INTEGRATED SOLID WASTE MANAGEMENT (ISWM) FOR VYARA TALUKA AS A REVOLUTION IN RURAL INDIA

Aman Gandhi[1], Dr. Arti Pamnani[2]

M-Tech student, Infrastructure Engineering & Technology, B. V. M. Engineering, Anand, India[1]

Sr. Lecturer, Civil Engineering, B & B Institute of Technology, Anand, India[2]

Abstract

Absence of efficient solid waste management infrastructure impacts quality of life in many peoples' lives in rural areas. Developing this infrastructure will benefit public health, livelihood, and infrastructure value. Additional benefits can be achieved from a recovery of valuable materials such as compost, paper, and plastic. A priority is to not encourage open dump waste in a rural area, since it doesn't give environmental protection to solid waste management, who offers great amount of resources. In this paper, we present an integrated approach to develop a technology of solid waste management in Vyara taluka. Vyara already has a sustainable infrastructure for solid waste management. By taking full advantage of this infrastructure, we propose integration between Vyara and its surrounding villages and, to develop sustainable infrastructure for green waste as well. To achieve sustainable solid waste management, it requires an analysis and characterisation of data collection, mitigation measures, and resource recovery potentials. On analysing the data, it revealed that the villages generate the highest amount of biodegradable waste, and least amount of non-biodegradable. Biodegradable waste in rural area is convenient to manage with composting facility. With the help of sustainable infrastructure of Vyara, least amount of non-biodegradable waste from villages can be transferred to Vyara. We propose the integration between the small-scale town and its surrounding villages for Integrated Solid Waste Management (ISWM).

Key words

Composting, cost analysis, Infrastructure, ISWM, recyclable waste, small-scale town, villages.

Introduction

Solid waste consists of unwanted and discarded materials from houses, street sweeping, and commercial and industrial operations. Increase in population and changing lifestyles also leads the generation of solid waste. Generally, solid waste comprises a mixture of vegetables, food items, paper, plastics, metal, glass, etc. If solid waste is disposed of on land in open areas, then it invites various problems associated with improper management of solid waste include diseases, odour nuisance, fire, air and water pollution, aesthetic nuisance and economic loss. [1]

India contributes 18% of the world's population, with a population of 1.32 billion. However, it does not have enough resources or infrastructure in place to treat its solid wastes. The per capita waste generation rate in India was 0.44 kg/day in 2001, and in 2011, it was increased by 0.5 kg/day. Solid waste management consists of generation, collection, transfer, treatment and landfill. In this process, collection is very important part of proper management. In India developed cities collect about 70 - 90% of Municipal Solid Waste (MSW) generated, whereas smaller cities and towns collect less than 50% of MSW generated. Due to lack of infrastructural, financial and human resources, some cities have achieved some progress in SWM; perhaps, many cities and towns have not even initiated measures. [2]

Definition of Integrated Solid Waste Management (ISWM) is a comprehensive waste of reuse, recycling, composting, and disposal program. Integrated solid waste management is an approach to manage the municipal waste to generate coordination of waste from one manner to become resources for another. [3] Aim of this is to reduce the amount of waste being disposed to landfill. In first aspect source, reduction is preferred as we can utilize this by reusing the material. In second aspect, recycling is a factor as we can utilize this by segregation of useful material like plastic, metal, glass, etc. In third aspect we can achieve recovery by composting of organic waste. In a fourth aspect after doing above treatments, whichever material we cannot recover or reuse, we can use those materials for waste-to-energy plants. In last aspect left out waste material after all treatments should be disposed to landfill. Based on above aspects we have to choose appropriate technology to manage municipal solid waste. [4]

Present scenario of villages in terms Solid waste management

In the opinion of, Government of India, Ministry of Drinking Water and Sanitation (MDWS), in rural area is generating 0.3 to 0.4 million metric tons of waste per day. Domestic solid waste management is a severe concern in rural areas of India. It generates a maximum percentage of bio-degradable waste. The requirement for well-planned initiatives in rural solid waste management has been voiced in India. Inconsiderable littering can pollute the environment and create unhealthy conditions for living. In the absence of proper disposal of solid waste, people like to litter in the vacant land surroundings such as, their residential area and overtime it will result in an unsanctioned landfill of waste. The amount of solid waste is directly proportional to population. Less population means the quantity of waste is less, and large population creates large amounts of waste. [5]

Solid waste management is very convenient to manage with less quantity. In rural areas, most of the wastes can be safely reused for beneficial purposes with limited resources. At present, most of the rural area is not adapting this process of management, because of inefficient infrastructure and lack of proper technology. [6]

Study area

Vyara is located in the southern part of Gujarat. Vyara is headquarter of Tapi District and is considered as one of the most beautiful towns of South Gujarat. The Tapi District consists of the five Talukas, and they are Songadh, Valod, Vyara, Ucchal, and Nizar. Vyara has many attractive natural places to visit across the town, and that includes: Jalvatika Garden, Ram talao, Gayatri Temple, Vyara fort, Mayadevi waterfall temple, Padamdugri, Mahal Campsite, Gaumukh, Ukai Dam, Unai, Kakrapar Dam. Vyara Taluka has 148 villages, its population ranges from 113 to 8830.

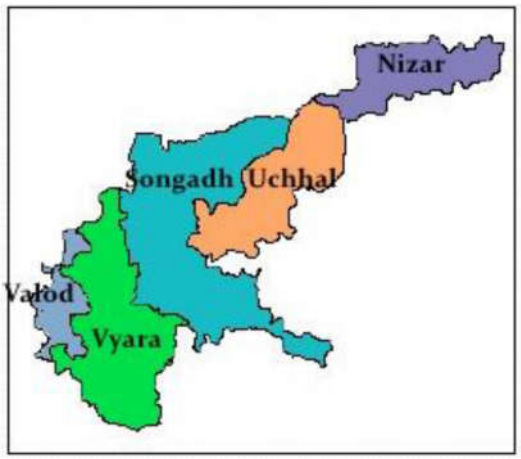

Figure 1 Map of Tapi

Figure 2 Map of Vyara Taluka

Table 1 Demographic details of Vyara

Taluka	Total/M/F	Total Population					
		Total		Rural		Urban	
		2001	2011	2001	2011	2001	2011
Vyara	Total	249810	268289	213584	228500	36226	39789
	M	125086	133335	106782	113191	18304	20144
	F	124724	134954	106802	115309	17922	19645

This beautiful town was transformed to a garbage centre with the increasing volume of wastes. Its' impacts have been observed in the urban environment and public health where there was no sustainable infrastructure for solid waste management. Municipality of Vyara was disposing the waste to open landfill. This dumping yard was disturbing the surrounding area; hence, the municipality decided to develop Infrastructure for solid waste management. Infrastructure has a facility to separate the bio-degradable waste and non-degradable waste from mixed domestic waste. Trommel is the equipment which transfers the non-degradable waste to conveyor platform. This platform used to separate plastics, glass, rubber, metal, cloth, wood, etc. by rag pickers from mixed dry waste. It also has pyrolysis equipment facility which converts plastics to bio-fuel. Vyara generates 14 tons of waste per day. Primary objective of this study is to develop integrated solid waste management between small scale town and its surrounding villages for a sustainable future. (Vyara Municipality)

Characterization of waste in villages

Villages of the study area have low population. Those villages have an average generation of solid waste 0.08 Kg/capita/day[7], which is a low per capita generation of MSW, compared to those of small towns. Solid waste generated from small-scale towns and villages around them have a high amount of organic matter, because the majority of people are employed in the agriculture industry. At present, solid waste is disposed in open dumps in low-lying areas at the outskirts of the towns. The composition of solid waste in villages is approximately 73% bio-degradable, 20% recyclable and 7% inert waste [7]. According to these values, MSW of the surrounding villages of Vyara is calculated in table 2.

Table 2 Composition of solid waste of villages

Villages	Population	Waste generation rate (0.08 kg/capita/day) in kg	Recyclable Waste (20%) kg	Compostable (72%) kg	Inert waste (7%)
Achhopalo	113	9.04	1.81	6.51	0.63
Amania	818	65.44	13.09	47.12	4.58
Ambapani	323	25.84	5.17	18.60	1.81
Ambiya	1774	141.92	28.38	102.18	9.93
Amonia	672	53.76	10.75	38.71	3.76
Andharvadi Dur	2514	201.12	40.22	144.81	14.08
Andharvadi najik	758	60.64	12.13	43.66	4.24
Antapur	3591	287.28	57.46	206.84	20.11
Arkund	410	32.80	6.56	23.62	2.30
Bagalpur	388	31.04	6.21	22.35	2.17
Balpur	2830	226.40	45.28	163.01	15.85
Bamnamal Dur	2478	198.24	39.65	142.73	13.88
Bamnamal Najik	376	30.08	6.02	21.66	2.11
Bardipada	1508	120.64	24.13	86.86	8.44
Beda raypura	3912	312.96	62.59	225.33	21.91
Bedchit	1764	141.12	28.22	101.61	9.88
Bedkuva Dur	4008	320.64	64.13	230.86	22.44
Bedkuva Najik	1244	99.52	19.90	71.65	6.97
Besaniya	1329	106.32	21.26	76.55	7.44
Bhanavadi	1583	126.64	25.33	91.18	8.86
Bhatpur	1019	81.52	16.30	58.69	5.71
Bhojpur Dur	474	37.92	7.58	27.30	2.65
Bhojpur najik	1380	110.40	22.08	79.49	7.73
Bhurivel	229	18.32	3.66	13.19	1.28
Birbara	122	9.76	1.95	7.03	0.68
Borkachchh	876	70.08	14.02	50.46	4.91
Borkhadi	4609	368.72	73.74	265.48	25.81
Chakdhara	383	30.64	6.13	22.06	2.14
Champavadi	2527	202.16	40.43	145.56	14.15
Chhevdi	104	8.32	1.66	5.99	0.58
Chhindia	1883	150.64	30.13	108.46	10.54
Chhirma	389	31.12	6.22	22.41	2.18
Chichbardi	718	57.44	11.49	41.36	4.02
Chikhlda	1808	144.64	28.93	104.14	10.12
Chikhalvav	1511	120.88	24.18	87.03	8.46
Chikhli	2597	207.76	41.55	149.59	14.54
Chunawadi	2025	162.00	32.40	116.64	11.34
Dadakvan	611	48.88	9.78	35.19	3.42
Dhamandevi	831	66.48	13.30	47.87	4.65
Dhangdhar	1425	114.00	22.80	82.08	7.98

Dhanturi	1419	113.52	22.70	81.73	7.95
Dharampura	442	35.36	7.07	25.46	2.48
Dhat	1954	156.32	31.26	112.55	10.94
Dholia Umar	480	38.40	7.68	27.65	2.69
Dholka	890	71.20	14.24	51.26	4.98
Dhongi Amba	174	13.92	2.78	10.02	0.97
Dolara	2029	162.32	32.46	116.87	11.36
Dolvan	7179	574.32	114.86	413.51	40.20
Dungarda	313	25.04	5.01	18.03	1.75
Dungargam	1147	91.76	18.35	66.07	6.42
Gadat	3974	317.92	63.58	228.90	22.25
Gangpur	838	67.04	13.41	48.27	4.69
Garpani	340	27.20	5.44	19.58	1.90
Garvan	728	58.24	11.65	41.93	4.08
Ghani	1494	119.52	23.90	86.05	8.37
Ghata	2181	174.48	34.90	125.63	12.21
Gheriyavav	1167	93.36	18.67	67.22	6.54
Halmundi	732	58.56	11.71	42.16	4.10
Haripura	690	55.20	11.04	39.74	3.86
Indu	976	78.08	15.62	56.22	5.47
jamalia	405	32.40	6.48	23.33	2.27
Jesingpur	2427	194.16	38.83	139.80	13.59
Jetvadi	333	26.64	5.33	19.18	1.86
Jhankhari	2047	163.76	32.75	117.91	11.46
Kakadva	2729	218.32	43.66	157.19	15.28
kala vyara	1173	93.84	18.77	67.56	6.57
Kalkva	3841	307.28	61.46	221.24	21.51
kalamkui	732	58.56	11.71	42.16	4.10
Kamlapor	451	36.08	7.22	25.98	2.53
Kandha	1466	117.28	23.46	84.44	8.21
kanja	1422	113.76	22.75	81.91	7.96
Kanjan	1722	137.76	27.55	99.19	9.64
Kanpura	3399	271.92	54.38	195.78	19.03
Kapadvan	901	72.08	14.42	51.90	5.05
kapura	3285	262.80	52.56	189.22	18.40
Karanjkhed	2225	178.00	35.60	128.16	12.46
Karanjvel	2925	234.00	46.80	168.48	16.38
kasvav	2990	239.20	47.84	172.22	16.74
Katasvan	2447	195.76	39.15	140.95	13.70
Katgadh	372	29.76	5.95	21.43	2.08
katiskuva Dur	914	73.12	14.62	52.65	5.12
Katiskuva Najik	1290	103.20	20.64	74.30	7.22
katkui	1004	80.32	16.06	57.83	5.62
Kelkui	3781	302.48	60.50	217.79	21.17

Kelvan	338	27.04	5.41	19.47	1.89
Khanpur	1122	89.76	17.95	64.63	6.28
Khod talav	2192	175.36	35.07	126.26	12.28
Khuntadiya	1847	147.76	29.55	106.39	10.34
Khurdi	1639	131.12	26.22	94.41	9.18
Khushlpura	2476	198.08	39.62	142.62	13.87
Kohli	1261	100.88	20.18	72.63	7.06
Kosamkuva	319	25.52	5.10	18.37	1.79
Kumbhia	1827	146.16	29.23	105.24	10.23
Lakhali	1819	145.52	29.10	104.77	10.19
Limbarda	2140	171.20	34.24	123.26	11.98
Lotarva	1917	153.36	30.67	110.42	10.74
madav	579	46.32	9.26	33.35	3.24
Mgarkui	1969	157.52	31.50	113.41	11.03
Malotha	327	26.16	5.23	18.84	1.83
Mangalia	925	74.00	14.80	53.28	5.18
Maypur	1207	96.56	19.31	69.52	6.76
Meghpur	1429	114.32	22.86	82.31	8.00
Mirpur	934	74.72	14.94	53.80	5.23
Musa	838	67.04	13.41	48.27	4.69
Nana Satsila	227	18.16	3.63	13.08	1.27
Padam Dungari	1925	154.00	30.80	110.88	10.78
palasia	1352	108.16	21.63	77.88	7.57
Palavadi	606	48.48	9.70	34.91	3.39
Panchol	1806	144.48	28.90	104.03	10.11
Paniyari	1862	148.96	29.79	107.25	10.43
Panvadi	2012	160.96	32.19	115.89	11.27
Pthakvadi	2242	179.36	35.87	129.14	12.56
Pati	5144	411.52	82.30	296.29	28.81
Pervad	1277	102.16	20.43	73.56	7.15
Pipalwada	1775	142.00	28.40	102.24	9.94
Pithadara	2203	176.24	35.25	126.89	12.34
Ramkuva	783	62.64	12.53	45.10	4.38
Rampura Dur	403	32.24	6.45	23.21	2.26
Rampura Najik	658	52.64	10.53	37.90	3.68
Rani amba	931	74.48	14.90	53.63	5.21
Raygadh	1386	110.88	22.18	79.83	7.76
Rengan Kachchh	884	70.72	14.14	50.92	4.95
Rupvada	1733	138.64	27.73	99.82	9.70
Sadadvan	1028	82.24	16.45	59.21	5.76
Sankli	1110	88.80	17.76	63.94	6.22
Saraiya	1441	115.28	23.06	83.00	8.07
Sarkuva	1064	85.12	17.02	61.29	5.96
Shahpur	661	52.88	10.58	38.07	3.70

Tadkuva	2159	172.72	34.54	124.36	12.09
Takiamba	2648	211.84	42.37	152.52	14.83
Tichkpura	1064	85.12	17.02	61.29	5.96
Umarkachchh	1651	132.08	26.42	95.10	9.25
Umarkui	1347	107.76	21.55	77.59	7.54
Umarkuva	757	60.56	12.11	43.60	4.24
Umarvav Dur	2495	199.60	39.92	143.71	13.97
Umarvav Najik	2484	198.72	39.74	143.08	13.91
Unchamala	8830	706.40	141.28	508.61	49.45
Vadkui	1665	133.20	26.64	95.90	9.32
Vadpada	533	42.64	8.53	30.70	2.98
Vaghjhari	723	57.84	11.57	41.64	4.05
Vaghpani	505	40.40	8.08	29.09	2.83
valotha	361	28.88	5.78	20.79	2.02
Vandar Devi	736	58.88	11.78	42.39	4.12
Vankla	2202	176.16	35.23	126.84	12.33
Vanskui	2122	169.76	33.95	122.23	11.88
Varjakhan	1775	142.00	28.40	102.24	9.94
Veldha	553	44.24	8.85	31.85	3.10
Virpur	930	74.40	14.88	53.57	5.21

ISWM of small scale with surrounding villages

From the composition of MSW in villages, it demonstrates that higher amount of compostable waste is generated. Decomposition and stabilisation of organic waste are a natural phenomenon. Due to organic nature of wastes, composting is the most suitable, sustainable and environment friendly method of recycling. [6] Compost can be useful to people for farming. We are suggesting the vermin composting method to practice in all villages. By practicing such, they can get immediate compost available for their farming and it is cheap compared to market compost. The table 2 also shows the least amount of recyclable waste is generated, but it is not negligible. As the population increases, the amount of waste is also going to increase, which is harmful to the environment; as it generates toxic gases. By taking advantage of sustainable infrastructure for MSWM, we can solve this problem by transferring all recyclable waste of villages to Vyara town. We have decided 5 routes that cover all surrounding villages of Vyara Taluka. All routes are designed according to practical considerations such as, time constraint and capacity of the vehicle. Generally, a capacity of the vehicle used in the collection of MSW is 2 tons. Table 2 illustrates the time taken by vehicle for collection of recyclable waste; it shows the amount of waste generated in one day and as per those routes has been assigned to the number of trips per week for selected villages. '#' indicates the vehicle that has to go for collection of waste on a particular day. Table 2 shows that Route number 1 has 3 trips in a week, and it has interval of 1 day between trips. By this we can understand that when such vehicle will go for collection, it has to collect 2 days of waste. Hence, all other routes are designed as per such need and concern.

Table 3 Trips designed in a week

Route no.	1	2	3	4	5
Time taken	5hr	4hr	4hr 30min	4hr 30min	4hr 30min
Weight of recyclable waste	1tn	0.75 tn	0.5 tn	0.65 tn	0.6 tn
Monday	#	#			
Tuesday			#		#
Wednesday	#			#	
Thursday		#			
Friday	#				#
Saturday				#	

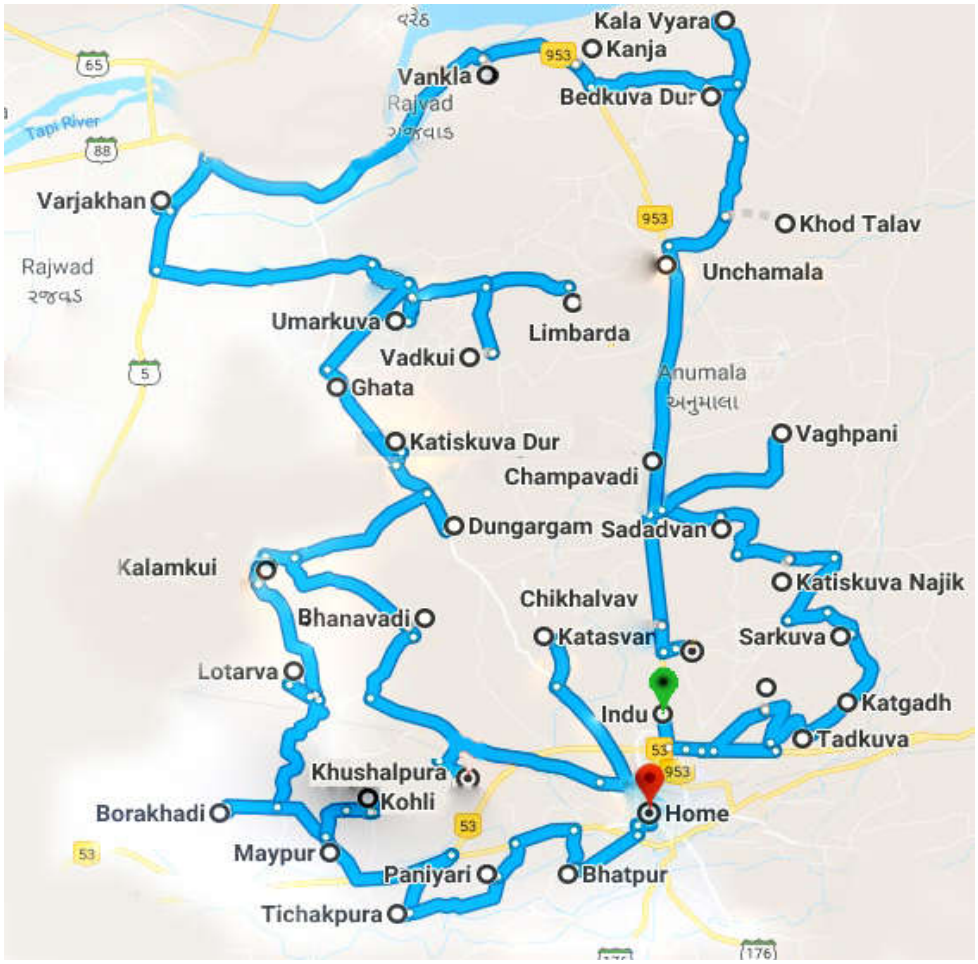

Figure 3 Route number 1

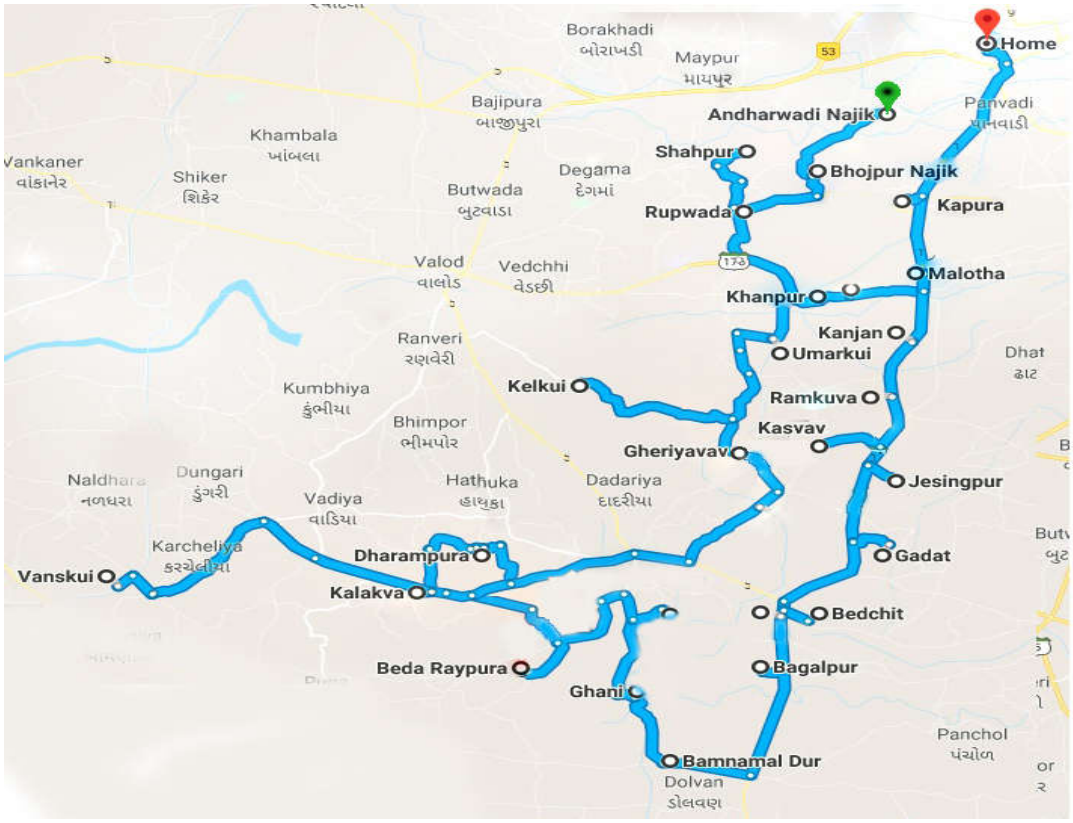

Figure 4 Route number 2

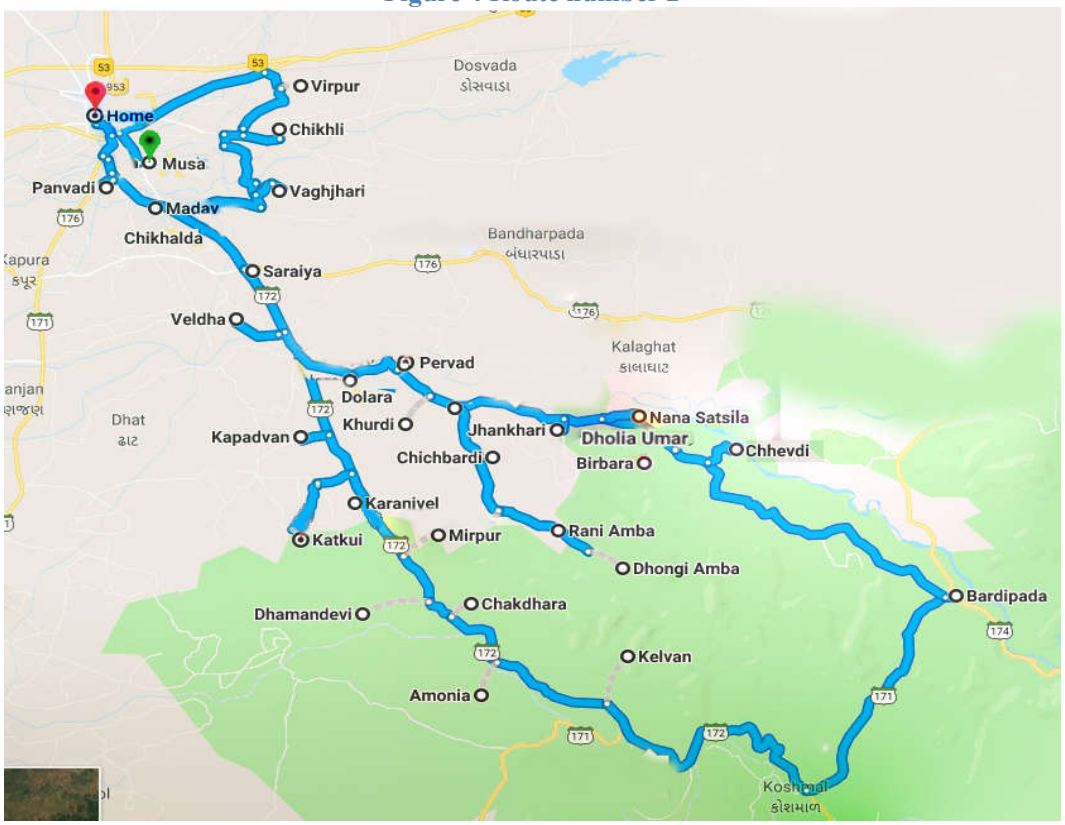

Figure 5 Route number 3

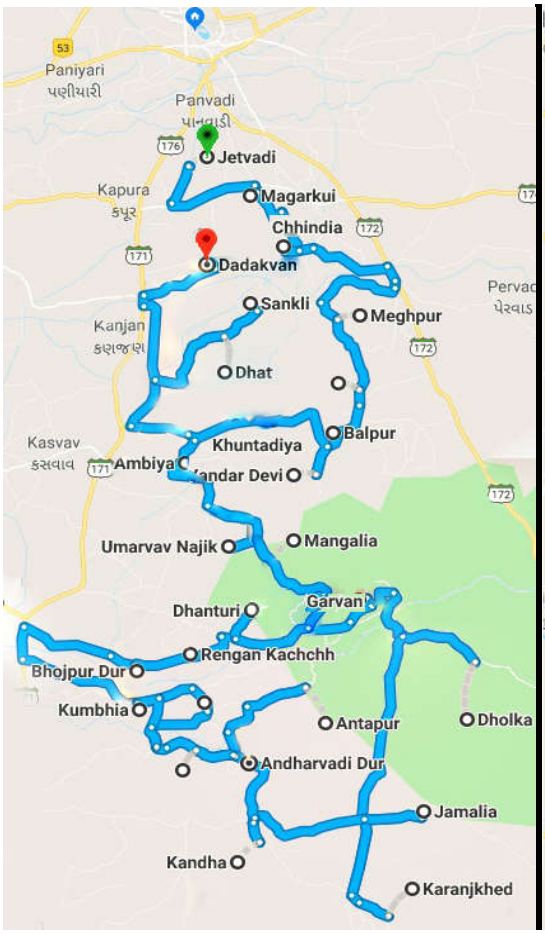

Figure 6 Route number 4

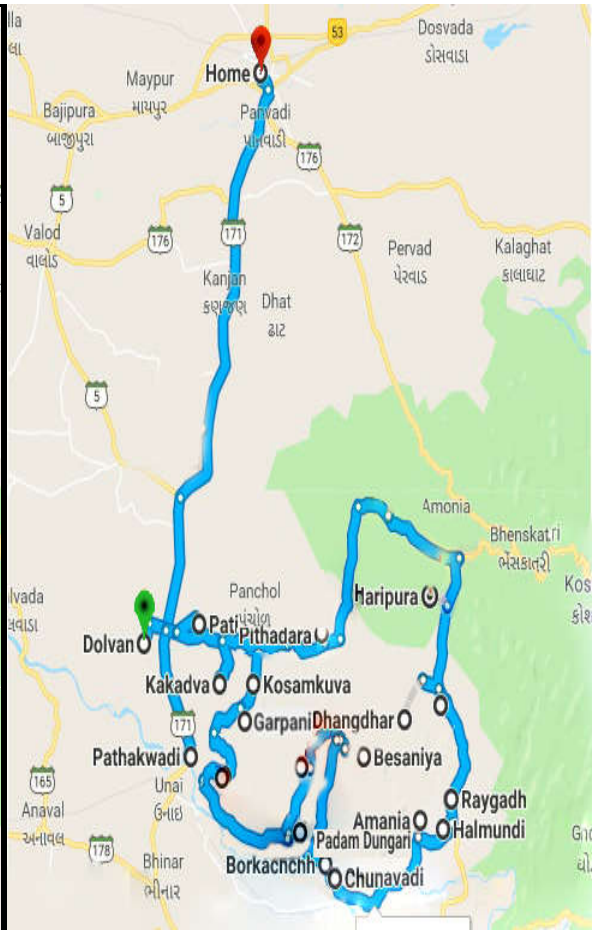

Figure 7 Route number 5

Cost Analysis:

For the designed routes between the small-scale town and surrounding villages for Integrated solid waste management, it involves various cost to make it successful. It comprises vehicular cost, transportation cost, labour cost.

Vehicular cost includes the cost of the vehicle and maintenance cost of the vehicle. Cost of vehicle for collection is considered 10,00,000 Rs. Two vehicles are needed per day to cover alternative routes. Normally, life of the vehicle is considered to have 10 years and its' maintenance is 15%. To compute annual maintenance of one vehicle (b) = ((% of maintenance*cost of vehicle)/ life of vehicle) = ((15%*10,00,000)/10)= 15000 Rs.

Transportation cost (A) includes fuel need to travel per trip for one route. Generally, a vehicle used for collection of waste gives a mileage of 9 km/lit and at the present cost of fuel is 70 Rs/lit. To compute transportation cost (A) = (fuel need per trip*cost of fuel).

Fuel need per route= (distance travelled by vehicle per route/mileage of vehicle).

Labour cost (B): We consider 3 labours needed per trip, 1 is driver and 2 helpers. Labour cost taken as 310/day.

Total cost computed by (X) = Transportation cost (A) + Labour cost (B)

Annual total cost (C) = Total cost * Annual trips (a)

The total annual cost per route (D) = Annual maintenance cost of vehicle (b) + Annual total cost (C)

Table 4 Cost calculation of routes

Route no	1	2	3	4	5
Total waste per Route (tons)	1	0.75	0.5	0.65	0.6
Collection Time per Route	5 hr	4hr	4hr 30 min	4hr 30 min	4 hr 30 min
Total kms per route	142.5	129.4	127.9	142	162.1
Fuel need to travel (litre)	15.38	14.38	14.21	15.78	18.01
A (Rs.)	1108	1006	995	1104	1261
L (Rs.)	930	930	930	930	930
X= A+L (Rs.)	2038	1936	1925	2034	2191
T	144	96	48	96	96
C= X*T (Rs.)	293520	185899	92389	195307	210315
M (Rs.)	15000	15000	15000	15000	15000
D= M+C (Rs.)	308520	200899	107389	210307	225315
Total Gram panchayat per route	32	22	18	23	15
Population per route	62382	45946	25553	37970	33910
Cost/person/year (Rs.)	5	4.37	4.20	5.62	6.64

The table 4 illustrates the calculation of all cost per year for all routes. Total cost we can levy from the total number of Panchayats coming in the routes. Panchayat can pull nominal charge the from village people as mentioned in table 4.

Advantages of ISWM in rural areas of India

- In most of the rural areas, systematic storage will be practiced.
- Vacant land and streets will look clean once the collection will achieve 100%.
- The environment will be less harmful if streets and roads will be clean.
- Recycling of waste can reduce the amount of waste to landfill.
- By building infrastructure, employment will be increased.
- The life of a landfill can be increased.
- Import of materials and fertilizer will be reduced.
- Methane emissions will be reduced from landfill.

Conclusion

Drastic population growth and haphazard development lead to the marvellous increase in municipal solid waste in cities and villages of India. Inadequate management of solid wastes not only causes serious environmental problems, but also risks to public health. Therefore, there is a modification from the traditional solid waste management options for more integrated solid waste management methods. The present management system in the study area is not satisfactory and it causes long term negative impact on the environment. This study has been developed an Integrated solid waste management system for Vyara Taluka by considering of waste generated in villages, the availability of resources and

facility in Vyara. It will help improve the environment, resources and energy recovery from waste, and further it will improve rural area's living standards. This programme will be successful when the municipality authority and residential community will be working together, as a result they will get a clean and better city for habitant.

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