

SOLID WASTE MANAGEMENT THROUGH PUBLIC-PRIVATE PARTNERSHIP MODEL

Sesha Sai Ratnamala Bommareddy

M.Tech Student, Civil Engineering Department,
K L University, Vaddeswaram, Andhra Pradesh, India

SS. Asadi

Associate Dean-Academics, Civil Engineering Department,
K L University, Vaddeswaram, Andhra Pradesh, India

ABSTRACT

Objective: The aim of this paper is to consider the new capital city of A.P “AMARAVATHI” as a case study which is going to handle a huge population in upcoming years. Municipal solid waste is the key alert which would be soon knocking the city with managing and handling issues.

Methodology: To study and evaluate the best fit PPP model that suits to the solid waste management as per the land fill estimate that can be implemented to generate revenue and manage solid waste effectively. Extent of land required for the solid waste management and population is estimated by exponential method growth to be generated for the projected year 2040. **Findings:** Results reveals that the best model for solid is waste management for the new capital city AMARAVATHI is automated plastic separation module. The estimated cost and land required for implementing this projected is 260,00,000 and 4500sqm. Total amount of estimated solid waste generated in the year 2040 is 1079 tonnes/day. **Applications:** Control and management of the municipal solid waste in cities. This model on application could reduce the maintenance cost for the sectors handling and also generate the revenue on using model. Automated plastic separation module which can be undertaken on public private partnership model.

Key words: PPP-Public Private Partnership, NGO-Non Governmental Organizations, ULB–Urban Local Bodies, Municipal Solid Waste (MSW).

Cite this Article: Sesha Sai Ratnamala Bommareddy and SS. Asadi, Solid Waste Management Through Public-Private Partnership Model. *International Journal of Civil Engineering and Technology*, 8(1), 2017, pp. 263–272.

<http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=1>

1. INTRODUCTION

Municipal solid waste which is a serious problem in most of the cities and in the rapid urbanization which is a hazardous issue for the inhabitants¹. About 90% of the municipal solid waste which is being generated by the inhabitants in most of the places are un scientifically following open dumps, littering, and landfills which causes a major issue. To manage this municipal solid waste government has initiated programs such as “SWATCHA BHARAT” by Prime Minister of India which somehow making the way towards hygienic

living²⁻⁴. Which involved NGO's and ULB's to work for aim of providing a hygienic and dignity of living in society.

Rapid industrialization and population explosion in India has led to the migration of people from villages to cities, which is responsible for the generation of huge amount of municipal solid waste every day^{5,6}. This ultimate generation of huge amount of municipal solid waste by every individual per day which may lead to problems if improper and poor handling and management of this municipal solid waste which is crucial problem in majority of cities. On the other way improper handling and disposal of this municipal solid waste cause adverse impact on inhabitants and environment which lead to unhygienic living⁷⁻¹⁰

Management of this municipal solid waste should be done with a discipline with proper management such as collection, transportation, processing and disposal keeping all the health and environmental issues into consideration.

A public private partnership (PPP) which is a contract between the government and a private sector in funding that is providing the technical, financial and risk assurance of monitoring a project improving and providing a quality in living for the public for any project to implement successfully.

This PPP does provide the infrastructure assets and delivering the public technological and cost effective infrastructural assets. Managerial efficiency in providing such infrastructural assets in managing the municipal solid waste management in contractual aspects between government and private sector.

1.1. Initiatives by the Government

The Indian Government is launching "Swactcha Bharat Mission" or "Clean India Mission" which aims toward providing public a clean and green India. Waste Management Market in India 2014 - 2025 report launched by NOVONOUS finds that waste management market is expected to be worth US\$ 13.62 billion by 2025¹¹⁻¹⁵. The Government of India has earmarked Rs.2500 crore exclusively for solid waste management.

The 12th Finance Commission has allotted Rs. 5000 core for supplementing the resources of the urban local bodies' for improving urban infrastructure. Out of this amount, 50% was earmarked for improving Solid Waste Management (MSW) SERVICES. With such huge investments into solid waste management sector, it demands efficient working and improved levels of services.

1.2. Municipal Solid Waste (MSW) Management using PPP model

PPP services and types of PPP projects or models being implemented by the different cities for the treatment of municipal solid waste generated and management by Public Private Partnership. PPP models and the projects in India with PPP models are defined in the Table 1

Table 1 MSW management using PPP model

S. No	PPP SERVICES	Projects in India With PPP Models
1	Door-door Collection	Bangalore, Ahmadabad, Nagpur, Dumdum, Gandhinagar Jaipur, North, Delhi
2	Sweeping Streets	Hyderabad, Surat
3	Storage and Transportation	Surat, Ahmadabad, Mumbai, Delhi
4	Integrated Treatment & Disposal	Delhi, Bangalore, Coimbatore, Kolkata, Chennai, Ahmadabad, Chennai
5	Integrated primary collection, street sweeping, storage and transportation	Chennai
6	Integrated MSWM (complete value chain)	Guwahati, Hyderabad

1.3. Description of Study Area

Location of Amaravathi coordinates latitude of Amaravathi 10,0167 (101°0.120"N) and longitude of Amaravathi 78,7833 (7846'59.880"E) altitude of Amaravathi 67m Location of study area is the proposed capital city of the Indian state of Andhra Pradesh; it is under construction. The planned riverfront capital is located on the southern banks of the River Krishna. The new city will cover a site of approximately 217.23 sq. km., within the Andhra Pradesh Capital Region. The Capital Region itself will cover an area of 8,352.69 sq. km., straddling on both sides of the Krishna River, in Guntur and Krishna districts^{12,13}.

Capital city soon going to handle huge mass of population migrating and taking spaces in city. For any city handling huge population major issues would be water and municipal waste. In this case handling of municipal solid waste is the major problem. So taking this into consideration before head it turn into a serious issue handling and management of municipal solid waste is to planned efficient to overcome upcoming unhygienic situation ahead to the capital city of A.P Amaravathi¹⁴⁻¹⁹.

In such a way that municipal waste can be managed and to convert into energy form which improve quality of living population and in the same way energy form that can be useful generating a mark of income leaving benefit to both the government and public as well.

1. Considering Amaravathi as trending capital city of Andhrapradesh. By the year 2040 a chance of occupying the capital city would be high. So major issues in any city handling high population is majorly WATER & SOLID WASTE DISPOSAL²⁰.
 - Considering this trending issue research on this proposal of PPP MODEL IN SOLID WASTE MANAGEMENT for location Amaravathi as core part of work.
 - Identify the issues regarding the management of solid waste.
 - Study on a PPP model in solid waste management and research how it could be implemented most effectively to generate revenue and manage waste effectively.
2. Work on the designing of PPP model in solid waste management such that solid waste can be managed and generate revenue for the government .To make a successful ppp model in solid waste management and possibly reduce the burden of spending huge investment on managing the MSW. Suggest a best fit ppp model which could be best in managing and handling solid waste and generate revenue in such a way that government need not spend huge amount on finding the solution.

2. METHODOLOGY

2.1. Study Area Profile

Study area the city is governing with all around 17 mandals as follows

Amaravathi, Attalur, Dharanikota, Didugu, Endroyi, Jupudi, Karlapudi, Lingapuram, Malladi, Munugodu, Narukullapadu, Nematikallu, PeddaMadduru, Pondugala, Puttipadu, Unguturu, Vykuntapuram Details if the each mandal Pin code, households, persons, males, females given in Table 2

Table 2 Details of the each Mandal

S.no	Name	Pin codes	Households	Persons	Males	Females
1	Amravathi	522020	2629	11378	5830	5548
2	Attalur	522436	1157	4825	2469	2356
3	Dharanikotu	522020	1661	7029	3606	3423
4	Didugu	522020	822	3268	1648	1620
5	Endroya	522020	665	2677	1338	1339
6	Jupudi	522212	465	2328	1207	1121
7	Karlapudi	522212	1570	5984	3099	2885

8	Lingapuram	522436	911	3923	1951	1972
9	Malladi	522020	589	2542	1250	1292
10	Munugodu	522402	945	3726	1887	1839
11	Narukullapadu	522016	670	2484	1238	1246
12	Nemalikalli	522413	1574	6111	3035	3076
13	Peddammadduru	522020	372	1390	701	689
14	Pondugala	521230	128	544	277	267
15	Prathipadu	522019	145	668	356	312
16	Unguturu	522016	715	2843	1436	1407
17	Vykuntapuram	522020	755	3169	1612	1557

2.2 Existing Situation

2.2.1. Primary Collection of Waste

The city has certain segment, where door to door collection and source segregation is followed. In general, the mixed waste is put in secondary collection bins of 3.5 and 4.5 cum bins²¹⁻²³. These bins are serviced by Dumper Place vehicles.

2.2.2. Secondary Collection & Transportation

The mixed waste (wet and dry) after is collected is transported to transfer stations through dumpers, tippers, large trippers, hook loaders, tractors etc. The waste collected at Transfer Stations (TSs) is being sent to Dumping yard by large trucks of 10cum.

2.2.3. Disposal at Site

3. TECHNICAL FEASIBILITY OF THE SOLID WASTE MANAGEMENT MODELS

Existing MSW models that are successfully being implemented.

- Door step Collection and transportation of the Waste generated
- Waste minimization and promotion of waste for recycling
- Stakeholders engagement in the implementation
- Processing, Treatment and Disposal of Waste
- State Level Institutional programs and arrangements.

3.1. Door Step Collection and Transportation of the Waste Generated

The strategy of collecting the waste from door to door step should be done preventing the individuals from dumping the waste at open dumps and littering unhygienic manner. The waste which is being collection collecting door to door should be done separately that is wet waste and try waste collection basis. Street level bins should be limited to public places. Root mapping of the city should be done for the perfect coverage of collecting of waste from doors. Mini vehicles such as pull rickshaws should be used to collect waste from door to door from the lanes where the waste should be segregate separately as dry and wet waste city wide.

3.2. Waste Minimization and Promotion of Waste for Recycling

MSW management is planned in accordance with five main principles which are considered as the approach for waste prevention and minimization. MSW is segregated at source grouped into organic,

inorganic, recyclable and the hazardous type of wastes. The program of ULB is to identify the land and to suggest or to establish the sorting facilities for dry waste and the facilities for material recovery.

Government should make programmes to encourage the communities and house hold individuals to set the individual composting and treatment units for kitchen waste at community level and at gated communities handling function halls, food courts, hotels and other units. Community based composting yards should be maintained places handling high public moving areas such as parks, colleges, residential apartments for welfare through encouraging the sweepers group, residential welfare and apartment societies

3.3. Stakeholders Engagement in the Implementation

To encourage the practices of contracts to set the operational goals to maintain the standards of services being provided and create awareness for the solid waste management among the stakeholders through the meetings with the communities of industries households by municipality and media by the ULBs.

ULBs has to involve the new task force for the proper planning and the implementation of the city sanitation and monitoring in a hygienic way keeping public health and the environmental problems into consideration.

3.4. Processing, Treatment and Disposal of Waste

Considering the centralized and decentralized options of the treatment and other disposal techniques by the ULB could develop the MSWM project state wide in all the metropolitan cities with fair operational cost sharing and arrangements by covering the PPP and the non PPP approach combinations in all the ULBs of the state in metropolitan cities and state wide.

The disposal and scientific treatment based is cost in technology dependant mode. The mechanism for the PPP projects is the processing fee for the scientific disposal and treatment.

3.5. State Level Institutional Programs and Arrangements

A metropolitan level of approach in recognizing and establishing the regional projects of MSW in smaller ULBs in setting up a technical cell for the support of experts in managing and following the hygienic and scientific methods for MSWM to ULBs by the PPP models, technologies in implementing the waste to energy and other projects.

For quick and justified results the appointment of the empowered committee under the state government is recommended under “Andhra Pradesh Land Management Act 2013” for setup of the treatment plant and sanitary landfill the allotment of land by the government should be allotted at free of cost or at nominal basic rents. This process has to be done by proper planning to further 40years process should be under the provision act.

4. ESTIMATED BEST FIT SOLID WASTE MANAGEMENT MODEL FOR AMARAVATHI

According to the current condition of the study area a model which could provide better management of the municipal solid waste management is through collection of waste from door step and separation of waste to organic and inorganic waste. They are transported separately and further process is done for treatment. The best fit solid waste management model for case study in detail is represented in the form of flow chart. Estimated best fit solid waste management model for study area is represented in Figure 1.

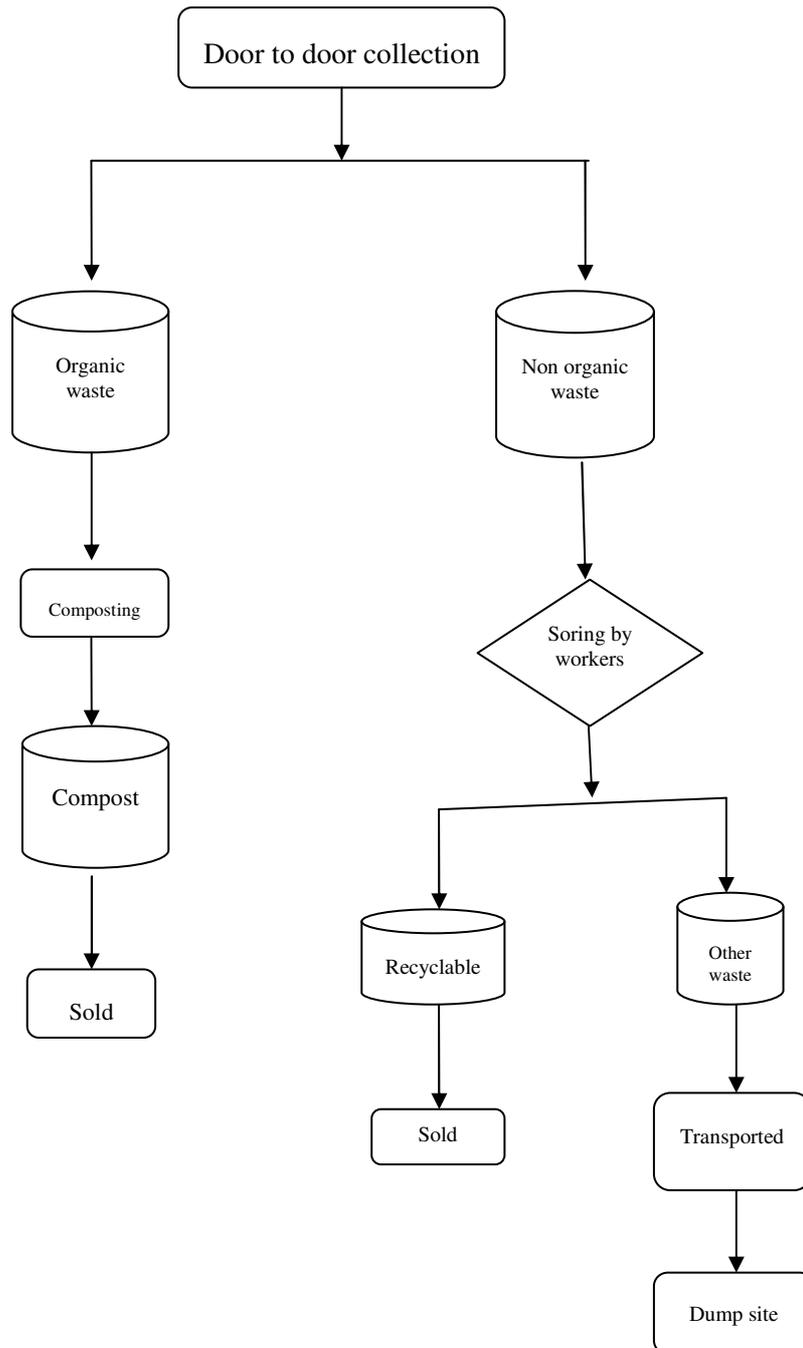


Figure 1 Flow chart of solid waste management

4.1. Eco Health Center

Treatment of municipal solid waste a best fit model and success story model to implement manage and handling in the solid waste management success story which is already being implemented in “KONDUNAGALLUR” KERALA.

- Doesn't give foul smell, No water pollution, No discharge of leachate, No fly's.
- The machine GREEN APSM (AUTOMATED PLASTIC SEPERATION MODULE) which can automatically separate the MSW into bio-degradable and non-bio degradable
- This is capable of separating rubber, plastic and other products instantaneously on feeding and can process the organic matter into aerobic /anaerobic composite.

- This is the only system available in India to process municipal solid waste on daily basis. Processing capacity of each module is 1-3 tons/ hour
- The municipal solid waste being collected is not a homogeneous mixture. the machines make it homogeneous to be fit for enough for anaerobic digestion aerobic composting , vermin-composting
- In anaerobic process , the products are bio gas and 99.5% plastic free bio manure and segregated plastic which carry commercial value the fuel extracted from this process can be utilized for running the plant and remaining can be sold directly or can convert into electricity

4.2. Limitations

However this project has some limitations such as Biomedical waste e waste and industrial waste could not be treated in process through this technology. As this system is dynamic machineries based, failure in critical machinery may effect regular function of the system. The presence of chemicals and may upset the bioreactor system.

5. RESULTS AND DISCUSSIONS

According to the population on current census of 2015 the waste generated is in tons per day. This is through the exponential method growth rate of the population from census 2015 to census 2040 and waste which could be generated by the population calculated is represented in the Table 3.

Table 3 Exponential method growth rate

Year	Population (exponential method)	Floating population @ 10%	Total population solid waste per capita generation considered (in kgs)	Floating population (solid waste per capita generation considered (in kgs)	Total population SW generation (in tons/day)	Floating population SW generation (in tons/day)	Total solid waste generated (in tons/day)
2015	818445	81845	0.45	0.05	368	4	372
2020	920645	92065	0.50	0.05	456	5	460
2025	1035606	103561	0.54	0.05	564	6	570
2030	1164922	116493	0.60	0.06	698	7	705
2035	1310386	131039	0.66	0.07	863	9	872
2040	1474015	147402	0.72	0.07	1068	11	1079

As per the results through exponential method population rate increase drastically this is an estimate population increase may vary from the results which are concluded there may be a scope of increment rather no chance of decrement of increase in population could be notifies. Similarly amount of municipal solid waste generation could also be increase certainly without any doubt.

Exponential method is applied to calculate the population and solid waste being generated in relevance to data.

$$E = (y_k) \cdot e^{r \cdot t}$$

E = exponential method

Y_k = known year

e = base of natural logarithm

r = average ration of growth

t = time period

Managing this huge increment in population and generation of solid waste which is estimated to generate would result in a serious issue of handling and managing this entire solid waste which is going to be the serious issue for the further years.

Accordingly to the population and municipal waste being generated by population for the census 2015 the population is 818445 and waste being generated is about 372 tons/day. Area required to manage this Municipal Solid Waste is about 84195 m²/year. Similarly according to the results basis population count by census 2040 would be increased drastically to 1474015 and Municipal Solid Waste which is going to be generated by the population by census 2040 by the population 1474015 is about 1079 tons/ day which is going to be a huge increment and this would definitely cause a serious issue in managing and handling. Area required to dump this Municipal Solid Waste for census 2040 would be 241773 m²/ year.

In this situation handling and managing this Municipal Solid Waste is key content for the problem. Managing and handling techniques currently being implemented by the local bodies and authorities governing the panchayat is not the key or solution for handling and managing such a huge issue. In order to govern this government have to take the initiatives and handle the issue before head it create a high end problem and unhygienic environment for the upcoming capital city.

5.1. Eco Health Center (EHC)

Doesn't give foul smell, No water pollution, No discharge of leachate, No fly's. The machine GREEN APSM (AUTOMATED PLASTIC SEPERATION MODULE) which can automatically separate the Municipal Solid Waste into bio-degradable and non-bio degradable. This is capable of separating rubber, plastic and other products instantaneously on feeding and can process the organic matter into aerobic /anaerobic composite. This is the only system available in India to process municipal solid waste on daily basis. Processing capacity of each module is 1-3 tons/ hour. The municipal solid waste being collected is not a homogeneous mixture. The machines make it homogeneous to be fit for enough for anaerobic digestion aerobic composting, vermin-composting. In anaerobic process , the products are bio gas and 99.5% plastic free bio manure and segregated plastic which carry commercial value the fuel extracted from this process can be utilized for running the plant and remaining can be sold directly or can convert into electricity.

5.2. Project Estimation Cost for EHC Method

Investment required for a basic module without a biogas plant

- Entire project cost is 2,60,00000.
- Area required to establish the plant is 4500sqm

Investment for the module with bio gas plant

- Entire project cost is 6,60,00000.
- Area required to establish the plant is 4500sqm

6. CONCLUSIONS

The complete case study that is the capital city of Andhra Pradesh "AMARAVATHI" WHERE PEOPLE ARE LIKELY TO FOLLOW THE ILLEGAL DUMPING and to litter solid waste unscientifically where the problems occur and increase over a time. Different methods have been employed by the municipalities of different areas to improve the collection and treatment of waste services providing the necessary equipment for treatment and storage to avoid the unscientifically and illegal dumping.

Municipal Solid Waste collection from the households at door step and transportation of MSW through trucks and mini vehicles which is collected by from door to door and from small bins on street .This collected municipal waste is transported for the disposal and treatment plants where a successful model idea is suggested which can give up good end results of complete treatment of solid waste by automated

solid waste method where plastic is separated automatically and all the bio degradable material is formed as a slurry and released through the equipment.

Through this process of automated plastic separation end process no harmful gases or untreated material would be evolved. So this process could be best suitable model for the management of municipal solid waste management. This process which can treat to 1-3tons /hour and end product of plastic which is separated can be recycled and reused to plastic manufacturers. Slurry which is evolved as byproduct can be used as a manure for the fields by the farmers. Which is supplies at a least cost this revenue could be useful for running and maintenance of the plant. The fuel evolved from the plant can be used for the maintenance of the plant and excess fuel can be sold directly or converted into electricity.

Most importantly this automated plastic separation process one hand does leave amazing results in managing and handling the Municipal Solid Waste on the other hand it is successfully being implemented at kondnallur in kerala by the local government bodies that is eco health center (EHC). So this case would be best fit for the managing of solid waste in PPP model which generate revenue to the government and end results ultimately which solves a major issue of handling and managing the municipal solid waste. Successful implementation can put a city from problems regarding unhygienic living of people in the city and quality of living could be developed automated.

REFERENCES

- [1] Ali S A. Partnerships for solid waste management in developing countries. *Habitat International* . 2004, 28, pp .467-79.
- [2] Amit Bajaj V K. Need of PPP in Solid Waste Management in India. *International Journal of Innovative Research & Studies*, 2013 Jul, pp .552-559.
- [3] Anderson B. Privatisation: A formula for provision or perversion of Municipal Waste Management ? Clear Impression Documentation Services. 2011 Jun, pp .1-6
- [4] Biswas A K, S K. Studies on Environmental Quality in and around Municipal Solid Waste Dumpsite. *Resources, Conservation and Recycling*, 2010, 55(2), pp .129-134.
- [5] Agrawal. Sustainable Waste Management: Case Study of Nagpur, India. 2005, pp .1-11.
- [6] Barman A. Report on 'Solid Waste Management in Class 1 Cities in India. Committee constituted by Supreme Court of India. 1999 Mar.
- [7] Das D, M S. Solid state acidification of vegetable waste. *Indian Journal of Environmental Health*, 1998, 40(4), pp .333-342.
- [8] Zhu D, P A. Improving Municipal Solid Waste Management in India. *The World Bank*.2008, pp .1-190.
- [9] Dasgupta T. Operation Model for Implementation of Municipal Solid Waste Management System-Through Public Private Partnership. *International Journal of Scientific Engineering and Technology*, 2014 May, 3(5), pp .474-481.
- [10] Wilson D C, C V. Role of Informal Sector Recycling in Waste Management in Developing Countries. *Habitat International*. 2006, 30(4), pp .797-808.
- [11] Dayvera R D. Privatisation of Solid Waste Management Service: Practices in Developing Countries. Dept of Economic Affairs, M. o. (2009). Position paper on THE SOLID WASTE MANAGEMENT SECTOR in India. Government of India.2013 Apr, pp .1-38.
- [12] Shabir Hussain Khahro Nafees Ahmed Memon, Tauha Hussain Ali and Zubair Ahmed Memon, Improving Material Waste Management Performance: An Attribute Study for Provential Projects. *International Journal of Civil Engineering and Technology (IJCIET)*, 7(6), 2016, pp.498 – 506
- [13] Busse F, E M. Waste Management in developing countries: a challenging business opportunity. *Private Sector Focus*. 2012 Sept, pp .1-2.

- [14] Saei H. Application Of Public Private Partnership In Sustainable Solid Waste Management, Case Of Delhi And Manila Metropolises Case Study Thesis, 2012 , pp .1-90.
- [15] Bharti O, Singh A, Singh D P. Vibhor Sood Effective Municipal Solid Waste Management Practices Case Study . 2014, pp .1-10.
- [16] Gir R, Rastogi D, Tiwari S. Through Managing Municipal Waste Public –Private Partnership International Journal Of Scientific And Engineering Technology , 2014, pp .1-5.
- [17] Dasgupta T. Operation Model For Implementation Of Msw In Ppp Model, International Journal Of Scientific And Engineering Technology .2014, 3(5), pp .1-8.
- [18] N. Jagadeesh and T. Reshma, Arti Pamnani and Meka Srinivasarao, Municipal Solid Waste Management in India: A Review and Some New Results. *International Journal of Civil Engineering and Technology (IJCIET)*, 5(2), 2014, pp. 01–08.
- [19] Amritha P K, Anilkumar PP. Sustainable Solid Waste Management through Landscaped Landfills. *Indian Journal of Science and Technology*. 2016 Aug, 9(29), pp. 1-8.
- [20] Magram S F. Worldwide solid waste recycling strategies: A review. *Indian Journal of Science and Technology*. 2011 Jun, 4(6), pp. 692-702.
- [21] Anilkumar PP, Chithra A R K. Land use Generator Based Solid Waste Estimation for Sustainable Residential Built Environment in Small/Medium Scale Urban Areas. *Indian Journal of Science and Technology*. 2016 Feb, 9(6), pp. 1-7
- [22] Bijay T, Kumar K C A. Solid waste management at landfill sites of Nepal. *Indian Journal of Science and Technology*. 201 Mar, 4(3), pp. 164-166
- [23] http://www.sanitation.kerala.gov.in/index.php?option=com_content&view=article&id=75&Itemid=85, Date Accessed: 10/05/2009.
- [24] China Crusher. <http://globehospital.in/plastic-crushing-unit-in-kerala/>. Date Accessed: 02/06/2008.
- [25] Municipal Solid Waste management_ Eco Health Center – Scribd, <https://www.scribd.com/presentation/219345937/Municipal-Solid-Waste-management-Eco-Health-Center>, Date Accessed: 08/07/2012.