

INTERNATIONAL JOURNAL FOR LEGAL RESEARCH AND ANALYSIS



Open Access, Refereed Journal Multi-Disciplinary
Peer Reviewed

www.ijlra.com

DISCLAIMER

No part of this publication may be reproduced or copied in any form by any means without prior written permission of Managing Editor of IJLRA. The views expressed in this publication are purely personal opinions of the authors and do not reflect the views of the Editorial Team of IJLRA.

Though every effort has been made to ensure that the information in Volume II Issue 7 is accurate and appropriately cited/referenced, neither the Editorial Board nor IJLRA shall be held liable or responsible in any manner whatsoever for any consequences for any action taken by anyone on the basis of information in the Journal.

Copyright © International Journal for Legal Research & Analysis

EDITORIAL TEAM

EDITORS

Dr. Samrat Datta

Dr. Samrat Datta Seedling School of Law and Governance, Jaipur National University, Jaipur. Dr. Samrat Datta is currently associated with Seedling School of Law and Governance, Jaipur National University, Jaipur. Dr. Datta has completed his graduation i.e., B.A.LL.B. from Law College Dehradun, Hemvati Nandan Bahuguna Garhwal University, Srinagar, Uttarakhand. He is an alumnus of KIIT University, Bhubaneswar where he pursued his post-graduation (LL.M.) in Criminal Law and subsequently completed his Ph.D. in Police Law and Information Technology from the Pacific Academy of Higher Education and Research University, Udaipur in 2020. His area of interest and research is Criminal and Police Law. Dr. Datta has a teaching experience of 7 years in various law schools across North India and has held administrative positions like Academic Coordinator, Centre Superintendent for Examinations, Deputy Controller of Examinations, Member of the Proctorial Board



Dr. Namita Jain



Head & Associate Professor

School of Law, JECRC University, Jaipur Ph.D. (Commercial Law) LL.M., UGC -NET Post Graduation Diploma in Taxation law and Practice, Bachelor of Commerce.

Teaching Experience: 12 years, AWARDS AND RECOGNITION of Dr. Namita Jain are - ICF Global Excellence Award 2020 in the category of educationalist by I Can Foundation, India. India Women Empowerment Award in the category of "Emerging Excellence in Academics by Prime Time & Utkrisht Bharat Foundation, New Delhi.(2020). Conferred in FL Book of Top 21 Record Holders in the category of education by Fashion Lifestyle Magazine, New Delhi. (2020). Certificate of Appreciation for organizing and managing the Professional Development Training Program on IPR in Collaboration with Trade Innovations Services, Jaipur on March 14th, 2019

Mrs.S.Kalpana

Assistant professor of Law

Mrs.S.Kalpana, presently Assistant professor of Law, VelTech Rangarajan Dr. Sagunthala R & D Institute of Science and Technology, Avadi. Formerly Assistant professor of Law, Vels University in the year 2019 to 2020, Worked as Guest Faculty, Chennai Dr.Ambedkar Law College, Pudupakkam. Published one book. Published 8 Articles in various reputed Law Journals. Conducted 1 Moot court competition and participated in nearly 80 National and International seminars and webinars conducted on various subjects of Law. Did ML in Criminal Law and Criminal Justice Administration. 10 paper presentations in various National and International seminars. Attended more than 10 FDP programs. Ph.D. in Law pursuing.



Avinash Kumar



Avinash Kumar has completed his Ph.D. in International Investment Law from the Dept. of Law & Governance, Central University of South Bihar. His research work is on "International Investment Agreement and State's right to regulate Foreign Investment." He qualified UGC-NET and has been selected for the prestigious ICSSR Doctoral Fellowship. He is an alumnus of the Faculty of Law, University of Delhi. Formerly he has been elected as Students Union President of Law Centre-1, University of Delhi. Moreover, he completed his LL.M. from the University of Delhi (2014-16), dissertation on "Cross-border Merger & Acquisition"; LL.B. from the University of Delhi (2011-14), and B.A. (Hons.) from Maharaja Agrasen College, University of Delhi. He has also obtained P.G. Diploma in IPR from the Indian Society of International Law, New Delhi. He has qualified UGC – NET examination and has been awarded ICSSR – Doctoral Fellowship. He has published six-plus articles and presented 9 plus papers in national and international seminars/conferences. He participated in several workshops on research methodology and teaching and learning.

ABOUT US

INTERNATIONAL JOURNAL FOR LEGAL RESEARCH & ANALYSIS
ISSN

2582-6433 is an Online Journal is Monthly, Peer Review, Academic Journal, Published online, that seeks to provide an interactive platform for the publication of Short Articles, Long Articles, Book Review, Case Comments, Research Papers, Essay in the field of Law & Multidisciplinary issue. Our aim is to upgrade the level of interaction and discourse about contemporary issues of law. We are eager to become a highly cited academic publication, through quality contributions from students, academics, professionals from the industry, the bar and the bench. INTERNATIONAL JOURNAL FOR LEGAL RESEARCH & ANALYSIS ISSN 2582-6433 welcomes contributions from all legal branches, as long as the work is original, unpublished and is in consonance with the submission guidelines.

UNRAVELING THE NEXUS: THE IMPACT OF WASTE MANAGEMENT ON CLIMATE CHANGE - AN EMPIRICAL STUDY

AUTHORED BY - MRS. BLESSIE AHINO J,
Assistant Professor of Law,
School of Excellence in Law, TNDALU.

CO-AUTHOR - S. RAMANA SUBRAMANIAN
Student, IV B.Com.,LL.B (Hons),
School of Excellence in Law, TNDALU.

ABSTRACT

Climate change is the significant increase in global average temperature over the last century. This is evident in the current times often manifested through changes in patterns of rainfall resulting in floods or draughts and extreme temperatures. When the need to address this issue is deliberated, the focal point always discussed is reducing carbon footprint. Lowering the amount of greenhouse gases such as carbon dioxide, methane, nitrous oxide or hydrofluorocarbons released into the atmosphere paves the way to heal and mitigate environmental degradation and its repercussions. Apart from industrial and vehicular emissions, a major contributor to carbon emissions is waste. Regulating and managing waste is an integral factor in ensuring a clean and healthy environment and pollution of the environment can be attributed in part to improper waste management. Waste management encompasses the tasks and procedures required to handle garbage from its creation to its disposal including domestic organic wastes and inorganic waste. This entails supervision and control in addition to garbage collection, transportation, processing, and removal. According to India's Solid Waste Management Rules of 2016, managing solid waste is a mandatory duty of civic local bodies and municipalities. With Chennai the capital of the state of Tamil Nadu ranking 199th among 446 cities surveyed under the Swachh Survekshan, the battle to improve waste management is still on the go. This paper will highlight the importance of domestic waste management and its significance in contributing to climate change by empirically analysing the implementation of waste management rules in Chennai city.

Keywords: Climate Change, Greenhouse Gases, Environment Protection, Solid Waste Management and Waste Management.

Intersection of Climate Change and Waste Management

Climate change refers to significant and lasting changes in the Earth's climate patterns over an extended period of time, typically decades to millions of years. The long-term, cumulative effects of variations in Earth's position to the Sun, according to Serbian scientist Milutin Milankovitch, are thought to be a major factor in determining Earth's long-term climate that initiates and terminates glacial eras (Ice Ages).¹ In particular, three different kinds of Earth orbital movements impact the amount and location of solar radiation, or insolation, that reaches the top of the planet's atmosphere. The shape of the Earth's orbit, the Earth's orbital plane and the direction of Earth's axis of rotation play a vital role in changing Earth's long-term climate change. This theory also known as the Milankovitch theory states that climate change is evident and will happen over a long period. However, these changes are accelerated by human activities, such as the burning of fossil fuels, deforestation, industrial processes, and agricultural practices, which release greenhouse gases such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) into the atmosphere. The accumulation of these greenhouse gases traps heat in the Earth's atmosphere, leading to a phenomenon known as the greenhouse effect. This results in a gradual increase in global temperatures, alterations in precipitation patterns, rising sea levels, more frequent and severe extreme weather events, shifts in ecosystems and habitats, and other environmental impacts.

With the rapid growth of industries and modern developments, man has hastened the impending climate change through the burning of fossil fuel, deforestation and industrial process. Although the burning of fossil fuel is seen as the most prominent contributor of greenhouse gases, emissions from landfills and waste treatment also play a major role in global warming. In fact it has been a silent contributor to global warming. Every year, 2.01 billion tonnes of municipal solid waste are produced worldwide. This is expected to grow to 3.40 billion by 2050. The amount of garbage produced daily per person worldwide varies greatly, ranging from 0.11 to 4.54 kg on average. The treatment and disposal of solid waste is projected to have produced 1.6 billion tonnes of carbon dioxide (CO₂) equivalent greenhouse gas emissions in 2016, or 5% of global emissions.² Global satellite data between January 2019 and June 2023 reveals 1,256 methane super-emitter incidents

¹ Buis, Alan. "Milankovitch (Orbital) Cycles and Their Role in Earth's Climate." *Climate Change: Vital Signs of the Planet*, NASA, nasa.gov Retrieved at : <https://climate.nasa.gov/news/2948/milankovitch-orbital-cycles-and-their-role-in-earths-climate/>

² "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2020." *Trends in Solid Waste Management*. World Bank, worldbank.org. Retrieved at: https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html

from landfills. Bangladesh, India, and Pakistan top the list of countries with the biggest breaches.³ According to scientists, as metropolitan populations increase, emissions from poorly managed landfills may quadruple by 2050, greatly increasing the likelihood of a catastrophic climate event for methane, often known as natural gas, is a crucial target for climate action because it traps 86 times more heat in the atmosphere over a 20-year period than carbon dioxide does.

India as a nation generates 160038.9 TPD of solid waste total, of which 152749.5 TPD is collected at a 95.4% collection efficiency, 79956.3 TPD (or 50%) is processed, and 29427.2 (18.4%) TPD is landfilled. Thirteen percent (31.7%) of the entire garbage created, or 50655.4 TPD, is still unaccounted for. Tamil Nadu generates 13422 TPD of the waste which is roughly 8.5% of the total waste generated. The solid waste generated per capita in India stands at 119.09 gms per day with increasing trends in solid waste management and decreasing trends in solid waste landfills. Tamil Nadu ranks eighth among the most state-wide solid waste generated.⁴ Greenhouse gases emissions is evident in various stages of municipal solid waste management. The collection, separation, treatment, transfer and disposal each in the various stage has some amount of emission of greenhouse gases. In addition to these instruments employed for management of wastes such as garbage cans, trucks used to transport waste, treatment plants and landfills all contribute to environment degradation.

Organic materials including food, paper, wood, and garden trimmings are found in waste. When rubbish is placed in a landfill, organic material starts to decompose because bacteria start eating the carbon in it. Methane-producing bacteria can be found in the microbial communities in landfills due to the anaerobic conditions that prevail there. Methane (about 50%), carbon dioxide (about 50%), and other gases are released when the bacteria break down organic matter over time. The act of burying waste and routinely covering deposits with a low-permeability substance in regulated landfills fosters the growth of methane-producing bacteria within the landfill.⁵ Emissions are produced by the slow decomposition of the carbon stock in a landfill even after waste discharge has stopped. This is due to the fact that only a small portion of the carbon

³ Carrington, Damian, and Sean Clarke. "Revealed: the 1,200 Big Methane Leaks from Waste Dumps Trashing the Planet." Greenhouse Gas Emissions. The Guardian Retrieved at:<https://www.theguardian.com/environment/2024/feb/12/revealed-the-1200-big-methane-leaks-from-waste-dumps-trashing-the-planet>

⁴ Annual Report 2020-21 on Implementation of Solid Waste Management Rules, 2016." Retrieved at:https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2020-21.pdf

⁵UNEP. "Waste and Climate Change – Global Trends and Strategy Framework." Retrieved at : <https://wedocs.unep.org/handle/20.500.11822/8648;jsessionid=F0B3E8CE38CE313ABA1BBD6FCE42D969>

contained in garbage is released in the year that it is disposed of, and chemical and biological reactions take time to complete. The majority is released progressively over many years predominantly being CO₂ and methane two major greenhouse gases. Numerous ecosystems throughout the world are still suffering from the widespread introduction of unsustainable, human-generated garbage into our environment.⁶ Poor or insufficient solid waste management system causes serious problems with the environment and public health at every level of the collection, handling, treatment, and disposal of waste.

Understanding Chennai's Environmental Footprint

6404 metric tons of municipal solid waste (MSW) are produced daily in Chennai. With 16667 persons per square kilometer, the city has a population density of 426 square kilometers. As of 2021, the population of Chennai is estimated to be 11235018. Chennai's daily average garbage production per person is 172 grams. Chennai generates 2337460 metric tons of Municipal Solid Waste (MSW) annually.⁷ Under the Chennai City Municipal Corporation Act, 1919, waste management falls under the purview of the corporation. The Solid Waste Management of the Greater Chennai Corporation headed by the Superintendent Engineer is vested with the responsibility of removing solid waste in Chennai. Every day around 6150 MT of garbage is collected from the city. Night conservancy is also being carried out in all bus route roads and Markets / commercial areas of the city. Door-to-door collection of garbage is done in all zones. The primary collection of waste is fully labour intensive. Conservancy operations takes place in two shifts from 6.30 AM to 1.30 PM and 9.00 PM to 2.00 AM based on the working schedule. The workers are provided with coco brooms, aluminium baskets, brushes, iron plates, containerized push carts, tricycles with bins and roto mold wheeled bins. Battery-operated vehicles are used to collect door-to-door source-separated waste from households; biodegradable waste is transferred to decentralized waste processing facilities, dry waste is sent to incinerators, and residual waste is sent to transfer stations or dump sites.⁸ Secondary collection is when the street collection and separated household wastes are transported from transfer stations to disposal site.

⁶ Downs, Austin, Richard Acevedo, and Kennedi Humble. "How Our Trash Impacts the Environment." Earth Day. Retrieved at: <https://www.earthday.org/how-our-trash-impacts-the-environment/>

⁷ Khalko, Salan. "Chennai: Municipal Solid Waste Management – Report." Last Updated: 16 Nov, 2022. Chennai: Municipal Solid Waste Management - Report. xbin.in. Retrieved at : https://xb.in/blog/488/Solid_Waste_Management_in_Chennai_Municipal_Corporation/

⁸Chennai Corporation. "Solid Waste Management." Greater Chennai Corporation. Retrieved at: <https://chennaicorporation.gov.in/gcc/departments/solid-waste-management/>

Garbage, junk (package materials), building and demolition wastes, leaf litter, hazardous wastes, etc. are among the wastes produced by a typical metropolitan society of which Household garbage, non-hazardous solid waste disposed of by commercial, industrial, and institutional establishments, market waste, yard debris, and street sweepings collected for disposal by municipal authorities are all considered to be part of municipal solid waste (MSW).⁹ Two solid waste disposal yards are kept up by the Corporation; one is located in the north at Kodungaiyur and the other in the south at Perungudi.¹⁰ The cities also hold processing centers to process construction and demolition wastes of seven zones of greater Chennai. The remaining construction and demolition wastes are used to cover layers of garbage in dumpsites. Door-to-door collection of wastes has been facilitated through battery-operated vehicles which has led to efficient door-to-door collection as well as a significant reduction in roadside bins. Source segregation is encouraged to decrease the amount of waste that is sent to landfills, prolonging their lifespan. In addition to being sold to the general public, the manure produced by ordinary compost plants, bio methanation plants, and other biodegradable waste processing facilities at the ward level is utilized for parks and green spaces in the GCC.

To manage Chennai's solid waste in a few areas of the city, the municipal corporation has worked with a number of private businesses, including Onyx, Neel Metal Farnalca (NMF), Ramk, Sume et Facilities Limited, and Urbaser SA.¹¹ Source-separated thin plastics are transported to cement mills as additional fuel after being balled. To move trash in a covered and compact manner, all open garbage collection lorries have been replaced with compactor vehicles. Utilizing BARC technology, five waste-to-energy facilities can process up to 8.80 MT of biodegradable garbage annually. The electricity produced is utilized to power high mast lights and street lights.

The results of the 2023 Swachh Survekshan, a cleanliness survey carried out as part of the Swachh Bharat (Urban) initiative that covers 446 cities, were recently made public by the Union Ministry of Housing and Urban Affairs (MoHUA).¹² The standards of cleanliness for public areas, business

⁹ Kandasamy, Selvi Permandy, and Paranjai Saranya. "Municipal Solid Waste Management at Chennai in Southern India – An Occupational Health Perspective." *International Journal of Health Promotion and Education*. Retrieved at: <https://www.researchgate.net/publication/256503715>

Municipal_Solid_Waste_Management_at_Chennai_in_Southern_India_-_an_occupational_health_perspective

¹⁰ Rangesh, J. "An Analysis on Solid Waste Management in Chennai." *International Journal of Engineering Technology Research and Management*, Vol. 06, Issue 01, Jan 2022. Retrieved at: <https://spiritofchennai.com/city/chennai-new-solid-waste/>

¹¹ Chennai Corporation. "Chennai Corporation's New Solid Waste Management Plan." spiritofchennai.com. Retrieved by at: <https://spiritofchennai.com/city/chennai-new-solid-waste/?amp=1>

¹² Ministry of Housing and Urban Affairs. "Swachh Survekshan 2023." [MyGov.in](https://www.mygov.in/mygov-survey/swachh-survekshan-2023/). Retrieved at: <https://www.mygov.in/mygov-survey/swachh-survekshan-2023/>

and residential buildings, parks, water features, waste management systems, and schools were all included in the evaluation. Tamil Nadu has no cities included among the top 100 clean cities. With a nationwide rating of 112, Trichy was deemed the cleanest city in the State, whereas Chennai received a middling value of 199 overall and a rank of 5 inside the State. Additionally, the city was deemed ODF++ (Open Defecation Free), demonstrating that appropriate sewage management and restroom facilities are in place. The survey's findings also confirmed that 79% of solid waste in Chennai is separated at the source. Chennai's house-to-house collection rates are between 80 and 100 percent, based on the 2023 TNPCB Annual Report on the execution of solid waste management guidelines. The city has 2,121,466 houses total, and 1,866,890 households are served by the service.

Legal Dimensions of Waste Management

Waste management in India is regulated by national and state laws in India. The Ministry of Environment, Forests, and Climate Change (MoEF) oversees waste management, collaborating with State Pollution Control Boards established in respective States. The Environmental Protection Act 1986, is the primary legislation on waste management. The Act prohibits emission or discharge of environment pollutants beyond the limits prescribed under it. The Polluter Pays Principle is enshrined in section 9 of the Act of 1986 vesting the responsibility on the polluter to make amends to the pollution caused. The solid waste management is regulated by specific rules based on the nature of solid waste. [Solid Waste Management Rules, 2016](#), [Plastic Waste Management Rules, 2016](#), [E-waste \(Management\) Rules, 2016](#), [Bio-Medical Waste Management Rules, 2016](#), [Hazardous and Other Wastes \(Management and Transboundary Movement\) Rules, 2016](#) and [Construction and Demolition Waste Management Rules, 2016](#) are the central rules under the Act to regulate solid waste management.¹³ Each Urban Local Body has its own set of laws pertaining to governance, development planning, assessment, and taxation. The waste management system's setup, operationalization, coordination, and safe collection, storage, segregation, transportation, processing, and disposal of plastic waste have been placed under the purview of the local authorities.

The Chennai Corporation Solid Waste Management Bye-law 2019 encompasses various provisions aimed at regulating the collection, segregation, transportation, processing, and disposal

¹³ Ministry of Environment, Forest and Climate Change. "Waste Management." The Official Website of Ministry of Environment, Forest and Climate Change, Government of India. moef.gov.in. Retrieved at: <https://moef.gov.in/moef/service/environment/waste-management/index.html>

of solid waste within the city limits. One of the fundamental aspects of this legislation is the emphasis on source segregation, wherein households, institutions, and commercial establishments are mandated to segregate waste at its point of generation into categories such as biodegradable, non-biodegradable, and sanitary waste. Furthermore, the bye-law outlines guidelines for the establishment and operation of solid waste management facilities, including transfer stations, material recovery facilities, and sanitary landfills. It also delineates the responsibilities of different stakeholders, including residents, waste generators, and the civic authorities, in ensuring effective waste management practices.

The implementation of the Chennai Corporation Solid Waste Management Bye-law 2019 holds immense significance for several reasons. Firstly, it addresses the pressing issue of environmental degradation caused by improper waste disposal. By promoting source segregation and efficient waste management practices, the bye-law aims to minimize the adverse impacts of solid waste on soil, water bodies, and air quality, thus safeguarding public health and ecological balance. Moreover, the bye-law aligns with broader sustainability goals by emphasizing the importance of resource conservation and recycling. Through the establishment of material recovery facilities and promotion of composting and recycling initiatives, the legislation seeks to reduce the burden on landfills and conserve valuable natural resources. Furthermore, the bye-law fosters community participation and awareness by encouraging citizens to actively engage in waste management processes. By sensitizing residents about the importance of segregation, recycling, and responsible waste disposal, the legislation aims to foster a culture of environmental stewardship and civic responsibility.

DATA ANALYSIS AND ANALYSIS

H01: Prioritization of waste segregation impacts climatic change

Table 1 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.318 ^a	.101	.082	1.055

a. Predictors: (Constant), waste management practices significantly impact climate change, current waste management strategies address climate change

It appears that the r square value of 0.101 has no significant impact on the waste management

practices and strategies related to waste segmentation. This is because the prioritization given to waste segmentation is not influenced by the prevention, minimization, and collection of waste management efforts. In essence, even though the r square value may not be ideal, it does not affect the implementation or effectiveness of waste management practices regarding waste segmentation.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.035	2	6.017	5.405	.006 ^b
	Residual	106.874	96	1.113		
	Total	118.909	98			
a. Dependent Variable: prioritize waste segregation						
b. Predictors: (Constant), waste management practices significantly impact climate change, current waste management strategies address climate change						

Based on the analysis of variance (ANOVA) table, it has been found that waste management practices and strategies play a crucial role in influencing climate change through the segregation of waste. The growing amount of waste and the lack of adequate funds for programs and policies have made it challenging to effectively manage waste and mitigate its impact on the environment.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.773	.508		5.453	.000
	Current waste management strategies address climate change	-.007	.129	-.005	-.054	.957
	Waste management practices significantly impact climate change	.323	.099	.319	3.273	.001
a. Dependent Variable: prioritize waste segregation						

The impact of waste management strategies on climate change on waste segregation is not statistically significant. However, the waste management practices have been shown to have a statistically significant impact on the waste segmentation. It is crucial to implement effective waste management measures to ensure the protection of human health and the preservation of natural resources. The implementation of best practices can lead to a reduction in the volume of waste that ends up in landfills, thus reducing the stress on the environment and improving the quality of life for everyone.

HO2: To analyze the services of a municipal corporation with the disposal of waste in the climate change

Based on the findings presented in Table 4, it can be inferred that waste disposal, recycling processes, waste collection services, and transportation of waste from other areas do not significantly affect the gender perspective towards climate change. This is due to the general awareness of the harmful effects of pollution on the environment and human health. However, it is observed that individuals are not willing to aid the government in controlling and mitigating the risks associated with waste management, as their primary concern is focused on ensuring their health and safety.

The correlation between waste collection schedules and the improvement of collection services with gender is statistically significant. This is because the timing of waste collection has a direct impact on traffic, pollution, disease spread, and accidents. As an essential part of waste management, the optimization of waste collection schedules can lead to a reduction in traffic congestion, pollution, and accidents. Therefore, it is crucial to conduct further research on gender-specific waste management practices to implement effective waste collection strategies that cater to the needs of all genders.

Table 4 Independent T-test

		T	df	Sig. (2-tailed)
Separate recyclable materials from non-recyclables before disposal	Equal variances assumed	-.583	97	.561
	Equal variances not assumed	-.615	94.057	.540
Accepted for recycling	Equal variances assumed	.417	97	.678

	Equal variances not assumed	.397	67.881	.693
Waste collection services provided	Equal variances assumed	-.477	97	.634
	Equal variances not assumed	-.475	80.381	.636
Waste collection schedules and guidelines	Equal variances assumed	-2.659	97	.009
	Equal variances not assumed	-2.523	67.208	.014
Addressing complaints related to waste collection services	Equal variances assumed	-.507	97	.613
	Equal variances not assumed	-.510	83.002	.611
Improvements in waste collection services	Equal variances assumed	-2.160	97	.033
	Equal variances not assumed	-2.032	64.971	.046
Corporation's role in the transport of waste	Equal variances assumed	1.321	97	.190
	Equal variances not assumed	1.286	73.924	.203

HO3: To examine the disposal of waste items and guidelines and penalties of municipal corporation

According to the analysis presented in Table 5, the impact of waste disposal and pickup on the services provided by the municipal corporation to the gender is not significant. The public, however, exhibits a greater concern towards waste disposal near their homes as compared to how corporations dispose of the waste. This suggests that the municipal corporation should focus on waste management strategies that prioritize the removal of waste from residential areas in a timely and effective manner. Such an approach is likely to be more effective in satisfying public expectations and enhancing the quality of services provided by the corporation.

Table 5 Independent T-test

		t	df	Sig. (2-tailed)
Waste separation and disposal	Equal variances assumed	.669	97	.505
	Equal variances not assumed	.672	82.495	.504

Disposing of hazardous waste items; such as batteries or electronics	Equal variances assumed	-1.152	97	.252
	Equal variances not assumed	-1.120	73.595	.266
Official guidelines or resources provided by your local municipality	Equal variances assumed	-.375	97	.708
	Equal variances not assumed	-.366	74.167	.716
Fines or penalties for improper waste disposal practices	Equal variances assumed	-3.082	97	.003
	Equal variances not assumed	-2.705	50.338	.009
Missed waste collection pickups by the municipal corporation in the past year	Equal variances assumed	-.642	97	.522
	Equal variances not assumed	-.615	69.654	.541
Door-to-door collection of waste	Equal variances assumed	2.630	97	.010
	Equal variances not assumed	2.523	70.052	.014

Improper waste disposal can have serious consequences including fines and door-to-door collection. Interestingly, these penalties can be strongly influenced by gender because the fines often affect income. For example, if a fine is issued to someone who earns a lower income, it may have a greater impact on their financial stability compared to someone who earns a higher income. This can create an uneven playing field and further exacerbate existing gender inequalities.

SUGGESTIONS

A number of the Sustainable Development Goals of the United Nations, including achieving clean water and sanitation, inclusive and sustainable cities and communities, reducing climate change and showcasing sustainable patterns of consumption and production can be met with the support of sustainable solid waste management.¹⁴ The city has definitely upgraded from waste being carelessly dumped on roads, lawns, and bodies of water as a result of inadequate solid waste management. The city has notably developed and has been executing an integrated solid waste management strategy in all phases of solid waste management, including generation, separation, transportation, transfer/sorting, treatment, and disposal.

¹⁴ Rimi, Ismaila. "Environmental Sustainability Impacts of Solid Waste Management Practices in the Global South." *International Journal of Environmental Research and Public Health*, vol. 19, no. 19, Oct 2022. PMC. Retrieved at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9566108/>

Promoting Public Awareness and Education

For a more efficient implementation by the Corporation there is a need to encourage favourable public perceptions of sustainable waste management. Individuals have to be sensitised to stop littering and to adopt good garbage dropping and sorting procedures, public awareness programs using print, electronic, and social media are therefore necessary. As many people believe, waste management is a shared obligation rather than the exclusive domain of local government.¹⁵The creation of waste is not the end of a person's duty.

Although people are anxious to get their waste out of their houses, as long as it is not in their backyard, they don't care where it ends up. But until the garbage is disposed of properly and safely, nobody is freed from the responsibility of the waste they produce. Sorting has been given a primary role in the best waste management strategy this study suggests to facilitate resource and energy recovery as well as make waste processing, treatment, and disposal easier. It is also necessary to pay special attention to the provision of sorting bins and public knowledge regarding waste sorting at the source. Similarly, recycling is a simple and practical way to reduce greenhouse gas emissions and mitigate the effects of climate change.¹⁶ According to Project Drawdown, recycling would cut carbon dioxide emissions by 5.5 to 6.02 gigatons between 2020 and 2050, which is the same as removing nearly a billion cars off the road for a year. Encourage home composting will also minimise environmental effects.

Strengthening Regulatory Framework

The Chennai Corporation Solid Waste Management Bye-law 2019 represents a significant step towards addressing the multifaceted challenges of solid waste management in urban areas. By promoting source segregation, resource conservation, and community participation, the legislation lays the foundation for a more sustainable and resilient city. However, its successful implementation hinges on effective enforcement mechanisms, stakeholder engagement, and collaborative efforts towards achieving the common goal of a cleaner and greener Chennai. There is a need to impose strict environmental regulations and better oversee of civic responsibilities for

¹⁵ Nnaji, Chidozie Charles, and Terlumun Utsev. "Climate Change and Waste Management: A Balanced Assessment." *Journal of Sustainable Development in Africa*, vol. 13, no. 7, 2011, ISSN: 1520-5509. Retrieved at: <https://jsdafrica.com/Jsda/Vol13No7Winter2011A/PDF/Climate%20Change%20and%20Waste%20Management.Chidozie%20Nnaji.pdf>

¹⁶ Robinson, Celeste, and Kate Huun. "The Impact of Recycling on Climate Change." Environmental Center, University of Colorado Boulder. Retrieved at: <https://www.colorado.edu/center/2023/12/15/impact-recycling-climate-change>

sustainable waste storage, collection, and disposal, as well as the health risks associated with solid waste management. Furthermore, in order to deter unsustainable behaviour, waste generators must be penalised for unsustainable waste disposal. Furthermore, waste collection services are yet to cover a certain geographic area of significance.

Enhancing Stakeholder Engagement

There is a need to include multiple stakeholders this strategy to be successful, and it must take into account the technological, institutional, legal, economical, and environmental factors for a most inclusive and efficient functioning of the strategy. With concerted efforts from the civic authorities, community organizations, and other relevant stakeholders, these challenges can be overcome. Capacity-building initiatives, public awareness campaigns, and partnerships with the private sector can play a pivotal role in augmenting the implementation of the bye-law and fostering a culture of sustainable waste management. Community-based and non-governmental groups can support the promotion of material reuse/recycling, trash reduction, and separation and sorting at the source.

Invest in Infrastructure and Technology

Chennai seems to be going through a transitional period as a result of numerous infrastructure initiatives such as bio-mining at perungudi, bio CNG plants and compost plants at various locations are proposed to address various civic problems.¹⁷ A well-executed plan might yield results in future. The current facilities must be upgraded to more eco-friendly technology. Open dumpsites and landfills affect human habitation and animal habitat. Anaerobic biodegradable waste decomposition and composting methods currently adopted for waste treatment do not effectively address greenhouse gas emissions.¹⁸ The harmful environmental effects of these conventional methods are yet to be scientifically explored in India. Waste management by the municipality is labour intensive and financing for upgradation of the technology would be much applauded.

¹⁷ Venugopal, Varsha. "Lukewarm scores for Chennai in Swachh Survekshan 2023: How can the city improve?" Citizen Matters. Retrieved at: <https://citizenmatters.in/chennai-swachh-survekshan-2023-boost-rankings-gcc-waste-management-cleanliness-drive-43904>

¹⁸ Rimi, I. (2022). Environmental Sustainability Impacts of Solid Waste Management Practices in the Global South. International Library of Information. Retrieved from PMC (nih.gov) <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9566108/>

Collaborative Global Efforts:

Given the global nature of climate change, addressing improper waste management requires collaborative efforts on a global scale. All nations must work together to establish sustainable waste management practices that benefit both current and future generations. By sharing knowledge, resources, and best practices, countries can collectively mitigate the negative impacts of waste on the environment and public health, ensuring a more sustainable future for all.

CONCLUSION

India is grappling with a myriad of environmental challenges arising from waste generation and inadequate waste collection, transport, treatment, and disposal mechanisms. The country's existing waste management systems are struggling to adapt to the burgeoning volumes of waste being generated by an ever-increasing urban population, leading to severe environmental degradation and public health concerns. The lack of effective waste management policies and infrastructure in India is causing significant harm to the environment and public health, and if immediate action is not taken, India will continue to suffer from poor waste management practices and their associated impacts on public health and the environment.

The study revealed that individuals possess knowledge of waste management strategies and policies, as well as an understanding of the impact of climate change. However, due to personal lifestyles and mindsets, people tend to prioritize their own lives and that of their families over the welfare of society. To tackle the challenges of waste management and maintain a clean city, a shift in mindset is necessary, whereby individuals cooperate with the government in minimizing non-recyclable waste production. In this regard, people are willing to segregate waste and assist workers in their disposal services. The corporation's waste management services can schedule waste disposal without disrupting the people's daily routines. Proper waste management practices have the potential to mitigate the adverse effects of climate change and benefit future generations. To conclude ensuring compliance and enforcement of laws, particularly among diverse stakeholders with varying levels of awareness and resources coupled with adequate infrastructure, human resources, and technological interventions will help Chennai in being the top sustainable and environmentally resilient city in India.