

Sustainable Solid Proactive Waste Management Practices in India Towards 2030

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ABSTRACT

Waste has become the order of the day as it is commonly found everywhere in the planet. Waste has been accumulating in volumes. Leaps and bounds which is scary. Waste by nature could be classified as medical, biomedical, agricultural, animal, solid, humane, demolition debri, mining, oil and gas extractive waste. As the global population leaps forwards with intense intensity – the waste has also increased phenomenally. There is a need for human awareness in effective management of waste which could bring in more social, environmental benefits. The awareness must result in effective implementation of waste management practices which could provide sustainability in Indian context.

This study has been attempted as a research paper, as the researches which have been done on solid waste management practices and its impact at the national level and specifically towards 2030 would be covered in this study. This study covers a period from 2018 till date as research papers, publications and reviews which have been already done on these dimensions would be covered.

This study focuses on the solid waste management practices which are carried out in India. This study is evaluative as it would determine the nature and management of solid waste management practices which have been implemented in Indian context. The study would also address the issues like solid waste generation, quantum & extent, composition & impact, collection methods & procedures, segregation methods used & disposal of waste which are practiced in India. This study focuses only on solid waste management practices in India. This examination study is exploratory and decisive in its tendency and approach. This examination is exploratory as it would investigate in to the different parts of strong waste administration rehearses and its execution systems in India. This study is convincing as it would give systems and answers for successful strong waste administration rehearses moreover. This study is empirical in its approach as it would use secondary data and its analysis. This study is descriptive in its approach as it would describe the aspects and dimensions of solid waste management practices in Indi in the most effective way. This research would be purposive as it would provide research frontiers and knowledge orientation for professionals and academicians in this field.

There is a need for holistic, integrative, sustainable future oriented proactive strategies & solutions which can provide progressive pathways in Solid waste management implementation in India.

Keywords: Strategic waste management practices, generation of waste, composition of waste, collection and utilization of waste, segregation systems, treatment and disposal practices

INTRODUCTION

The sorrowful story of waste as has been as old as human civilization. When man and his inhabitance sta

rted in this world – the creation of waste and its management became a challenge which has remained. So, this long association of waste with man continues in the modern world which has differed with urban development and techno cultural orientations. Waste has a long history, cultural orientation, standards, and treatment which alter with variations and intensity across the world. This has also led to socio economic chaos and confusion across global societies who are fighting hard to eradicate this day-to-day menace. Modern technological tools and support systems have provided novel methods and approaches which have made it elegant – but and still this waste problem has increased in its intensity and growth along with the populations of countries. There is a need for effective ways and means to manage this chaos as the globe must be clean, safer, and purposive for future generations also. This would also ensure sustainability of our civilization to a larger extent as this can harm and pollute our environment and it can lead to global disaster and disharmony.

LITERATURE REVIEW

Gour, A.A. and Singh, S.K et.al, 2023 had done secondary data-based analysis on solid waste management practices and its implications in Indian context. This study also examines the state of art which is prevalent. This study has been done as a review paper as the research gaps are also provided. It is evident in this study in the earlier period the disposal of wastages was easier and simpler because majority of the wastage were organic (Khan S, Anjum R, Raza ST, Ahmed Bazai N, Ihtisham M(2022)) which could be disposed in low lying areas which also did not harm the environment. This also ensured that it has lesser socio economic implications as the environmental protection (Yousefloo A, Babazadeh R(2020)) was also taken care. In these modern days we could find that waste management practices have become more complex and intense as there is more prevalence of inorganic waste. Industrial, medical, bio medical wastage has increased (Ebekozien A, Aigbavboa C, Nwaole ANC, Aginah IL, Aigbedion M(2022)) to a larger extent which has impacted our socio economic living and health. There is a greater prevalence of chemicals and hazardous substances in these wastes which could harm the environment as it leads to air pollution and problems in disposal management.

Our urban living and engagement has increased our economic conditions as we have become more adaptive to global culture and cosmopolitan living. This has also lead to major changes in our food habits & consumption patterns, timing and our life style. The harmonious collective joint family system in India has totally eroded for economic welfare, self identity and nuclear mindset. As the human consumption patterns have become more complex without specific structure and patterns, we do have its implications on waste management and in specific on solid waste management practices in India. As we are the silent spectators of global changes in food habits & life style orientations (Bolingbroke D, Ng KTW, Vu HL, Richter A(2021)) this has led to massive increases in solid waste and its management has been more complex and challenging. As this solid waste management system and practices have become a global challenge it has its strong implications and representations in Indian context.

This research paper reviews on the various aspects of waste like solid waste generation, quantum & extent, composition & impact, collection methods & procedures, segregation methods used & disposal of waste which are practiced in WB.

The developed European countries along with Australia & Italy have found novel ways to manage this problem effectively.

India has almost 18% of the world population as it has its 1.4 billion people spread across 2.4% (Das S, Lee S, Kumar P, Kim K-H, Lee SS, Bhattacharya SS(2019)) of the world space. This clearly indicates the

importance of solid wastage management practice and its effective implementation in India which could have global implications. The various research papers and contributions made on solid waste management practices is given as a table as per their valuable research outcomes which have evolved over a period of time.

Author name	Contributions of the study
<p><i>Ebekozien A, Aigbavboa C, Nwaole ANC, Aginah IL, Aigbediom M et. al (2022)</i></p>	<p>This study strongly emphasizes on the role of education and awareness towards transformative solid waste management practices which have huge implications for the future also</p> <p>This study also states that a proper consistent and social oriented engagement of private sector is the need of the hour as this could bring faster results. This can also lead to social progress and inclusive development in the long run</p>
<p><i>Perex LE, Ziegler Rodriguez K, Perez ATE, Vasquez OC, VazquezRowe I et. al (2021)</i></p>	<p>This paper has contributed towards life cycle management practice of solid waste which can lead to far reaching implications in metro and rural regions of a country there is a need for transformative new strategy which can modify this solid waste in to energy which can contribute to the social welfare and GDP of a nation</p>
<p><i>Bui TD, Tsai FM, Tseng M L, Ali MH et. al (2020)</i></p>	<p>Fuzzy Delphi method of analysis was used. This study found that there are 146 barriers which could prevent towards sustainable solid waste management practices. The important and pertinent are house hold wastes, hazardous waste, lack of resources, lack of researches, staff and skills, infrastructure establishment & management, standards benchmarking and implementation</p>

The following section would deal with the various themes on which solid waste management practices has been researched.

Theme, author name & year	Contributions of the study
<p><i>Theme: managment</i> <i>Bolingbroke D, Ng KTW, Vu Hl, Richter A(2021&gaeta GL, Ghinoi S Silvestri F, Tassinari M Et. al (2021)</i></p>	<p>The need for effective waste management practices is evident now. Continuous improvement and up gradation with technology is needed waste analysis has to be done and a need for crafting a</p>

	<p>framework which can improve waste management practices and its efficiency</p> <p>Innovation is essential as it would lead to product and process innovation which can contribute to organizational orientation also this could also lead to drastic contributions in disposal methods and practices</p>
<p>Theme: Framework Folarin OS(2022) Azevedo BD, et,al(2020) Brotosusilo A et.al(2020)</p>	<p>Management of circular economy with an effective collection and management of waste – procedures, process and systems have to be established and managed effectively</p> <p>Need for public awareness is again reestablished as it leads to effective SWM practices communal orientations, education, commitment and involvement could have strong positive impact on creating solid waste management frameworks which can lead to effective implementation</p>

Other dimensions which are covered in waste management practices include Covid, segregation and evaluation, disposal methods, ways of storage, treatment methods and ways of recycling & conversion of waste to energy transformations has been studied. It is also evident from this research studies that exceptionally less observational exploration studies have been finished on maintainable strong waste administration rehearses towards 2030 in India as this research is an attempt towards it.

RESEARCH DESIGN

This study aims to evaluate the various existing solid waste management practices which are followed in India. This study would propose various sustainable solid waste management strategies and practices in Indian context. The study would also provide futuristic directives and strategies for effective solid waste management towards 2030.

This study is exploratory and convincing in nature. This study investigates in to the different perspectives and aspects of strong waste administration rehearses in Indian setting as it would conclude by providing sustainable strategies towards 2030. This study is done based on secondary data only. Inferential analysis would be done as evaluations on the data would be done empirically with suitable conclusions on sustainable solid waste management proactive practices towards 2030.

OBJECTIVES OF THIS STUDY

1. To evaluate the various existing solid waste management practices which are practiced in India
2. To propose various sustainable solid waste management strategies and practices in Indian context
3. To provide futuristic strategies & progressive pathways for sustainable solid waste management practices towards 2030 in India

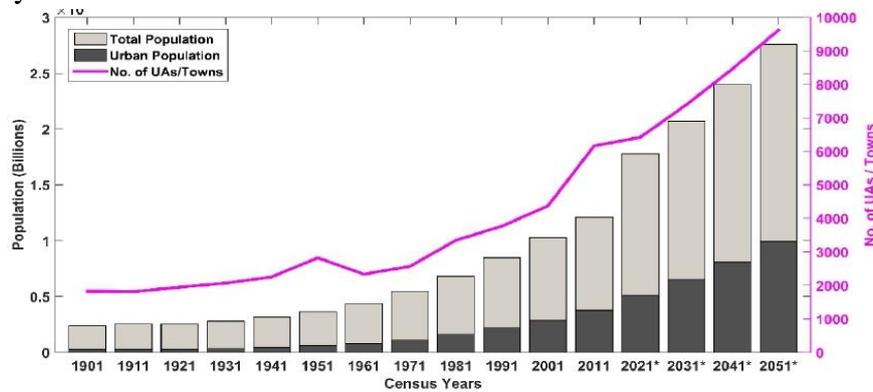
SCOPE AND LIMITATIONS

1. This study is based on secondary data only
2. This study is inferential in its analysis and approach
3. This study is restricted to Indian context

DATA ANALYSIS

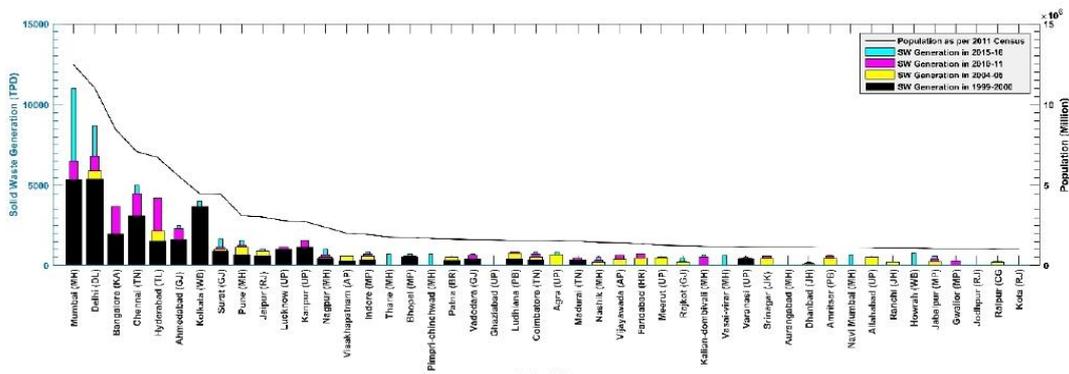
50% of the total solid waste generated across 28 states and 8 Union territories in five states Maharashtra, UP, WB, Gujarat & NCT of Delhi. Maharashtra produces 23,000 solid waste tonnes per day. UP and WB produce 15,000 tonnes of solid waste per day. Andhra Pradesh, Delhi, Gujarat, Karnataka, and Tamil Nadu produce 10,000 tonnes of solid waste per day.

Maharashtra stands first in waste collection also as it does it for 99.3% of its solid waste and 53% of it is reused using recycling methods. Remaining wastage is collected as 47% of waste is sent to landfills. Arunachal Pradesh, Chhattisgarh, Karnataka, Manipur, Nagaland, and Puducherry collected 80% of solid waste and only 25% has been treated.



Source: Gour, A.A. and Singh, S.K et.al, 2023

It is found from the above chart that more than 10,000 towns would have an increased solid waste by 2051 as the Indian population is projected to reach 3 billion by 2050. The solid waste generation in Indian cities has been clearly stated in the form of a chart given below:



Source: Gour, A.A. and Singh, S.K et.al., 2023

It is evident from the chart above Mumbai generates more than 10,000 tonnes of solid waste per day followed by Delhi to the extent of 8000 tonnes of solid waste per day. Bengaluru, Chennai, Hyderabad and Kolkatta are fast approaching as it is evident that metro cities have emerged to be generating solid waste per day to the maximum.

So there is a need for an effective sustainable long term strategy for Indian metro cities solid waste management proactive practices as there is an immense need for researches in this direction.

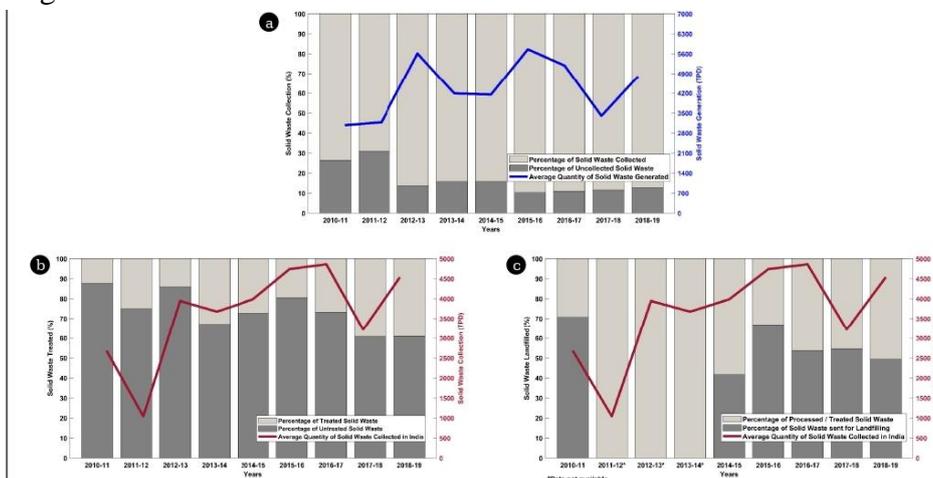
The nature and characteristics of Indian solid waste differs in its nature, intensity and content very largely from other western countries. The composition of Indian solid waste & its nature is clearly given in the following table as:

Population Range (millions)	Number of cities under Observation	Waste Quantity (TPD)	Waste Generation Rate (kg/c/day)	Recyclable (%)	C/N Ratio	Moisture (%)	Compostable (%)	HCV (Kcal/Kg)
< 0.1	8	22.5 ± 23.1	0.4 ± 0.2	21.0 ± 4.9	26.2 ± 7.1	48.6 ± 12.7	51.7 ± 12.5	2161.0 ± 786.8
0.1 - 0.5	11	96.8 ± 65.2	0.4 ± 0.1	19.6 ± 6.6	26.4 ± 6.8	49.8 ± 11.9	51.2 ± 8.0	2162.3 ± 1079.9
0.5 - 1	16	328.1 ± 139.8	0.4 ± 0.2	16.2 ± 4.1	28.9 ± 10.7	47.7 ± 15.3	54.2 ± 9.0	1480.9 ± 560.2
1 - 2	11	480.8 ± 151.3	0.4 ± 0.1	17.2 ± 4.7	27.1 ± 11.4	40.7 ± 13.3	47.4 ± 4.7	1410.9 ± 711.9
2 - 3	6	859.7 ± 301.1	0.4 ± 0.1	13.8 ± 2.3	32.7 ± 9.0	47.0 ± 15.2	51.2 ± 6.8	1685.8 ± 754.9
3 - 10	5	2169.4 ± 705	0.5 ± 0.1	16.7 ± 5.2	30.3 ± 3.4	45.2 ± 8.3	47.8 ± 6.2	1866.0 ± 656.5
> 10	2	5621 ± 425.7	0.5 ± 0.1	16.1 ± 0.8	37.0 ± 2.9	51.5 ± 3.5	58.4 ± 5.7	1794.0 ± 11.3

Source: Gour, A.A. and Singh, S.K et.al., 2023

The composition of Indian solid waste would comprise of biodegradable organic fraction (51.3±8.3%), recyclables up to 17.48±5%, the ash content of 30-40%, paper about 3-6%, and inert such as glass, plastic, and metals up to 1-6% { Consolidated Annual Report (For the year 2016-2017) on Implementation of Solid Waste Management Rules, 2016}.

The solid waste management, process and intensive disposal methods followed in India is clearly given as a chart which is given below:



Source: Gour, A.A. and Singh, S.K et.al., 2023

The solid waste management practices have been more prevalent and strong all over India which is evident from the above charts. The ways and methods of solid waste collection, management and disposal methods have improved a lot in India and yet and still there is a intense need for lot more to be done on this.

As the collection across Indian states could be ensured as Maharashtra stands first in collection to the extent of 93%, segregation of this solid waste is a real time problem as there is a need to focus more on technological solutions and strategies which can do it most effectively. This has to become more functional and simplified which can be implemented across Indian urban and rural populations. Social awareness has to be created on effective management of solid waste management practices which can

improve the existing solid waste management scenario in India. Intense, innovative and extensive segregation solutions have to be found & implemented which is the need of this hour.

MAJOR FINDINGS OF THIS STUDY

1. Inorganic waste is generated more in high-income cities of India
2. Solid waste from low-income cities (Tier III cities) has high calorific waste content
3. It is also found in this study that the correlation between economic development & organic waste is negative as organic share reduces considerably
4. It is also evident that plastic wastage all over the country has increased sharply and to a greater extent which indicates increased consumerism in urban cities of India.
5. More than 50% of Indian cities fail to collect even 25% of the total solid waste generated in India
6. 17% of all the solid waste generated in the entire country remains uncollected which is pathetic & problematic
7. Mumbai, Delhi, and Hyderabad collected 90% of the waste and processed in the conventional traditional way only. Modern systems and practices are yet to be implemented as the challenges and problems in effective implementation need to be studied.
8. Challenges still persist in organizational structure and policies, resource allocation and effective management, strategic initiatives, and futuristic pathways & waste to energy conversion practices in the Indian context.
9. Lack of public awareness has had greater challenges in developing a holistic integrative, progressive pathway for the development of strategic sustainable solid waste management policy and implementation mechanism in the Indian context.
10. Open dumping has been the most common method that has been used and effectively implemented in the Indian context for solid waste management practices. But the need for a techno-oriented proactive sustainable futuristic strategy for solid waste management and effective implementation towards 2030 has to be provided which is the need of this hour.

SUSTAINABLE PROACTIVE STRATEGIES: 2030

1. The government has been reactive to the strong burn-through administration throughout some undefined time frame. Technology-oriented practices and effective disposal systems must emerge in the Indian context. There is a need to evaluate the futuristic solid waste as appropriate proactive strategies must be formulated
2. Civic awareness is the need of the hour which can lead to effective solutions for collection, segregation, and disposal
3. Events, contests, and programs can be conducted all over the country to foster new thinking and practices among the younger generation which can also be rewarded
4. Stakeholder engagement and commitment in solid waste management can help to reduce the formation of solid waste to a greater extent as it can be disposed of effectively also
5. An effective solid waste management plan has to be created with the involvement of all the people which can also enforce communal practices
6. Eco-friendly systems and practices have to be crafted, designed, and implemented which can create proactive sustainable solid waste management strategies for 2030

7. Holistic integrative commitment, involvement along consistent engagement of all can be the right directive toward sustainable solid waste management practices.
8. Resilience and adaptiveness have to be there at the local level which can contribute in the formulation of a global strategy for sustainable solid waste management strategy for 2030 which can ensure proactive practices.

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