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Proposal for Conceptualising Zero Waste City: Katraj

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***Abstract*: *The* practices *of "zero waste* city concept*"* which *has been* implemented successfully *in* very few town /cities in *the world,* in that merely *developed* countries comes *where there is* availabilty *of funds. It is in the developing* countries *that* research *have been made towards sustainability due to the* less or un*availability of funds. "Zero waste* city *," where the entire municipal solid waste is treated with organic scientific method , is a perfectly sustainable & durable solution to the rapidly* increasing ecological *, eco friendly and socio-domestic problem facing today's* era.**

"Zero landfills* approch" *is another feature*/side *of zero waste* city practices *. Landfills* requires *high costs both private and external costs that get hidden in taxes on already tax*-paying *citizens. It then becomes very relevant to* find *out sustainable solutions to municipal solid waste management (MSWM).* In this *Zero waste* city concept the *"zero" or minimal waste to landfills creates a* efficient *solution to MSWM. We can not place / keep waste for future generations not even to incure unnecessary costs of maintaining unsustainable processes.

Keywords*: *zero waste* city concept, *MSWM*, *Zero landfills* approch, SWM, *sustainability

I. INTRODUCTION

Globaly today, we have adopted the linear economic model of manufacturing the goods and genrating the resultant waste from consumption of these goods by "use &throw " approach. The nature's free services of pure water, clean air and unpolluted land, has been increasingly get cantaminated/ distrubed due their over use

The zero waste concept enhance less/minimum/zero polution to land , water as well as air bt adapting effective methodolgy for MSW Processing Because when Municipal solid waste (MSW) released into nature untreated pollutes water heavily , air and land, and causes health issues and major climate change risks due to spread of pathoges air pollution due to release of toxic gases, soil and water contamination due to leachate percolation etc

Due to MSW dumping at openly on dumping site causes global warming as its major source of emmision of carban dioxide(CO) 2 , & this unprocessed MSW releases methane & methaneous gases(GHG- green house gases) which are 16% contributor of global warming ,so that its is essential to avoid completely /minimise the such pollutions to decrease the impact /risk factor on environmental& living being's health.

This can be done in two ways: one, by recycling and processing the entire waste so that there is no release of waste into the ecosystem and, two, by analysing vital resources from the waste and using it for further production, this is the circular economy model a "cradle to cradle" approach. "Zero waste" is a concept that enhances minimum or less or zero pollution to land, water and air due to effective MSWM. Urban India is facing an increasing challenge to provide for the huge& exceeding infrastructural needs of the growing urban population. According to the 2011 census, the population of India was 1.21 billion, of this 31% lives in urban cities. It is further projected that by 2050 half of India's population will stay in urban cities.

Solid Waste Management is one of the most essential &unavoidable services for maintaining the quality of life of the people in the urban areas and for ensuring better standard facilities of health, sanitation and the weather . With this rapid increasing population, the management of Municipal Solid Waste (MSW) in the country has emerged as a severe problem not only because of the environmental and aesthetic & health concerns but also due to the overall quantities generated every day

With rising urbanization and change in lifestyle , food habits and social environment , the amount of municipal solid waste has been increasing widely and its composition is also varing step by step. With huge migration of rural areas masses to urban region, particularly in metro cities & cosmopolitian towns, MSW is being produced at an ever large increasing rate. The growing population directly impacted the municipal solid waste generated in the surrounding areas. Again industrialization affects on urbanization and increases population stage to there by increasing the overall waste generated

II. STUDY AREA

It is important place from all sides in Pune district & city . Katraj is situated on 18°27"13' north latitude and 73°51'42" east longitude in Pune District (Figure.1). The total area of Katraj is 20 km² urban area, and Population is 3124458 as per Census 2011.Katraj, Ward 40 in Pune city in the western state of Maharashtra, India, is unique of the 41 such wards under Municipal Corporation , pune(PMC). Katraj is a newly elaborated part of the town and the ward is a mix of slum households, semi-slum chowl-households, apartment complexes and commercial areas. It has 34,578 households/families in total, 675 slum households units, 31,917 non-slum households units and 1,986 commercial units. The statistics of residence in this region Katraj is 131,000. Ward 40 was., Ward 40 has maintained this status for the 2-3 years, until date to process all waste also Ward 40 has no landfills. Its success led to the replication of the model in 50 per cent of the wards, presently, memorandums of understanding (MOU) are being prepared to replicate the model in all the remaining 21 wards of the district. In the remaining wards which have been copied, few per cent (0-3%) of inerts are moved to landfill sites, hence they have not made it to the zero waste criteria. Ward 40 katraj can be termed as "zero waste town" in a country that is ridden with an insurmountable waste problem. Though it is a mix of slum region and semi-slum areas and waste segregation and disposal has been so hard to made in the other slum areas of the district, here they have gained almost total segregation of wet and dry waste. Total Area – 20 km2,Height from mean sea level -450m(1480ft), an Average temperature of katraj Pune – 31 0C and an Average Rainfall at katraj Pune – 600 mm

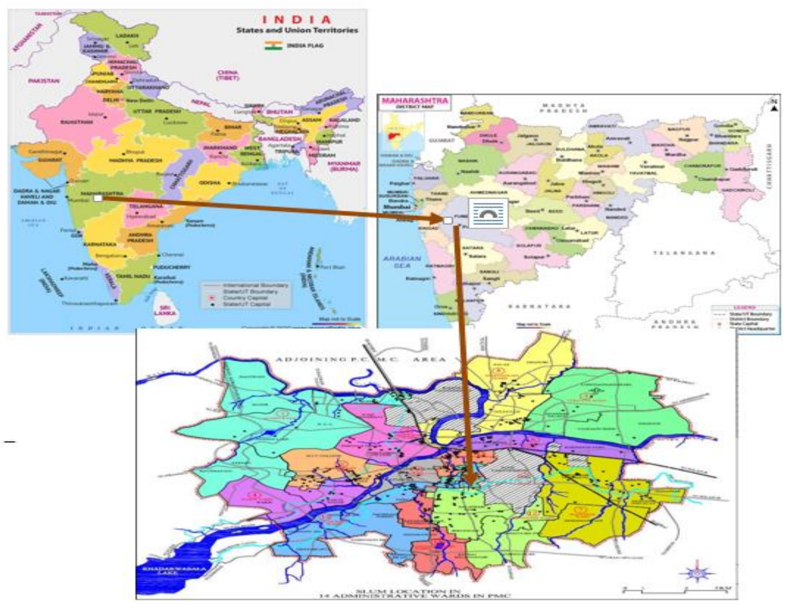

Figure.1 India-Maharastra- Pune-Katraj

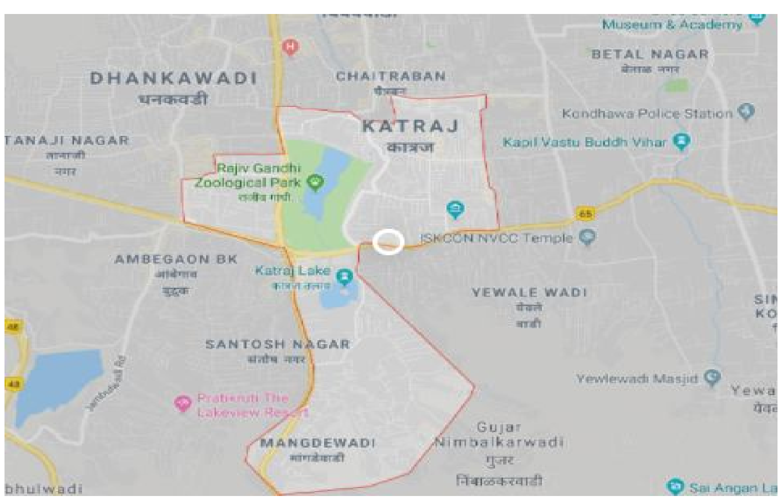

Figure.2 Katraj, Pune(18°27"13' north latitude & 73°51'42" east longitude)

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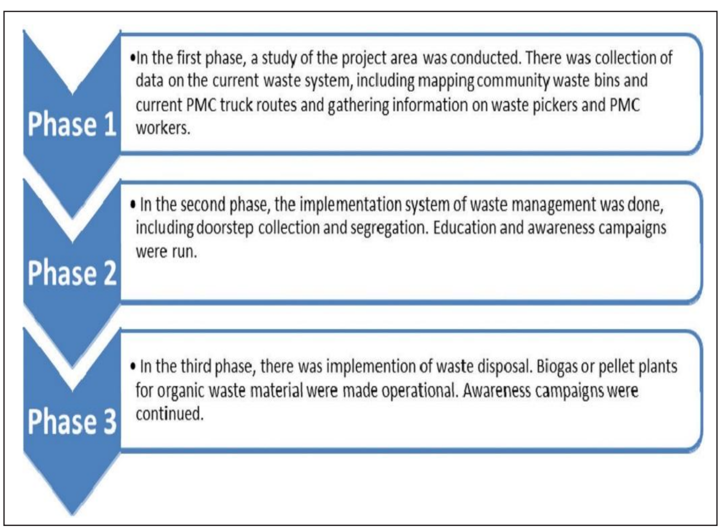
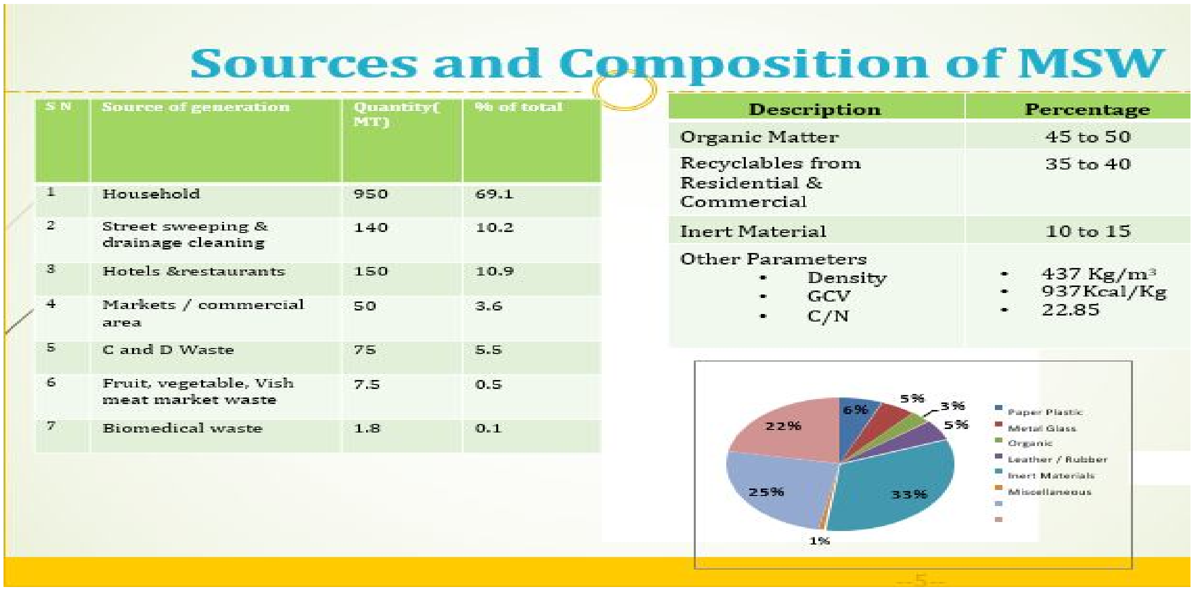
III.METHODOLOGY

A. Collection of Data

1) Pune generates around 1600 tons of solid waste per day.amongs that 60tonn is from katraj region
2) 160 trucks collect waste door--to--door, collecting an average of 198 tons per day.
3) 847containers and 116 compactor buckets dispersed around Pune.
4) Ward wise average-- 350 to 750 gms per capita per day
5) Construction and demolition waste generation –80--90 TPD
6) Garden waste generation – 50--60 TPD
7) Biomedical waste – 3 TPD



B. Analysing the data & Classification of Data



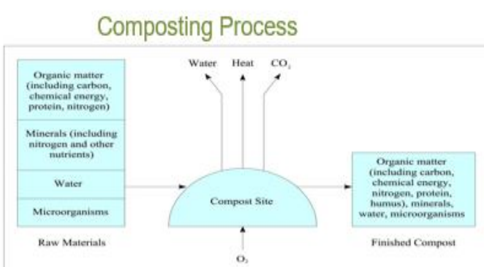
S N	Source of generation	Quantity(MT)	% of total
1	Household	950	69.1
2	Street sweeping & drainage cleaning	140	10.2
3	Hotels &restaurants	150	10.9
4	Markets / commercial area	50	3.6
5	C and D Waste	75	5.5
6	Fruit, vegetable, Vish meat market waste	7.5	0.5
7	Biomedical waste	1.8	0.1

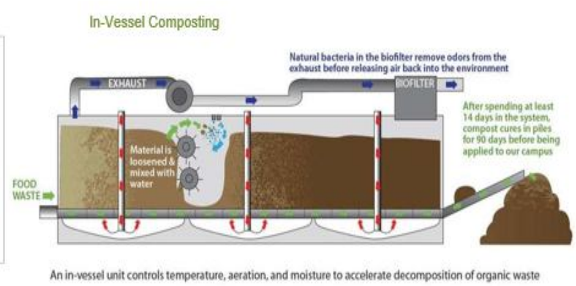
Description	Percentage
Organic Matter	45 to 50
Recyclables from Residential & Commercial	35 to 40
Inert Material	10 to 15
Other Parameters: • Density • GCV • C/N	• 437 Kg/m³ • 937Kcal/Kg • 22.85

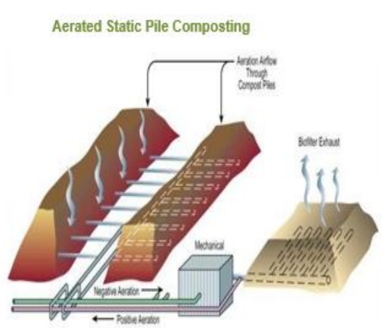
C. Implementation Of Data To Find Capasity,&Appropriate Technology

Technology Options for Treatment of Wet MSW

The technology options available for operation of the Municipal Solid Waste (MSW) are based on either bio conversion or thermal based conversion. The bio-conversion process is pertinent to the organic fraction of wastes (wet waste), to form compost or to collect biogas such as methane (biomethanation) and residual sludge (manure). The thermal conversion technologies are incineration with or without heat recovery, pyrolysis process and gasification method, plasma pyrolysis and pelletization process or manufacturing of Refuse Derived Fuel (RDF) are pertinent for treating dry waste or mixed waste. Composting Composting is a process of properly systematic decomposition of the organic waste, typically in aerobic conditions, resulting in the production of steady humus like product, compost. Considering the basic composition of wastes and the climate conditions, composting is highly related in India. Composting of the segregated wet fraction of waste is followed. Mixed waste composting, with effective & durable and appropriate pre-treatment of feedstock may be considered an interim solution; in such cases severe following of the compost quality is needful.







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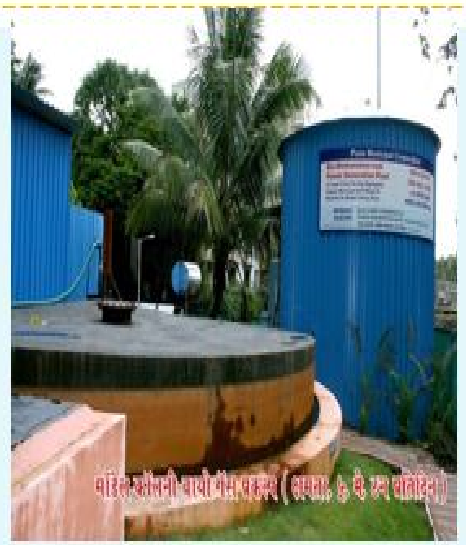
D. Biomethanation/ Anaerobic Digestion

Biomethanation involves controlled biological degradation cycle of organic wastes by microbial activity in the absence of oxygen. The process involves the anaerobic (without air) decomposition process of wet organic wastes to produce a methane rich biogas fuel and a small amount of residual sludge that can be used for making compost. It takes place in digester tanks or reactors, which enable control of temperature and pH levels for optimizing process control. Methane-rich gas produced is suitable as fuel for energy generation. The residual sludge is also produced, which is suitable for enriching compost materials. Input preparation or source separation is required to ensure that waste is free of non-organic contamination. Anaerobic digestion is best following practices to the treatment of wet organic feed stocks such as high moisture agricultural biomass, food waste, and animal wastes involving manure and domestic sewage. A made feedstock stream with less than 15 percent Total Solid (TS) is considered wet and feed stocks with TS greater than 15-20 percent are considered dry. Feedstock is typically diluted with process water to gain the achieveble solids content during the preparation stages.

Biomethanation



Description	Value
Biogas Generation	300+5% m3/day
Calorific Value	4800--5000 Kcal/ cum
Engine Efficiency	25%
Electricity Generation	1.5 kWh/cum of Biogas
Equivalent Electricity Generation	450kWh/day
Auxiliary Power requirement	@50 kWh/day
Net Surplus Electricity for sale	400 kWh/day

E. Selection of Appropriate tool & Technology for Processing

Criteria	Windrow Composting	Vermi Composting	Biomethanation
Applicable with Population Size	Above 1 Lakh	Between 5,000 to 1 Lakh	Small scale – between 5,000 to 25,000 Can be extended to Large scale as in case of Sholapur
Facility Location [1,2]	Plant should be located at least one km away from habitation, if it is open windrow composting. The distance could be 500m in case of covered plants.	Within the residential area (with appropriate environmental safe guards)	Plant should be located at least 500 m away from residential areas, for plant sizes upto 500 TPD.
Buffer Zone (no Development Zone)	500 m for facilities dealing with 100 TPD or more of MSW; 400 m for facilities for dealing with more than 75 or less than 100 TPD; 300 m for facilities dealing with 50-75 TPD of MSW; 200 m for facilities dealing with less than 50 TPD MSW. For Decentralized plants handling less than 1 TPD MSW no buffer zone is required; however adequate environmental controls are required.		
Natural Environment	Composting in coastal/ high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation	Composting in coastal/ high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation	
Land Requirement	High (For 500TPD of MSW: 6 ha of land is required)	High (Suitable for quantities less than 25 TPD)	Low to Moderate For small units: 500 sq. m for 5MT unit For large scale: 300 TPD of MSW: 2 ha of land is required)
Waste Quantity which can be managed by a single facility	25 TPD and above	1 TPD to 25 TPD	1-5 TPD at small scale to
Requirement for Segregation prior to technology	High	Very high	Very high
Rejects	About 30% including inert if only composting is done	About 30% including inert	About 30% from mixed waste
Potential for Direct Energy Recovery	No	No	Yes
Technology Maturity	Windrow composting technique is well established	Community scale projects are successful	Feasibility for segregated biodegradable waste is proven. Not suitable for mixed waste

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F. Waste Treatment Technology Options Based on Population Size

Population Range/ Waste Generated (TPD)	Technology Option		Minimum Requirement	Value Added Product
	Wet Waste	Dry Waste		
Population: Less than 50,000 Quantity: Less than 10 TPD	• Windrow Composting • Vermi Composting • Biomethanation (Nisarguna)	• Material Recovery & Recycling	Segregate wet organic waste at source for Biomethanation/ Vermi Composting Dry waste for recycling and material recovery Inert to Regional Landfill	Compost (Manure)/ Biogas Recyclables: Paper/ Plastics/ Metals
Population: 50,000 to 1 Lakh Quantity: 10 TPD to 30 TPD	• Windrow Composting • Vermi Composting • Biomethanation (Nisarguna)	• Material Recovery & Recycling	Segregate wet organic waste at source for Biomethanation/ Vermi Composting Dry waste for recycling and material recovery Inert to Regional Landfill	Compost (Manure)/ Biogas Recyclables: Paper/ Plastics/ Metals
Population: 1 Lakh to 10 Lakh Quantity: 30 TPD to 500 TPD	• Windrow Composting • Biomethanation	• Material Recovery & Recycling • RDF	Segregate wet organic waste at source for Biomethanation Dry waste to be recycled or converted in to RDF as feedstock for centralized facility Inert to Regional Landfill	Compost (Manure)/ Biogas/ RDF Recyclables: Paper/ Plastics/ Metals
Population: 10 Lakh to 20 Lakh Quantity: 500 TPD to 1000 TPD	• Windrow Composting • Biomethanation • Waste to Energy	• Material Recovery & Recycling • RDF • Waste to Energy	Segregate wet organic waste at source for Biomethanation Dry waste to be recycled or converted in to RDF as feedstock for power plants	Compost (Manure)/ Biogas/ RDF/ Electricity Recyclables: Paper/ Plastics/

Population Range/ Waste Generated (TPD)	Technology Option Wet Waste	Technology Option Dry Waste	Minimum Requirement	Value Added Product
			Inert to Landfill	Metals
Population: 20 Lakh and above Quantity: More than 1000 TPD	• Windrow Composting • Biomethanation • Waste to Energy	• Material Recovery & Recycling • RDF • Waste to Energy	Segregate wet organic waste at source for Biomethanation Dry waste to be recycled or converted in to RDF as feedstock for power plants Inert to Landfill	Compost (Manure)/ Biogas/ RDF/ Electricity Recyclables: Paper/ Plastics/ Metals

G. Computation Of Requirment, Transportation, Cost, Misc Expences Etc

Table 1. Generation and Disposal Matrix of Waste in Ward 40 (March 2018)

Generation and Disposal Matrix			
	Generation	Disposal	
Waste Type	TPD	TPD	End Uses
Wet waste	22	3	To biomethanation plant
		19	To farmers for farm use
Dry waste	24	30	To private operator
Mixed waste	6		for segregation, re-use, recycle and processing
Total	52	52	

Table 3. Economics of the Biomethanation Plant

Biomethanation		
Plant capacity	5	tonnes
Input from Ward 40	3	tonnes
Input from other wards	2	tonnes
Revenue economics (Biomethanation)		
Particulars	₹	
Value of electricity (3-ton feed) per day	2,613	
Less: Operating costs per day	1,728	
Net excess revenue/Saving per day	885	
Annual excess revenue	292,050	

Table 2. Transport Cost Savings Accruing to the Pune Municipal Corporation (April 2018)

Transport Cost Savings Accrued to PMC			
	M ton	Saving/MT*	Total/Day
Transport cost saving due to farmers collecting wet waste (WW) directly			
WW to farmers (savings)	19	700	13,300
Transport cost savings due to transfer of WW for biomethanation			
WW to biogas	3	700	2,100
Transport cost savings due to transfer of waste to private operator			
Transport charges to dumpsite	30	700**	21,000
Less: Tipping fees	30	350**	10,500
Net savings			10,500
Total savings/day			25,900
Annual savings			8,547,000

Source: The authors.
Notes: *: Metric Tonne.
**: http://pmc.gov.in/en/swm

Table 4. Revenues, OPEX and Net Cash Revenue of Segregation and RDF Plant Operator (March–April 2018)

Economics of Private Operators Segregating, Reselling, Re-using/Recycling	
	₹/Year
Revenue (30 TPD DW & MW feed)	12,771,000
Annual OPEX	7,976,000
Net retained cash revenue (post-tax)	5,356,500

Source: Authors' calculations based on Aditya Waste Paper Suppliers (Operator).
Notes: DW: Dry Waste.
MW: Mixed Waste.

Table 5. Costs and Revenues of the Plastic Recycling Plant (April 2018)

Economics of Plastic Recycling Plant*	
	MTD
Input/feed	1.200
Sellable output	0.840
Scrap sale	0.360
	₹/day
Revenue	22,800
Total OPEX	19,260
Net revenue/day	3,540
Annual net revenue	1,168,200

Source: The authors.
Notes: *Details of input and output pricing in appendix A.

Table 6. Total Benefits to the Public–Private Partnership (PPP) of Ward 40 (April 2018)

Combined Benefits of PPP	₹
Transport cost saving to PMC	**8,547,000**
Benefits to operators	**6,816,750**
Biomethanation	292,050
Segregation/resale/re-use	5,356,500
Recycling of plastics	1,168,200
Total financial benefits/year	**15,363,750**

Sources: The authors.

Table 8. Checklist of Critical Factors Necessary for a Successful Zero Waste Project

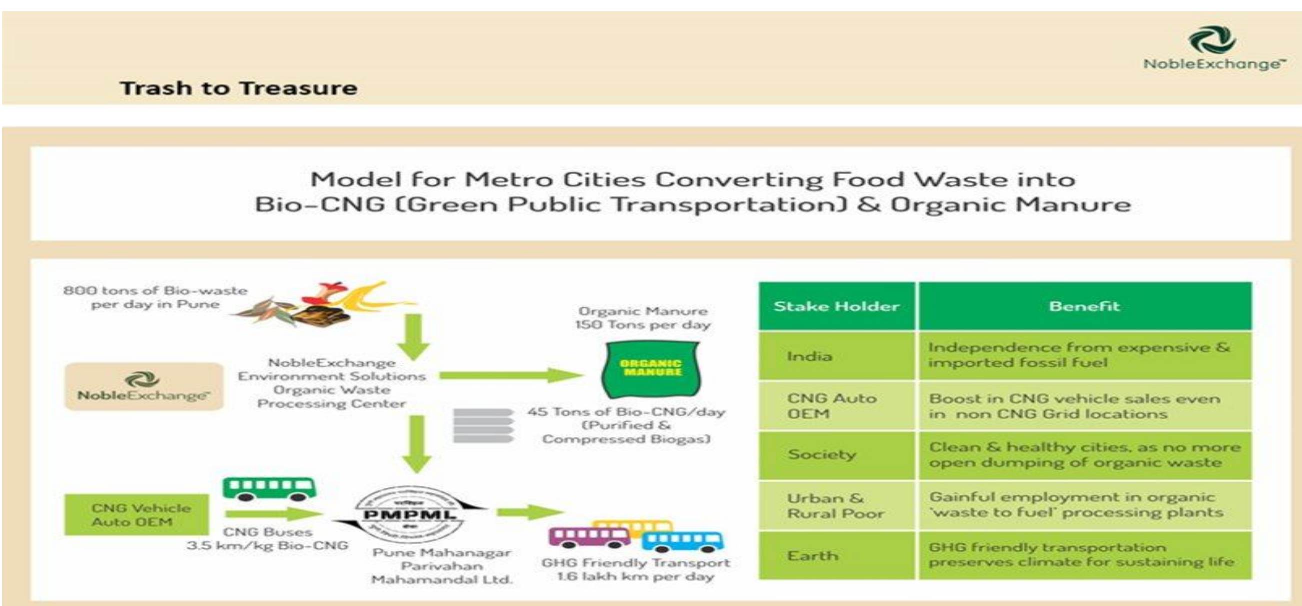
Sr. No	Governance and Planning	Ward 40 (✓)
1	Substantial change in consumer's behaviour and consumption pattern	✓
2.	PAYT, sufficient regulations and rules for MSWM	✓
3.	Modifications in the logistics system, development of public–private partnership (PPP) and financial incentives system	✓
4.	Promotion of green innovation—research and development of technologies around green production and waste management.	✓
	Operational	
5.	Product redesigning to eliminate wastage and elimination of toxicity in the composition of products	✓
6.	Prioritize use of renewable raw materials	✓
7.	Investing in products made with sustainable designing	✓
8.	Investing in labour training	✓

Source: Pietzsch, Ribeiro, and de Medeiros.[8]
Note: PAYT: Pay as you Throw.

Table 7. Employment/Income Due to the MSWM of Ward 40 (March 2018)

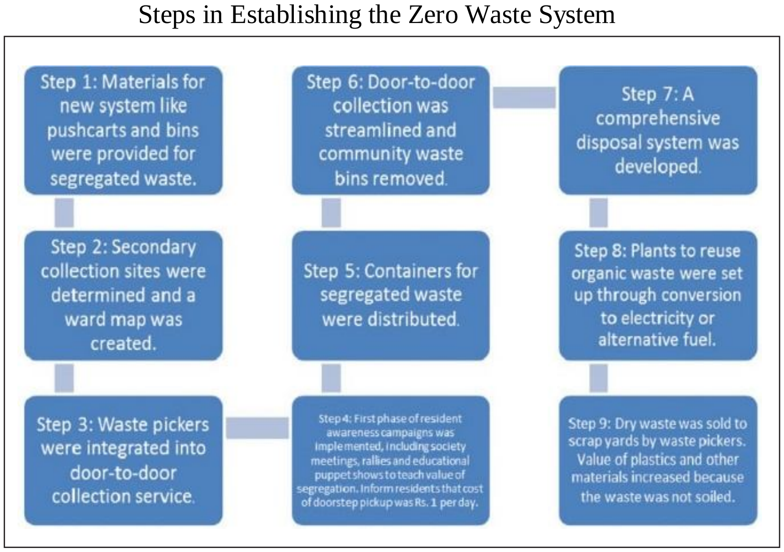
	Organization	No of People Employed	Annual Income Generated (₹)
1.	SWaCH (waste pickers)	61 (10,000)	7,320,000
2.	Segregation/RDF plant	40	3,900,000
3.	Plastic plant	12	576,000
4.	Janwani	3 (12,000)	432,000
5.	Biomethanation plant	7	1,380,000
	Total employment and income created solely due to zero waste project Ward 40	123	13,608,000
6.	PMC (existing)	182 (168 labourers)	39,510,000
	Total employment and income generated	**305**	**53,118,000 (US$843,143 @ US$1 = 63)**

Source: The authors.



IV. RESULT

Steps in Establishing the Zero Waste System



V. CONCLUSION

If we are looking at a durable & smart but effective , clean environment for our progeny to grow in, we definitely cannot behind waste and a “cradle to grave” linear economic model where resources are depleting at a rate that will not leave much for them and the generations to come. We also cannot leave a hierachy of landfills, nay dumpsites with mountains of waste polluting land, air and soil, the effects of which will be borne mostly by them in radical, dangerous and unfortunate ways for it takes time for this pollution to travel through the “earth, worm, healthy life cycle” and then leaves no bird song for the springs to come . If we are to bring this, then the only solution that can gain out in all types of ethics is a “zero waste” and round type model economy that reduces the stress on precious sources, follows the round economy’s “cradle to cradle” map and leaves “zero landfills achievement ” for the future scope

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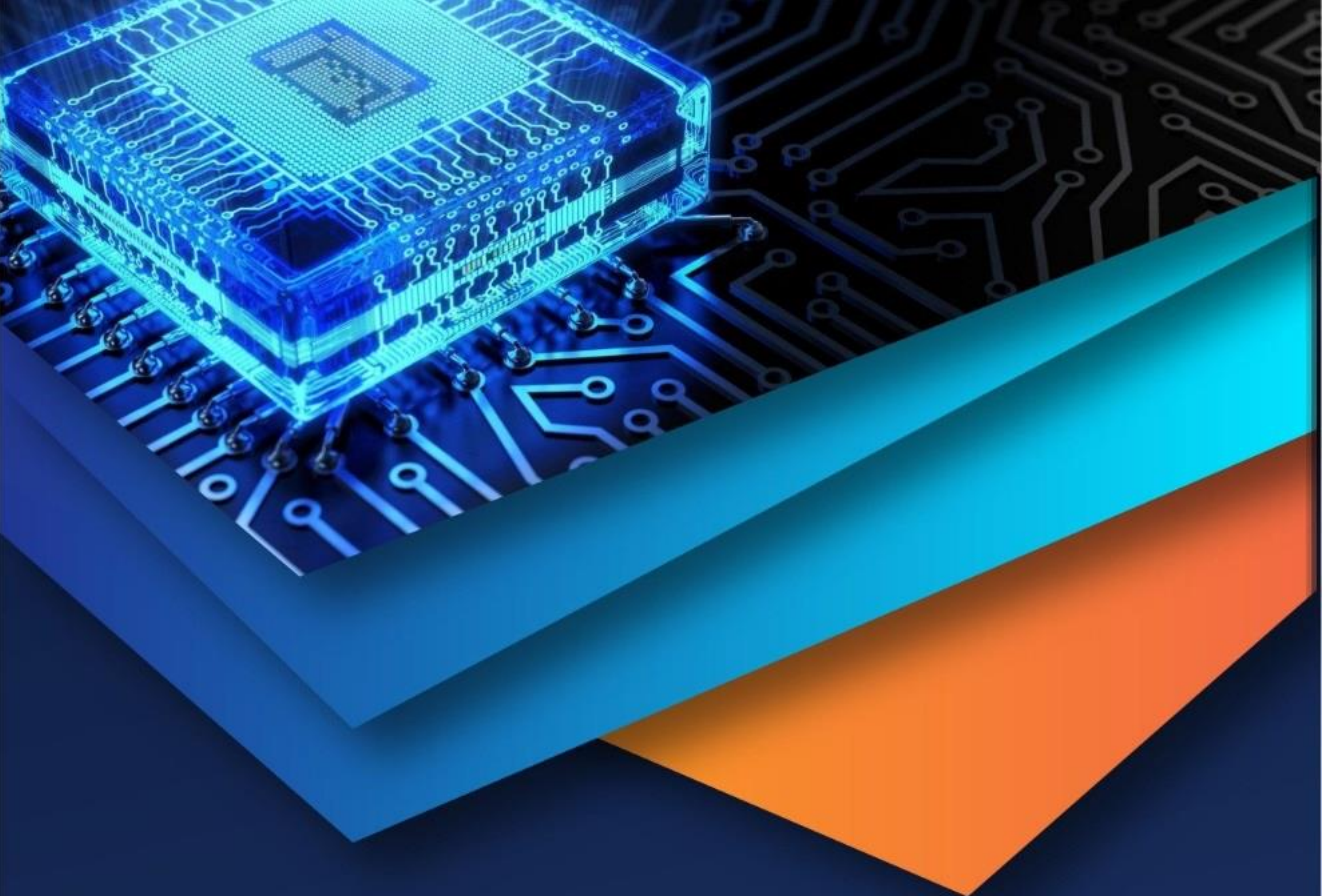

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