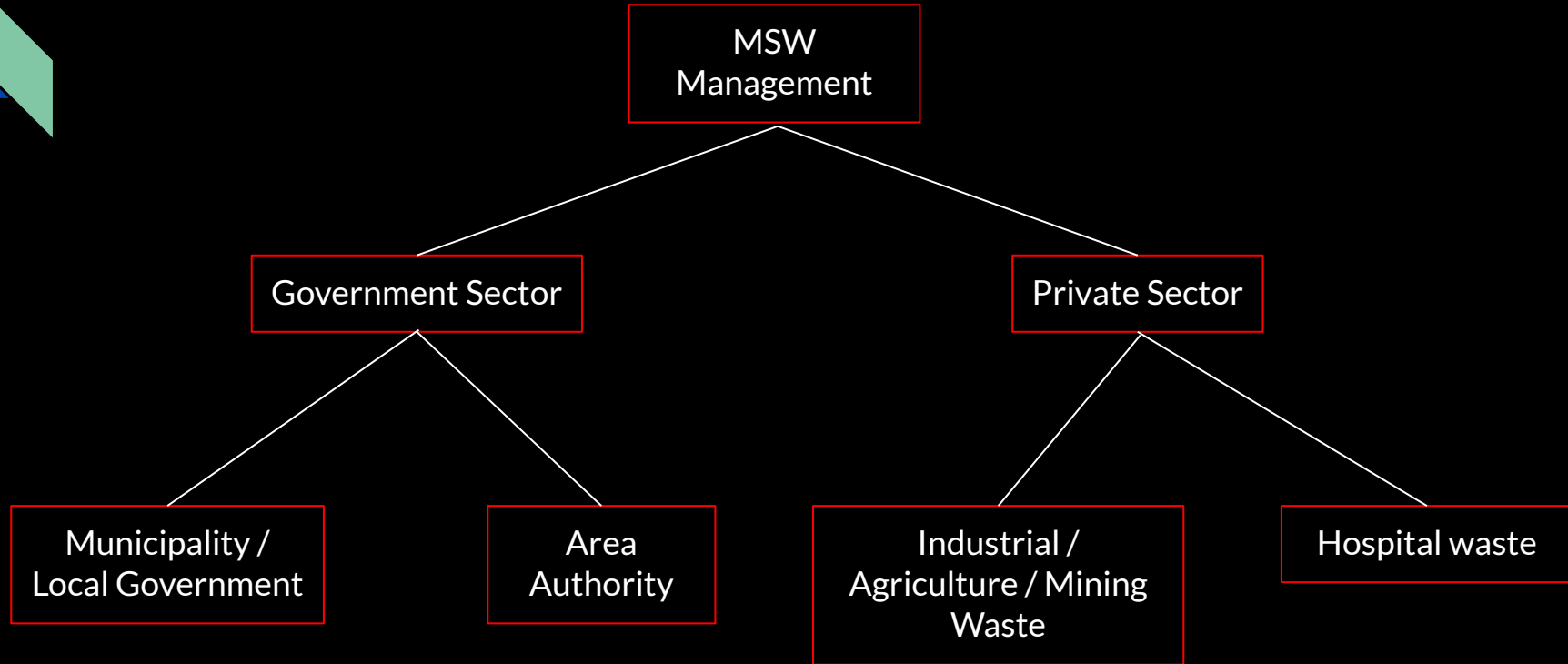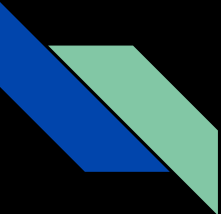
Fig: MSW Collection to Energy Value Chain

Population Forecasting

Calculations

Source of population

 -census of India

https://www.censusindia.gov.in/2011census/PCA/A2_Data_Table.html

Year	Rupnagar Population	Arithmetical Increase	Incremental Increase	Geometrical Increase
1951	251804			
1961	319389	67585		26.84
1971	357783	38394	-29191	12.02
1981	439165	81382	42988	22.75
1991	535970	96805	15423	22.04
2001	628846	92876	-3929	17.33
2011	684627	55781	-37095	8.87
Total		432823	-11804	109.85
Value of 'N'	7	6	5	6
Average		72137.167	-2361	18.3083
Ref. population	684627			

How to manage MSW waste ???

There is so much waste generated as municipal solid waste from different sources in cities and they all go wasted but we can convert them into fuel and then all the waste can be used again in the form of fuel and it is a huge use of waste material and here comes the idea of RDF(Refuse Derived fuel).

MSW waste consists of combustible and non-combustible waste, the combustible waste can be

Converted into fuel and this can be further used for other purposes like, we make RDF fuel sticks out of these and these sticks can be further used in burners for cooking purposes.

Rupnagar District Population, Punjab - Census India 2011

- Rupnagar is one of district of Punjab in India. There are 4 Tehsils, 611 villages and 9 towns in Rupnagar district.

- As per the Census India 2011, Rupnagar district has 135635 households, population of 684627 of which 357485 are males and 327142 are females. The population of children between age 0-6 is 72926 which is 10.65% of total population.

- The sex-ratio of Rupnagar district is around 915 compared to 895 which is average of Punjab state. The literacy rate of Rupnagar district is 73.43% out of which 77.91% males are literate and 68.53% females are literate. The total area of Rupnagar is 1356 sq.km with population density of 505 per sq.km.

- Out of total population, 74.03% of population lives in Urban area and 25.97% lives in Rural area. There are 26.42% Scheduled Caste (SC) and 0 Scheduled Tribe (ST) of total population in Rupnagar district.

Population Forecasting Methods:

1. **Arithmetic Increase Method**

$$P_n = P_o + n\,X$$

2. **Geometric Increase Method**

$$P_n = P_o \left(1+r/100\right)^n$$

3. **Incremental Increase Method**

$$P_n = P_o + n\,X + [n(n+1)/2]\,Y$$

Here, P_n = Population after n decades

P_o = Last known population

n = No. of decade

X = Avg. of increase of known population

r = Geometric Mean of % increase in population

Y = Avg. of incremental increase in population

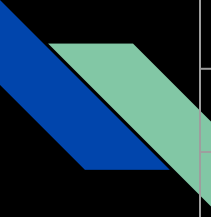# Population Forecasting of Rupnagar (District) by different methods

Year	Value of 'n'	Population by Arithmetical Increase Method	Population by Incremental Increase Method	Population by Geometrical Increase Method
2012	0.1	691841	691711	696234
2013	0.2	699054	698771	708038.8
2014	0.3	706268	705808	720043.25
2015	0.4	713482	712821	732251.23
2016	0.5	720696	719811	744666.2
2017	0.6	727909	726776	757291.6
2018	0.7	735123	733718	770131.12
2019	0.8	742337	740637	783188.31
2020	0.9	749550	747532	796467

Year	Value of 'n'	Arithmetical Increase Method	Incremental Increase Method	Geometrical Increase Method
2021	1	756764	755466	809970.6
2022	1.1	763978	761251	823703.21
2023	1.2	771192	768075	837668.7
2024	1.3	778405	774876	851871
2025	1.4	785619	781653	866314
2026	1.5	792833	788406	881002
2027	1.6	800046	795136	895939
2028	1.7	807260	801842	911129.04
2029	1.8	814474	808524	926577
2030	1.9	821688	815183	942286.413
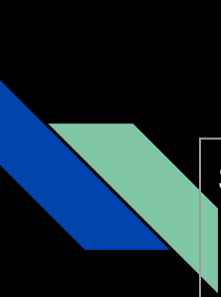
Year	Value of 'n'	Arithmetical Increase Method	Incremental Increase Method	Geometrical Increase Method
2031	2	828901	821818	958262.403
2032	2.1	836115	828430	974509.3
2033	2.2	843329	835018	991032
2034	2.3	850542	841582	1007834.02
2035	2.4	857756	848123	1024921.34
2036	2.5	864970	854640	1042298.4
2037	2.6	872184	861134	1059970.01
2038	2.7	879397	867604	1077941.3
2039	2.8	886611	874051	1096217.22
2040	2.9	893825	880473	1114803.04

Year	Value of 'n'	Arithmetical increase method	Incremental increase method	Geometrical Increase method
2041	3	901038	886872	1133704
2042	3.1	908252	893248	1152925.34
2043	3.2	915466	899600	1172473
2044	3.3	922680	905928	1192351.3
2045	3.4	929893	912233	1212567
2046	3.5	937107	918514	1233126
2047	3.6	944321	924772	1254033
2048	3.7	951534	931006	1275294
2049	3.8	958748	937216	1296916
2050	3.9	965962	943403	1318904.5
2051	4	973176	949566	1341266

Population Forecasting of Towns with the Help of arithmetic increase method and ratio and proportion method

S.No	Town	Census Population 2001(C1)	Census Population 2011(C2)	Ratio of C1/R1	Ratio of C2/R2	Average of Ratios (A1)
1	Nangal	40694	41172	0.0647	0.0601	0.0624
2	Bhalan	3228	3674	0.0051	0.0054	0.0052
3	Anandpur sahib	13889	16282	0.0221	0.0238	0.0230
4	Aggampur	4678	4874	0.0074	0.0071	0.0072
5	Kiratpur	2004	2348	0.0032	0.0034	0.0033
6	Nurpur	3537	4503	0.0056	0.0066	0.0061
7	Bharatgarh	2480	2732	0.0039	0.0040	0.0040
8	Rupnagar	49159	56038	0.0782	0.0818	0.0800

S.No	Town	Census Population 2001 (C1)	Census Population 2011(C2)	Ratio of C1/R1	Ratio of C2/R2	Average of Ratios (A1)
9	Chamkor (Chamkaur Sahib)	8284	13920	0.0132	0.0203	0.0168
10	Morinda	22635	24022	0.0360	0.0351	0.0356

Population of Rupnagar (District)(2001) = R1 = 628846

Population of Rupnagar (District)(2011) = R2 = 684627

Average of

(Population of City (2001)/Population of Rupnagar(District)(2001) , Population of City (2011)/ Population of Rupnagar (District)(2011)) = A1 = Population of city(2020)/Population of Rupnagar (District)(2020)

Source - http://www.citypopulation.de/en/india/villages/rupnagar/

Considering Punjab is a developed state, and according to the previous data, the population is increasing at a constant rate hence we will take **Arithmetic Increase Method** as the method for population forecasting.
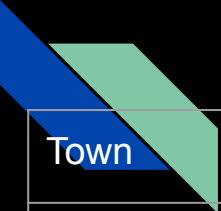
Town	2021	2022	2023	2024	2025	2026	2027	2028	2029
Nangal	47241	47691	48142	48592	49042	49493	49943	50393	50844
Bhalan	3973	4011	4049	4086	4124	4162	4200	4238	4276
Anandpur Sahib	17356	17521	17687	17852	18018	18183	18349	18514	18679
Aggampur	5509	5561	5614	5666	5719	5771	5824	5876	5929
kiratpur	2504	2527	2551	2575	2599	2623	2647	2671	2694

Town	2021	2022	2023	2024	2025	2026	2027	2028	2029
Nurpur	4617	4661	4705	4749	4793	4837	4881	4925	4969
Bharatgarh	3002	3031	3059	3088	3117	3145	3174	3202	3231
Rupnagar (sub division)	60551	61128	61705	62282	62859	63437	64014	64591	65168
Chamkor (Chamkaur Sahib)	12678	12799	12920	13040	13161	13282	13403	13524	13645
Morinda	26896	27153	27409	27665	27922	28178	28435	28691	28947

Town	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Nangal	51294	51744	52194	52645	53095	53545	53996	54446	54896	55347	55797
Bhalan	4314	4352	4389	4427	4465	4503	4541	4579	4617	4655	4692
Anandpur sahib	18845	19010	19176	19341	19507	19672	19838	20003	20168	20334	20499
Aggampur	5981	6034	6086	6139	6191	6244	6296	6349	6401	6454	6506
Kiratpur	2718	2742	2766	2790	2814	2838	2861	2885	2909	2933	2957

Town	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Nurpur	2718	2742	2766	2790	2814	5233	5277	5321	5365	5409	5453
Bharatgarh	3260	3288	3317	3346	3374	3403	3431	3460	3489	3517	3546
Rupnagar (sub division)	65745	66323	66900	67477	68054	68631	69209	69786	70363	70940	71517
Chamkor (Chamkaur Sahib)	13766	13886	14007	14128	14249	14370	14491	14612	14732	14853	14974
Morinda	29204	29460	29716	29973	30229	30486	30742	30998	31255	31511	31768

Town	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
Nangal	55842	55887	55932	55977	56022	56067	56112	56157	56202	56247	56292
Bhalan	4696	4700	4703	4707	4711	4715	4718	4722	4726	4730	4734
Anandpur Sahib	20516	20532	20549	20565	20582	20598	20615	20631	20648	20664	20681
Aggampur	6511	6516	6522	6527	6532	6538	6543	6548	6553	6558	6564
Kiratpur	2959	2962	2964	2966	2969	2988	2974	2976	2978	2981	2983
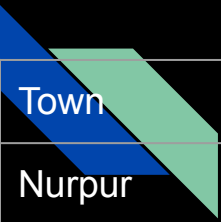
Town	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
Nurpur	5458	5462	5467	5472	5476	5481	5486	5490	5495	5499	5504
Bhalan	3549	3552	3555	3558	3560	3563	3566	3569	3572	3575	3578
Rupnagar (sub division)	71574	71632	71690	71747	71805	71863	71921	71978	72036	72094	72151
Cham kor (Chamkaur Sahib)	14986	14998	15010	15022	15034	15046	15059	15071	15083	15095	15107
Morinda	31793	31819	31844	31870	31896	31921	31947	31973	31998	32024	32050

Calculated MSW and Per capita generation for year 2021

S.No.	Town	Domestic	Commercial	MSW	Population (2021)	Per capita generation in Kg/capita/day we have to choose between 0.369-0.451
1	Nangal	70	20	9000	47241	0.1905
2	Bhalan	19	5	2400	3973	0.604
3	Anandpur Sahib	50	15	6500	17356	0.3745
4	Aggampur	35	15	5000	5509	0.907
5	Kiratpur	54	20	7400	2504	2.95
6	Nurpur	35	6	4100	4617	0.888

7	Bharatgarh	6	2	800	3002	0.266
8	Rupnagar (sub division)	155	18	17300	60551	0.285
9	Chamkor	50	15	6500	12779	0.508
10	Morinda	42	5	4700	26896	0.174

Literature review of per capita waste generation-
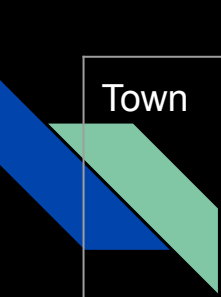
1) 0.312 kg/person/day(CPCB 2000) ,

2) 0.276kg/person/day(2011),

3)**0.315 kg/person/day(2021),**

4)0.359 kg/person/day (2031),

5)0.410 kg/person/day (2041)

Source - punjab waste management - https://www.teriin.org/projects/green/pdf/, Punjab-waste-management.pdf

Per capita we consider- 0.41 kg/person since we will take higher side of per capita so that if we will design for higher side than the waste generated will be in order of it but otherwise if we will make for lower side than may be some year if more waste is generated than our design will fail hence we consider 0.41 kg/person and we will design according to it.

Municipal Solid Waste Forecasting
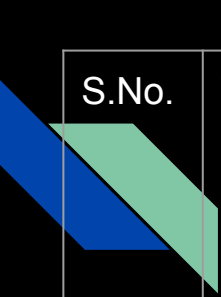
Town	Population (2031)	Population (2041)	Population (2051)	Per capita waste gen.(kg/capita/day)	MSW(kg/day) 2031	MSW (kg/day) 2041	MSW (kg/day) 2051
Nangal	51744	55842	56292	0.41	21215	22895	23080
Bhalan	4352	4696	4734	0.41	1784	1925	1941
Anandpur Sahib	19010	20516	20681	0.41	7794	8411	8479
Aggampur	6034	6511	6564	0.41	2473	2669	2691
Kiratpur	2742	2959	2983	0.41	1124	1213	1223

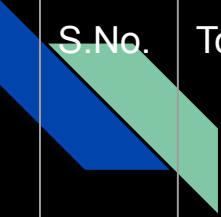| Town	Population (2031)	Population (2041)	Population (2051)	Per Capita Waste Gen. (kg/capita/day)	MSW (kg/day) 2031	MSW (kg/day) 2041	MSW (kg/day) 2051
Nurpur	2742	5458	5504	0.41	1124	2237	2257
Bharatgarh	3288	3549	3578	0.41	1348	1455	1467
Rupnagar (sub division)	66323	71574	72151	0.41	27192	29345	29582
Chamkor (Chamkaur Sahib)	13886	14986	15107	0.41	5693	6144	6194
Morinda	29460	31793	32050	0.41	12078	13035	13140

Waste Segregation of Towns for year 2031

S.No.	Town	MSW (Kg/day) (2031)	Organic Waste (wet) (42.51%) (kg/day)	Plastic(dry) (10.11%) (kg/day)	Metals (dry) (0.63%) (kg/day)	Paper (dry) (9.63%) (kg/day)	Glass (dry) (0.96%) (kg/day)	Inert (dry) (17%) (kg/day)
1	Nangal	21215	8940.08	2126.19	132.49	2025.24	201.89	3575.19
2	Bhalan	1784	751.89	178.82	11.14	170.33	16.98	300.69
3	Anandpur Sahib	7794	3284.51	781.14	48.68	744.06	74.17	1313.5
4	Aggampur	2473	1042.43	247.92	15.45	236.15	23.54	416.88
5	Kiratpur	1124	473.72	112.66	7.02	107.31	10.7	189.44

S.No.	Town	MSW (Kg/day) (2031)	Organic Waste (wet) (42.51%) (kg/day)	Plastic (dry) (10.11%) (kg/day)	Metals (dry) (0.63%) (kg/day)	Paper (dry) (9.63%) (kg/day)	Glass (dry) (0.96%) (kg/day)	Inert (dry) (17%) (kg/day)
6	Nurpur	1124	873.72	207.79	12.95	197.93	19.73	349.41
7	Bharatgarh	1348	568.19	135.13	8.42	128.71	12.83	227.22
8	Rupnagar (sub division)	27192	11458.76	2725.2	169.82	2595.81	258.77	4582.43
9	Chamkor (Chamkaur Sahib)	5693	2391.06	569.3	35.8659	548.2359	54.6528	967.81
10	Morinda	12078	5134.35	120.78	76.0914	1163.11	115.94	2053.26

Waste segregation of towns for year 2041

S.No.	Town	MSW (kg/day) 2041	Organic waste (wet) (42.51%) (kg/day)	Plastic (dry) (10.11%) kg/day	Metals (dry) (0.63%) kg/day	Paper (dry)(9.63%) kg/day	Glass (dry)(0.96%)kg/day	Inert (dry) 17% kg/day
1	Nangal	22895	9733	2315	144.24	2205	220	3892.2
2	Bhalan	1925	818.32	194.62	12.13	185.4	18.5	327.25
3	Anandpur Sahib	8411	3575.52	850.4	53	810	81	1430
4	Aggampur	2669	1135	270	17	257.02	25.62	453.7
5	Kiratpur	1213	515.65	122.63	7.64	116.81	11.64	206.21

S.No.	Town	MSW (kg/day) 2041	Organic waste (wet) (42.51%) (kg/day)	Plastic (dry) (10.11%) kg/day	Metals (dry) (0.63%) kg/day	Paper (dry) (9.63%) kg/day	Glass (dry) (0.96%) kg/day	Inert (dry) 17% kg/day
6	Nurpur	2237	951	226.16	14.09	215.42	21.5	380.3
7	Bharatgarh	1455	618.52	147.1	9.17	140.12	13.97	247.4
8	Rupnagar (sub division)	29345	12475	2967	185	2826	282	4989
9	Chamkor	6144	2612	621.2	38.71	592	59	1044.5
10	Morinda	13035	5541.2	1318	82.12	1255.3	125.14	2216

Waste segregation of towns for year 2051

S.No.	Town	MSW (kg/day) 2051	Organic waste (wet) (42.51%) (kg/day)	Plastic (dry) (10.11%) kg/day	Metals (dry) (0.63%) kg/day	Paper (dry) (9.63%) kg/day	Glass (dry) (0.96%)kg /day	Inert (dry) 17% kg/day
1	Nangal	23080	9693.6	2308	145.404	2222.604	221.568	3923.6
2	Bhalan	1941	815.22	194.1	12.2283	186.9183	18.6336	329.97
3	Anandpur Sahib	8479	3561.18	847.9	53.41	816.52	81.3984	1441.43
4	Aggampur	2691	1130.22	269.1	16.95	259.14	25.8336	457.47
5	Kiratpur	1223	513.66	122.3	7.70	117.77	11.74	207.91

S.No.	Town	MSW (kg/day) 2051	Organic waste (wet) (42.51%) (kg/day)	Plastic (dry) (10.11%) kg/day	Metals (dry) (0.63%) kg/day	Paper (dry)(9.63%) kg/day	Glass (dry)(0.96%)kg/day	Inert (dry) 17% kg/day
6	Nurpur	2257	947.94	225.7	14.2191	217.3	21.66	383.69
7	Bharatgarh	1467	616.14	146.7	9.2421	141.2	14.08	249.39
8	Rupnagar (sub division)	29582	12424.24	2958.2	186.36	2848.7	283.98	5028.94
9	Cham kor (Chamkaur Sahib)	6194	2601.48	619.4	39.02	596.4	59.46	1052.98
10	Morinda	13140	5518.8	1314	82.782	1265.38	126.144	2233.8

Dry waste

As we have calculated the dry MSW waste from various cities near rupnagar, we have found dry waste as Plastic, paper, metals, glass and inert materials such as sand, now among these there are waste which are recyclable such as dry paper, metals, glass, and uncrushed plastic we will recycle them and rest non-recyclable waste such as inert material sand and all are used for the purpose of reduced derived fuel(RDF) which can be further be used for other purposes such as the heat produced from burning of RDF can be used for the purpose of heating water and forming steam which can further be used to run the turbine and produce electricity .

Wet Waste

Similar to dry waste we also have wet waste such as wet paper, and they can also be further segregated and used for composting purposes or production of biogas, CNG and CBG.

Under composting method we can have two types of composting with the supply of oxygen i.e. aerobic and without supply of oxygen i.e. anaerobic.

There are methods such as windrow composting and landfill also.

Landfill Composting for dumping of Wet Waste

What are Landfills -

Landfills are sites which are used to dump garbage, agricultural waste, other sorts of solid wastes etc. It is different from the dump as they are carefully designed and monitored and they are used to separate the trash from the surrounding environment which is generally accompanied by the use of the bottom liner and the daily covering for the soil.

The term Landfill is usually shorthand for the municipal landfill or sanitary landfill. The sanitary landfill is an engineered facility that separates and confines waste. Sanitary landfills are intended as biological reactors (bioreactors) in which microbes will break down complex organic waste into simpler, less toxic compounds over time.

During the early phases, little material volume reaches the leachate, as the biodegradable organic matter of the waste undergoes a rapid decrease in volume. Meanwhile, the Lea chate's chemical oxygen demand increases with increasing concentrations of the more recalcitrant compounds compared to the more reactive compounds in the leachate. Successful conversion and stabilization of the waste depend on how well microbial population functions in syntrophy, i.e. an interaction of different populations to provide each other's nutritional needs.

The lifecycle of a municipal landfill undergoes five distinct phases:

Initial adjustment (Phase 1)

Transition (Phase 2)

The lifecycle of a municipal landfill undergoes five distinct phases:

Initial adjustment (Phase 1)

Transition (Phase 2)

Acid Formation (Phase 3)

Methane Fermentation (Phase 4)

Final maturation and stabilization (Phase 5)

RDF (Refuse - Derived Fuel) Facility

- It is defined as a fuel produced from various types of waste such as Municipal Solid Waste (MSW), Industrial Waste and Commercial Waste

- It mainly consists of combustible components of such waste, as non-recyclable plastics (excluding PVC), paper cardboard, label and other corrugated materials.
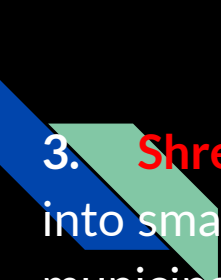
Manufacturing Process

Municipal Solid Waste (MSW) is processed through five important steps for manufacturing Refuse Derived Fuel.

1. **Preliminary Liberation :** It involves separating the municipal waste into Biodegradable, Glass, Rags, Paper, Plastic, Leather and Rubber, metals and other domestic hazardous, etc.

   For manufacturing RDF, the main particles involves Biodegradable, paper, plastic, leather and rubber.

2. **Size Screening :** It involves separating the municipal waste based on size and shape of the particle. It helps in material handling comfortably.

3. **Shredding :** It involves the process of destructing the large amount of solid waste into smaller pieces by crushing and cutting. This process converts the larger particles of municipal waste into smaller particles for easy handling and transporting.

4. **Air Ballistic Knife :** It is used for removing the moisture content of wet materials from the shredded waste.

5. **Magnetic Separation :** It is process in which magnetically susceptible material is extracted from the mixture using magnetic force. This is basically used to separate metal particles, as these are of no use in RDF facility.

6. **Pelletizing :** It is defined as process of compressing or molding a material into the shape of a pellet.

- After magnetic separation, the RDF particles are added with binders such as Calcium Hydroxide and then it is mixed thoroughly.

- Then it is converted into pellets of required size and shapes normally 30 mm capsules.

- A RDF pellet having about 11% or more Calcium Hydroxide is utilized in a combustible mixture.

- Combustion of the mixture is effective to produce an effluent gas from the combustion zone having a reduced SO_X, NO_X and polycyclic aromatic hydrocarbon content of effluent gas.

Comparison of RDF v/s Coal

S. No.	Fuel / Factor	Coal	RDF
1.	Calorific Value (KCal / Kg)	4000	3500-3700
2.	Equivalent Ton in CV	1	1.14
3.	Cost per Ton in Rs.	6000	2000
4.	Sulphur Content (% weight)	0.4	0.2-0.5
5.	Moisture Content (% weight)	39	10
6.	Ash Content (% weight)	4.2	<15
7.	NO_X Content (% weight)	1.2	1-1.5
8.	Carbon (% weight)	31.4	35-40
9.	Oxygen (% weight)	7.4	25-30
10.	Hydrogen (% weight)	4.3	5-8

Uses of RDF Facility

- RDF can be used in a variety of ways to produce electricity or as a replacement of fossil fuels.

- The important applications of RDF are found in following spheres:

1. RDF Power Plants
2. Coal - Fired Power Plants
3. Cement Kilns
4. Industrial Steam / Heat Boilers
5. Pellet Stoves

➢ RDF is considered as one of the green fuel and lead to green environment.

➢ It basically helps in both Waste Management and Energy / Fuel requirement.

Advantages of RDF Facility

- Waste is utilized to generate electricity.

- It contains high Calorific Value compare to its parent materials.

- It is one of the alternative and renewable resources of fuel which has been derived from municipal solid waste.

- The emission characteristics of RDF are superior compared to that of coal with fewer emissions of pollutants like NO_X , SO_X , CO and CO_2 .

- It saves the land by using less Landfills area.

Disadvantages of RDF Facility

- A cost is associated with the front - end processing to recover the fuel fraction.

- The Unit Yield of Energy (i.e. KJ per Kg of MSW) in case of RDF is less than that of the parent MSW.

Location Planning for the RDF Facility

Sr.No.	Town	Latitude (x coordinate)	Longitude (y coordinate)
1	Nangal	31.38	76.282
2	Bhalan	31.293	76.366
3	Anandpur Sahib	31.234	76.505
4	Ajjampur	31.129	76.332
5	Kiratpur	31.185	76.557
6	Nurpur	31.169	76.446
7	Bharatgarh	31.093	76.508
8	Rupnagar	30.966	76.523

Source : Google Maps

Location Planning For the RDF Facility

Sr.No.	Town	Latitude (x coordinate)	Longitude (y coordinate)
9	Morinda	30.791	76.487
10	Cham kor	30.793	76.411

Location planning for RDF facility near ropar

$\overline{X} = \sum X_i / N$

X_i = x- coordinate of location, i

N = number of locations

$\overline{X}$ = x- coordinate of composting facility

$\overline{Y} = \sum Y_i / N$

Y_i = y- coordinate of location, i

N = Number of locations

$\overline{Y}$ = y- coordinate of composting facility

Location Planning for the RDF Facility

$\overline{X} = \sum X_i / N = 31.1033$

$\overline{Y} = \sum Y_i / N = 76.4417$

The location of this coordinate is

Kolar, Dist. Hoshiarpur Punjab

nearly 28 kms from Rupnagar city.

31°06'11.9"N 76°26'30.1"E

31.103300, 76.441700 · 🚗 49 min

SOURCE :
https://www.google.com/maps/place/31%C2%B006'11.9%22N+76%C2%B026'30.1%22E/@31.1033046,76.439506,17z/data=!4m5!3m4!1s0x0:0x990cb5c70c39e7d5!8m2!3d31.1033!4d76.4417
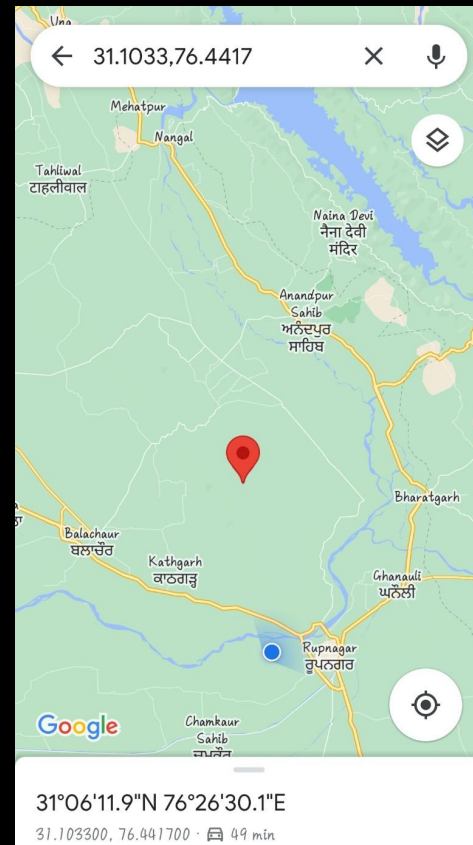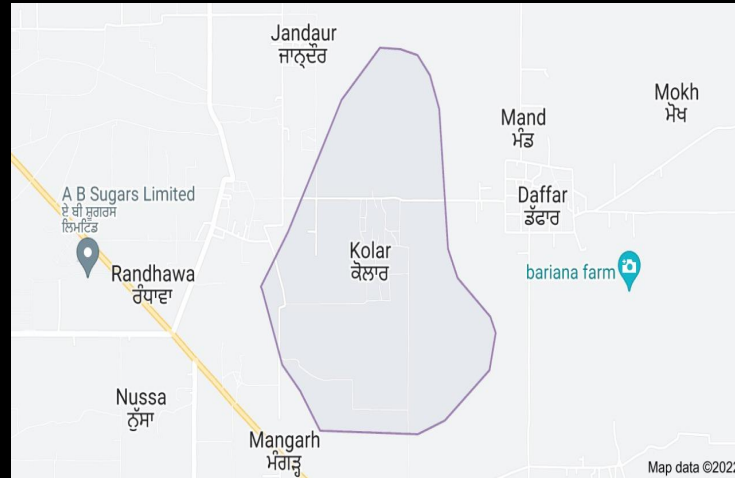
Collection of Waste:

For the collection of waste, different types of methods were taken in count but we have to choose most economical method.

After many deliberations and research on different types of trucks, their capacity, power and torque they produced along with their fuel efficiency, we conclude that:

Truck to be used:

Tata LPK 2523 HD

Tata LPK 2523 HD - 9S is a tipper with gross vehicle weight of 25000 kg. Power of this Tata tipper is 5883 cc 6 cylinder, Cummins ISBe 5.9 CRDi, SCR Technology engine. This tipper produces 228 HP of power and 850 Nm of maximum torque.

Source : https://www.trucksbuses.com/trucks/tipper/tata-lpk-2523-hd-9s

Development of Logistic Network

Route No.	Route	Waste volume collected in one trip(m^3)	Trips done
1	Kolar - Nangal - Kolar	20	2
2	Kolar-Ghanuali-Chatauli-Morinda-Behrampur-Kolar	19.53	1
3	Kolar-Bharatgarh-Kiratpur-Anandpur sahib-Kolar	18.97	1
4	Kolar-Rupnagar-Kolar	20	2
5	Kolar-Morinda-Kolar	18.49	1
6	Kolar-Nurpur-bhalan-Nangal-Aggampur-Kiratpur-Kolar	19.15	1
Total			8

Development of Logistic Network

➤ An app, namely CIRCUIT, is used for choosing optimum route for the collection of waste.

➤ The truck chosen for collecting waste is the tipper truck of volume 20 m^3 . For making a trip economically, we choose to fill it full and then one final route is finalized for optimization.

➤ After making the route combinations such that waste volume become 20 m^3 , the route is optimized by the CIRCUIT app.

Working of CIRCUIT app:-

1. Initially the start and end points are filled like "Kolar" in our case.
2. The departure time from Kolar is entered.
3. Intermediate stops are entered.
4. Halt time is also mentioned for every stop.
5. Finally, the optimization is done by the app and most time efficient route is displayed.

Development of Logistic Network

Development of Logistic Network

|	Route no.	Route	Distance (km)	Trip duration (min)	No. of trips	Total time	Total distance	Waste volume collected in one trip (m^3)	Total volume collected
Combination 1	1	Kolar - Nangal - Kolar	105	170	2	340	210	20	40
	2	Kolar-Ghanuali-Chatauli-Morinda-Behrampur-Kolar	125	240	1	240	125	19.53	19.53
	3	Kolar-Bharatgarh-Kiratpur-Anandpur sahib-Kolar	86	180	1	180	86	18.97	18.97
	4	Kolar-Rupnagar-Kolar	65	130	2	260	130	20	40
	5	Kolar-Morinda-Kolar	110	190	1	190	110	18.49	18.49
	6	Kolar-Nurpur-bhalan-Nangal-Aggampur-Kiratpur-Kolar	112	220	1	220	112	19.15	19.15
		Total			8	1430 min	773 km		156.14 m^3

Development of Logistic Network

Combination 2

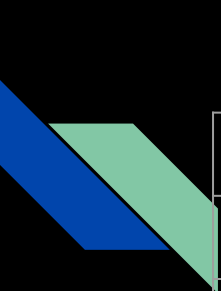| Route no.	Route	Distance (km)	Trip duration (min)	No. of trips	Total time	Total distance	Waste volume collected in one trip (m^3)	Total volume collected
1	Kolar-Anandpur sahib-Nangal - Kolar	96	160	2	320	192	20	40
2	Kolar-Bharatgarh-Chatauli-Ghanuali-Morinda-Rupnagar-Kolar	139	240	1	240	139	19.35	19.35
3	Kolar-Kiratpur-Anandpur sahib-Kolar	71	140	1	140	71	20	20
4	Kolar-Rupnagar-Behrampur-Kolar	74	155	1	155	74	18.67	18.67
5	Kolar-Rupnagar-Kolar	65	130	1	130	65	19.17	19.17
6	Kolar-Nurpur-bhalan-Nangal-Aggampur-Kiratpur-Kolar	112	200	2	400	224	18.95	37.90
	Total				1385 min	765 km		155.09 m^3

Combination 2 is chosen as it consumes less time and total distance cover is also less.

It is more economic and almost same amount of waste is collected.
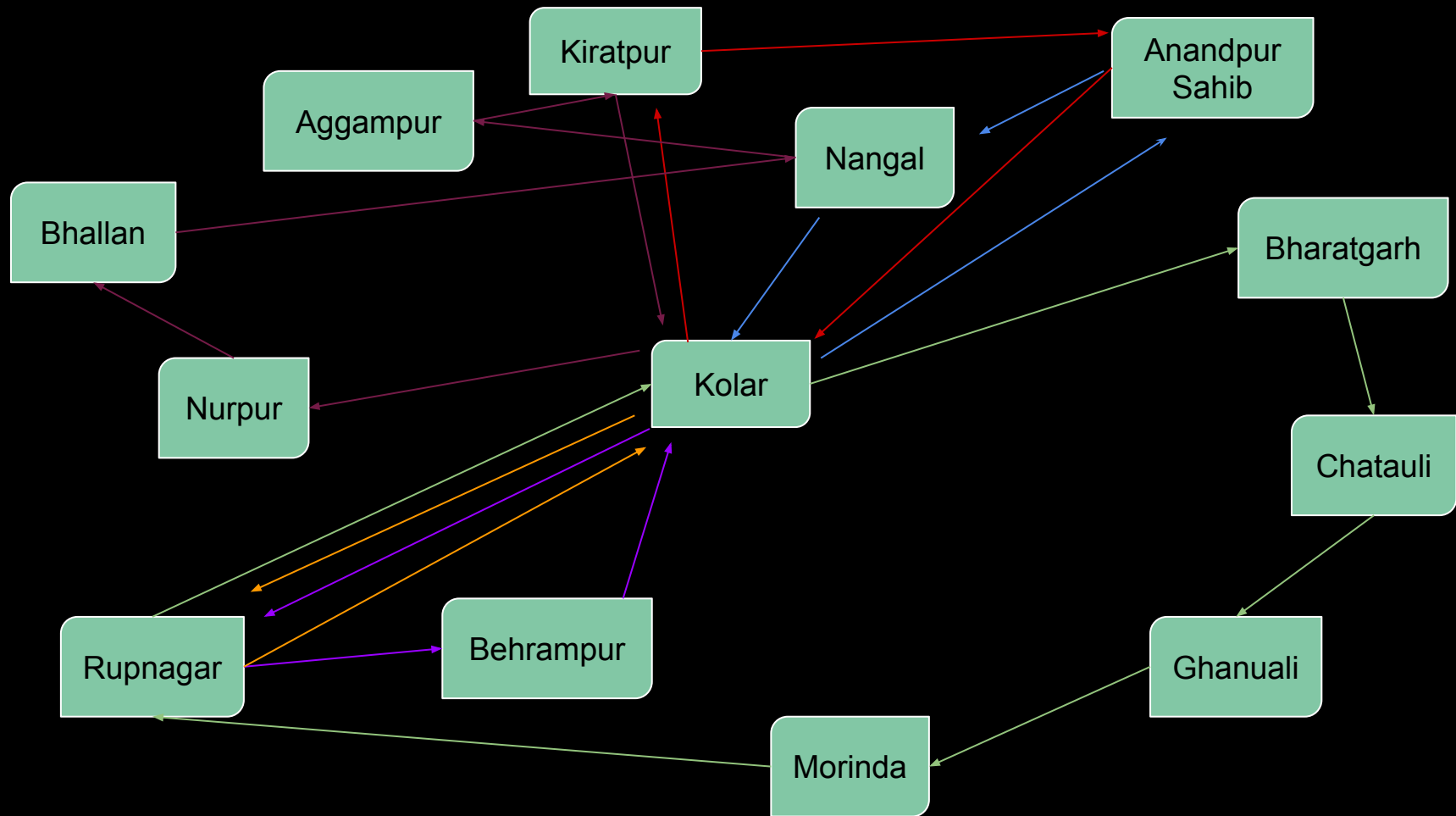
Cost Estimation for Collection Process 2021-2031

PARAMETER	VALUE
TOTAL DISTANCE COVERED	765 km
TOTAL TIME TAKEN (INCLUDING PICKUP TIME, AT-SITE TIME, HAUL TIME, OFF ROUTE TIME)	20 hours
TOTAL NO. OF TRUCKS REQUIRED	3 unit
COST OF ONE TRUCK (INCLUDING INSURANCE)	30 lakhs
COST OF THREE TRUCK (INCLUDING INSURANCE)	90 lakhs
MILEAGE OF 1 TRUCK	4 km/l
FUEL REQUIRED FOR THE COMPLETE DISTANCE	240 liters

COST OF 1 LITRE OF FUEL (DIESEL)	85 rupees
TOTAL COST OF FUEL FOR 1 DAY	20726 rupees
TOTAL DRIVERS REQUIRED	3
HOURLY CHARGE OF ONE DRIVER	120 rupees
CHARGE OF 3 DRIVER FOR 8 HRS	2880 rupees
NO. OF DAILY WAGE WORKER REQUIRE	4
CHARGE OF 1 DAILY WAGE WORKER FOR 8 HRS	400 rupees
CHARGE OF 3 DAILY WAGE WORKERS FOR 8 HRS	1200 rupees

Fixed Cost	Purchase Vehicle (in lakhs)	Rent cost of three vehicle for one year
Vehicle cost (including insurance)	90	54
Total fixed cost	90	54
Variable costs		
Fuel	75	75.65
Servicing of vehicle	0.6	0
Expenses for collection items	0.04	0.04
Driver salary	10.51	10.51
Daily wage labourer salary	4.38	4.38
Total variable cost	91.19	90.6
TOTAL COST OF WASTE COLLECTION	181.19	144.6

Design of RDF Facility

Parameter	Units	Quantity
Quantity of waste to be recover	MT	55.123
Density of waste	kg/cum	484
Volume required	Cum	113.89
Assume height of storage heap	m	1.2
Area required	sqm	94.91
Provide storage capacity for	day	20
Area required for machine	sqm	300
Space required for circulation of vehicle	sqm	100

Area required for storage	sqm	1897
Provide rectangular area having L : B		1.5
Total area required	sqm	2296
Width	m	33.16
Length	m	60.13
Total area provided	sqm	2400

REFERENCES

- https://en.wikipedia.org/wiki/Refuse-derived_fuel

- Usage of Various Derived Fuel by **Central Public Health and Environmental Engineering Organisation** (CPHEEO), Ministry of Housing and Urban Affairs in October 2018 (www. swachhbharaturban.gov.in)

- https://www.netl.doe.gov/sites/default/files/netl-file/production-refuse-derived-fuel-chapter12.pdf

- https://www.census2011.co.in/census/district/604-rupnagar.html#:~:text=In%20 2011%2C%20Rupnagar%20had%20population,percent%20of%20total%20Mahar ashtra%20population.

- http://cpheeo.gov.in/upload/uploadfiles/files/Part2.pdf

- https://www.suratmunicipal.gov.in/Clea nSurat/Documents/SOP/SBMAdvisoryO nMRFforMSW.pdf

Thank You