Prepublished copy

Nature Environment & Pollution Technology

This is a peer-reviewed prepublished version of the paper

Waste in Flux: Temporal and Seasonal Shifts in Mysuru & Tiruchirappalli

***Kavya P. Siddeshwar**[1], **Rajeev Joseph D**[2], **Prashanthi Devi M**[1], **Shivaraju H.P**[3]

[1]Department of Environmental Science and Management, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India

[2]Biomining Westart Communications India Pvt.Lt, Ekkattuthangal, Chennai, Tamil Nadu, India

[3]Department of Water and Health, JSS Academy of Higher Education and Research, Mysore, Karnataka, India

Corresponding author: **spkavya1@gmail.com**

Abstract

Efficient management of municipal solid waste is essential to fostering sustainable urban growth, especially in rapidly urbanizing countries such as India. This study conducts a comparative analysis of waste collection patterns in Mysuru and Tiruchirappalli, two significant major cities in India. The study specifically examines temporal shifts and seasonal variations. A study of daily waste collection data over six years indicates apparent differences among the cities. Mysuru has a greater average daily waste collection of 481.82 tons compared to Tiruchirappalli's 445.68 tons. A two-sample t-test assuming unequal variances indicates that this difference is statistically significant with a p-value of 0.0423. However, a more thorough analysis of seasonal patterns uncovers significant deviations. Mysuru exhibits elevated waste generation during the dry summer and wet winter seasons, whereas Tiruchirappalli encounters a surge in waste generation during the wet summer and wet winter periods. The seasonal variations highlight the impact of climate-related factors and consumption habits on waste generation. This study offers valuable insights into the intricacies of urban waste management in India, highlighting the importance of customized strategies that consider both temporal and seasonal fluctuations to improve the sustainability and resilience of waste management systems in rapidly developing urban areas.

Key Words	Temporal Analysis, Seasonal Variations, Mysuru, Tiruchirappalli, Comparative Study
DOI	https://doi.org/10.46488/NEPT.2025.v24i03.B4266 (DOI will be active only after the final publication of the paper)
Citation of the Paper	Kavya P. Siddeshwar, Rajeev Joseph D, Prashanthi Devi M, Shivaraju H.P, 2025. Waste in Flux: Temporal and Seasonal Shifts in Mysuru & Tiruchirappalli. *Nature Environment and Pollution Technology*, 24(3), B4266. https://doi.org/10.46488/NEPT.2025.v24i03.B4266

Introduction

Effective waste management is a critical concern with substantial implications for public health and environmental sustainability. Inadequate methods, such as uncontrolled waste burning and improper landfill management, can contaminate air, water, and soil, posing significant health risks, especially in urban areas where waste accumulation is more pronounced (Mangoro & Kubanza, 2023; Oluwagbayide et al., 2024; Titto & Savino, 2024). The decomposition of waste also emits greenhouse gases that contribute to climate change, worsening global health and environmental issues (Somani, 2023). In developing nations, these challenges are intensified by insufficient resources, infrastructure, and public awareness, resulting in unsustainable practices like unregulated disposal and burning (Mahajan, 2023).

Current trends in municipal waste management reflect increasing complexity driven by urbanization and environmental concerns. There is a noticeable shift toward sustainable practices like recycling, composting, and waste-to-energy conversion. In India, rapid urbanization and population growth have led to innovative strategies such as decentralized waste management systems focusing on energy conversion, composting, and recycling. Initiatives like the "Swachh Bharat Abhiyan" have raised public awareness and improved sanitation infrastructure, promoting recycling and circular economy practices (Maalouf & Agamuthu, 2023; Gupta et al., 2024).

The COVID-19 pandemic has underscored the need for flexible waste management systems. Increased use of personal protective equipment (PPE) and changing consumer habits have significantly raised household waste levels. Medical waste generation surged dramatically during the pandemic, with increases ranging from 18% to 425%. For instance, Wuhan experienced a five-fold increase at its peak. Globally, daily medical waste escalated from 200 tons in February 2020 to over 29,000 tons by September 2020, straining existing storage and disposal systems (Liang et al., 2021; Richter et al., 2021). Waste composition shifted significantly during this period, with more packaging and food waste becoming prevalent. Many countries introduced new treatment policies for medical and municipal solid waste (MSW). For example, Poland saw a 6.7 percentage point rise in selective waste collection along with a 0.7-million-ton increase in recycled waste in 2020. However, the pandemic also posed challenges for policies aimed at reducing plastic use and enhancing recycling efforts (Chen et al., 2021; Urbańska et al., 2023).

Seasonal fluctuations further impact waste generation in India. Research indicates that yard and agricultural waste generation peaks during harvest seasons in February and March (Agrawal et al., 2013). A study on MSW in Guwahati revealed significant seasonal variation in organic waste and plastics; organic waste constituted 42.2% and plastics 25.2% of MSW with variations ranging from 22% to 49% across different seasons (Singhal et al., 2022). Tourism exacerbates waste management issues in regions where infrastructure is strained by increased visitor numbers. In heritage sites like the Old City of Semarang in Indonesia, mismanaged waste detracts from historical value (Muqsit et al., 2024). The hotel industry faces challenges in adapting operations to minimize waste, with staff training identified as crucial (Diaz-Farina et al., 2023). Food waste from tourism activities presents substantial challenges that can be addressed through circular bio-economy principles (Mejjad et al., 2023). Regions like Chamundi Hills in Karnataka struggle with difficult terrain and overwhelming tourist numbers during peak seasons (Ghosh et al., 2020). Deposit refund schemes could encourage responsible waste disposal among tourists (Shella et al., 2024).

Active community participation is vital for the sustainability of waste management systems. In Batam City, Indonesia, effective management relies on dynamic governance and community empowerment through stakeholder collaboration (Salsabila et al., 2024). In Bangladesh, youth-led initiatives demonstrate potential for engaging younger community members while addressing gender-related challenges (Ahmed et al., 2024). Decentralized community-led solutions enable effective handling of waste even in space-limited areas (Ambastha & Aich, 2019). However, challenges persist due to insufficient knowledge among households about segregation and recycling practices—particularly in India (Minhas, 2017; Singh & Ghosh, 2023; Arunkumar et al., 2024).

In developed countries, the focus of waste management is primarily on incorporating circular economy principles to minimize resource depletion while fostering economic benefits like innovation and job creation. Waste-to-energy methods such as incineration are frequently utilized to manage waste sustainably (Alao et al., 2022). However, developing nations face challenges implementing these technologies due to inadequate logistics and financial resources. Learning from successful practices in wealthier countries could enable quicker adoption of sustainable methods (Mochammad, 2024). The Swachh Bharat Mission (SBM) has spurred technological advancements aimed at enhancing urban waste management in India by promoting sustainable practices and community involvement (Anand & Devi, 2023). Smart segregation bins and mobile applications have been introduced, yet high costs and the need for public awareness remain barriers (Lonare, 2023; Sridevi et al., 2023).

The success of SBM relies on ongoing innovation, efficient policy execution, and engaged community participation. Mysuru (Mysore) and Tiruchirappalli (Trichy) serve as significant cities in Southern India, each with unique strategies for handling municipal solid waste, influenced by their historical, cultural, and socio-economic backgrounds. Both cities have received recognition for their endeavours in upholding cleanliness and sustainability, but they have distinct challenges that are influenced by factors such as rising populations, urbanization, and seasonal fluctuations. The objective of this study is to provide a thorough comparative analysis of waste collection trends in the cities of Mysuru and Tiruchirappalli. The study aims to comprehend the underlying causes that influence the patterns in waste collection in both cities by analysing the variances throughout different seasons. The results will provide a more comprehensive comprehension of the shift of waste collection dynamics over time and the possible influence of seasonal variations on urban waste management practices in Mysuru and Tiruchirappalli.

Study Area

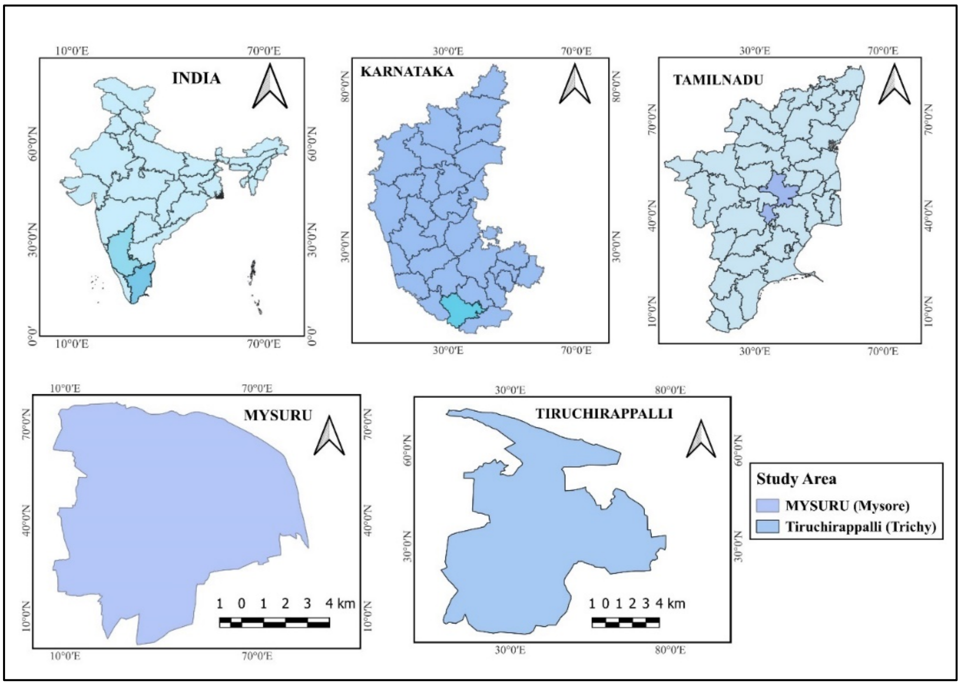


Figure 1: Study area location map _ Mysuru-Karnataka & Trichy-Tamil Nadu, India

Mysore, popularly referred to as Mysuru, is the second most densely populated city in Karnataka. It is situated at a latitude of 12° 18′ 26″ N and a longitude of 76° 38′ 59″ E. The city covers a total area of 156 km^2, including both the city itself and the surrounding census towns. It now has a population of roughly 1.26 million. Mysore is renowned for its abundant cultural heritage, earning it the titles of "City of Palaces" and "Cultural Capital of Karnataka." As part of the Swachh Survekshan movement, this city in India is known for its exceptional cleanliness and dedicated efforts in maintaining sanitation. Mysore, situated at the base of Chamundi Hills, is a popular destination for travellers, particularly during the annual Dasara celebration. The city serves as a nexus for exploring nearby tourist attractions and has been a focal point of urban growth within the state. Mysore is acknowledged for its proactive waste management strategies, encompassing explicit zero-waste objectives, robust municipal governance, and engaged citizen involvement in waste segregation initiatives. The decentralized waste management system comprises various material recovery facilities (Dry Waste Collection Centres operating in numerous wards), composting units, and a door-to-door collection system, all of which facilitate effective waste processing and advance the city's goal of achieving a zero-waste future.

Tiruchirappalli, often known as Trichy, is a significant II-tier city in Tamil Nadu and functions as the administrative centre of Tiruchirappalli district. The city is located at a latitude of 10°47′25″ N and a longitude of 78°42′17″ E. It covers a total area of 167.23 square kilometres. Trichy, with a present population of over 1.2 million, ranks as the fourth-largest city and urban agglomeration in the state. Renowned for being the cleanest city in Tamil Nadu, it has also been ranked among the most liveable cities in India. Trichy is renowned for its rich historical background and cultural importance. It is host to numerous notable structures, one of which is the famed Rockfort Temple. The city functions as a vital center for regional trade and education, asserting its importance as a prominent hub in Tamil Nadu. The city's governance strategy has predominantly emphasized infrastructure development, including the biomining of old dumpsites; nevertheless, the execution of waste management policies, especially in waste segregation, has been less consistent compared to Mysore. With only one major landfill, Trichy faces challenges related to centralized disposal methods, leading to inefficiencies in waste collection, especially during peak waste generation periods.

Mysore and Trichy generate waste from multiple sources, including residential, businesses, tourist activities, and industrial areas. Mysore sees seasonal waste increases due to tourism, especially during the summer season and Dasara festival. In contrast, Trichy generates significant amounts of household, commercial, and industrial waste, largely due to its substantial industrial activities and educational institutions. The varied sources of waste in both urban areas offer a comprehensive dataset for examining waste management strategies under differing city pressures. The selection of Mysore and Trichy for this study is motivated by their contrasting urban characteristics. The tourism-driven waste generation in Mysore contrasts with the industrial and educational waste profile of Trichy, facilitating a comparative analysis of how diverse sources influence waste management requirements. Moreover, the Swachh Bharat Mission rankings for both cities have shown a downward trend, emphasizing the importance of this study in assessing current waste management methods and the demand for modernization. The need for a temporal and seasonal waste analysis, which is central to this study, is further emphasized by the seasonal fluctuations in Mysuru's tourism and Trichy's industrial activities.

Methodology

The present study utilized waste collection data gathered from the Mysore City Corporation (MCC) and the Tiruchirappalli City Corporation (TCC) to examine waste management practices in Mysuru and Trichy from 2018 to 2023. Data was collected monthly, specifically showing the average amount of waste collected every day in each month. The monthly averages served as a reliable indicator of waste collection patterns. These figures were then utilized to compute annual averages for each city, facilitating a comparison of waste collection trends across time. To comprehend the overall variations between the two cities, the year averages of waste collection were analysed using descriptive statistical analysis and a two-sample t-test, assuming unequal variances. This approach was utilized to examine whether there were statistically significant variations in waste collection between Mysuru and Trichy.

Furthermore, a waste collection difference analysis was conducted to look further into the discrepancies between the cities throughout the six years span. The collection of waste data was analysed seasonally by dividing it into four distinct categories: dry summer (March, April, May), wet summer (June, July, August), wet winter (September, October, November), and dry winter (December, January, February). By segregating the data, it was possible to conduct a thorough analysis of how seasonal changes affect waste collection patterns in both cities. This analysis offers valuable insights into how climatic circumstances can impact waste management operations. To go beyond historical patterns, a predictive model was generated using waste collection data from 2018 to 2023. The model provides a seven-year forecast for waste collection in both cities, covering the years 2024 to 2030. The findings section presents the forecasting results, including expected waste collection figures, with a forecasting table.

Results and Discussion

Table 1: Descriptive statistics for Daily Average Waste Collection in tons in Mysuru and Tiruchirappalli (2018 – 2023)

	Mysuru	Tiruchirappalli
Valid	6	6
Median	479.71	443.00
Mean	481.82	445.68
Std. Deviation	34.71	30.57
Coefficient of variation	0.072	0.069
Variance	1205.04	934.88
Range	89.30	81.50
Minimum	436.28	410.06
Maximum	525.58	491.56

The descriptive statistics show that the average waste collection in Mysuru and Trichy is comparable with Mysuru consistently collecting more waste than Trichy, with an average daily collection of Mysuru Mean of 481.828 tons compared to Trichy's mean of 445.69 tons. However, Mysuru exhibits a considerably higher level of variation in its daily collection of waste, as evidenced by a larger standard deviation (34.71) and coefficient of variation (7.2%) in comparison to Trichy (Std. Dev = 30.57, CV = 6.9%). This indicates that Mysuru is more susceptible to variations in waste generation. In general, these statistics indicate that Mysuru faces challenges with higher and more variable waste collection, while Trichy's waste collection shows a constant performance.

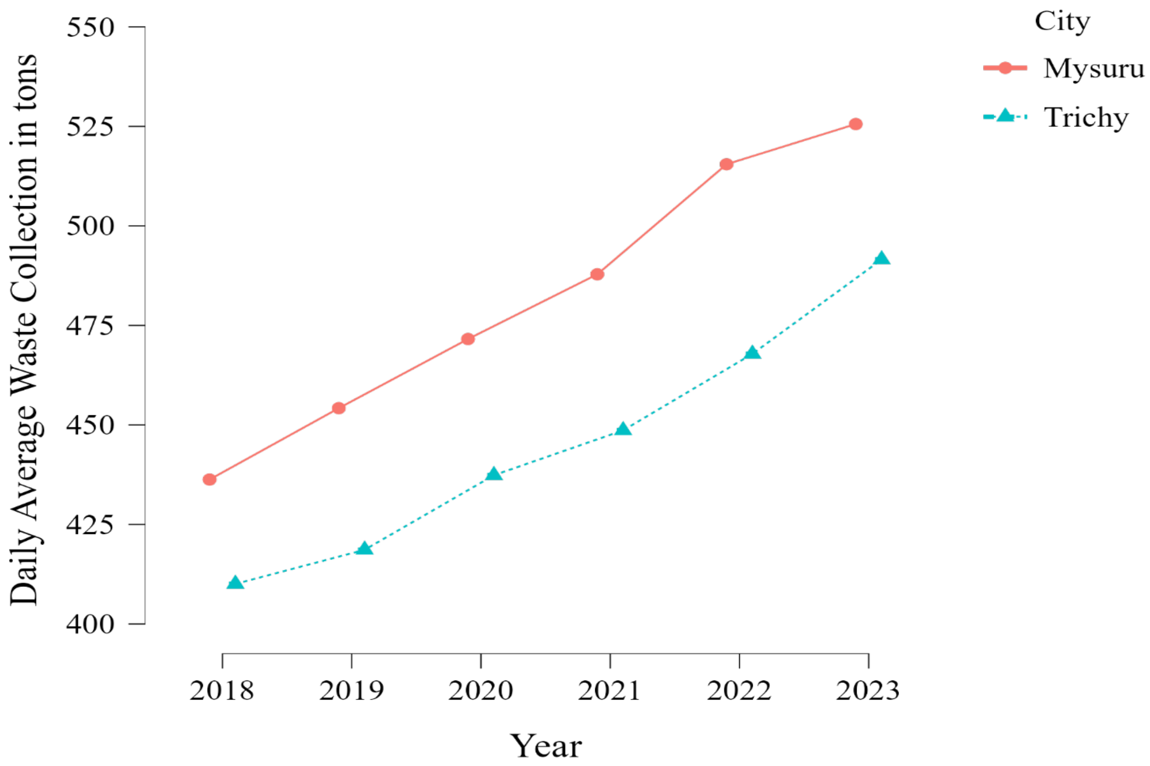


Figure 2: Temporal Comparison of Average Daily Waste Collection in Mysuru and Trichy (2018-2023)

The daily average waste collection trends for Mysuru and Trichy from 2018 to 2023, as depicted in (figure 2), reveal noteworthy patterns. While both cities generally experienced an upward trend in waste generation over the six-years, the COVID-19 pandemic led to a temporary dip in waste collection in 2020. This decline likely reflects the reduced economic activity and an altered consumption patterns during the lockdowns. However, as societal activities resumed, waste generation rebounded, with both cities recording notable increases in daily waste collection from 2022 onwards. Mysuru's daily average collection rose from 436.28 tons in 2018 to 525.58 tons in 2023, while Trichy's increased from 410.06 tons to 491.56 tons during the same period. These trends underscore the dynamic nature of waste generation and the need for adaptable and resilient waste management strategies effectively address long-term growth and unforeseen disruptions.

Table 2: Comparison of Average Daily Waste Collection: Mysore vs. Trichy

	Mysuru	**Trichy**
Mean	481.82	445.68
Variance	1205.07	934.78
Observations	6	6
df	10	
t Stat	1.913	
P(T<=t) one-tail	0.0423	

P(T<=t) two-tail	0.0846	

Although Mysore and Trichy share many urban characteristics, a two-sample t-test assuming unequal variances was conducted to explore a potential difference in average waste collection (Mysore: M = 481.83; Trichy: M = 445.68). A one-tailed test, based on the premise that even minor differences in city size and development stage might impact waste generation, revealed a statistically significant difference, t = 1.914, p = .042. This suggests that despite their similarities, Mysore's waste management system handles a significantly larger volume. However, it is essential to acknowledge that a two-tailed test would not have reached the conventional significance level (p = .085). These findings highlight the complex interplay of factors influencing municipal waste generation, suggesting that city size alone may not fully explain variations in waste collection even among seemingly comparable urban environments.

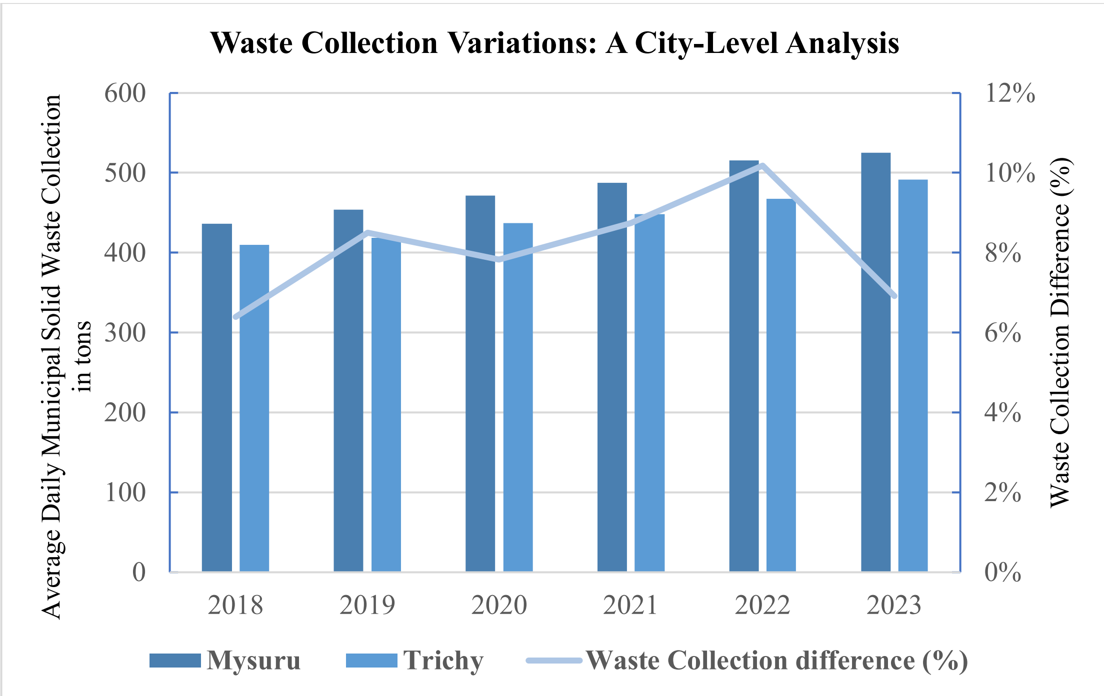
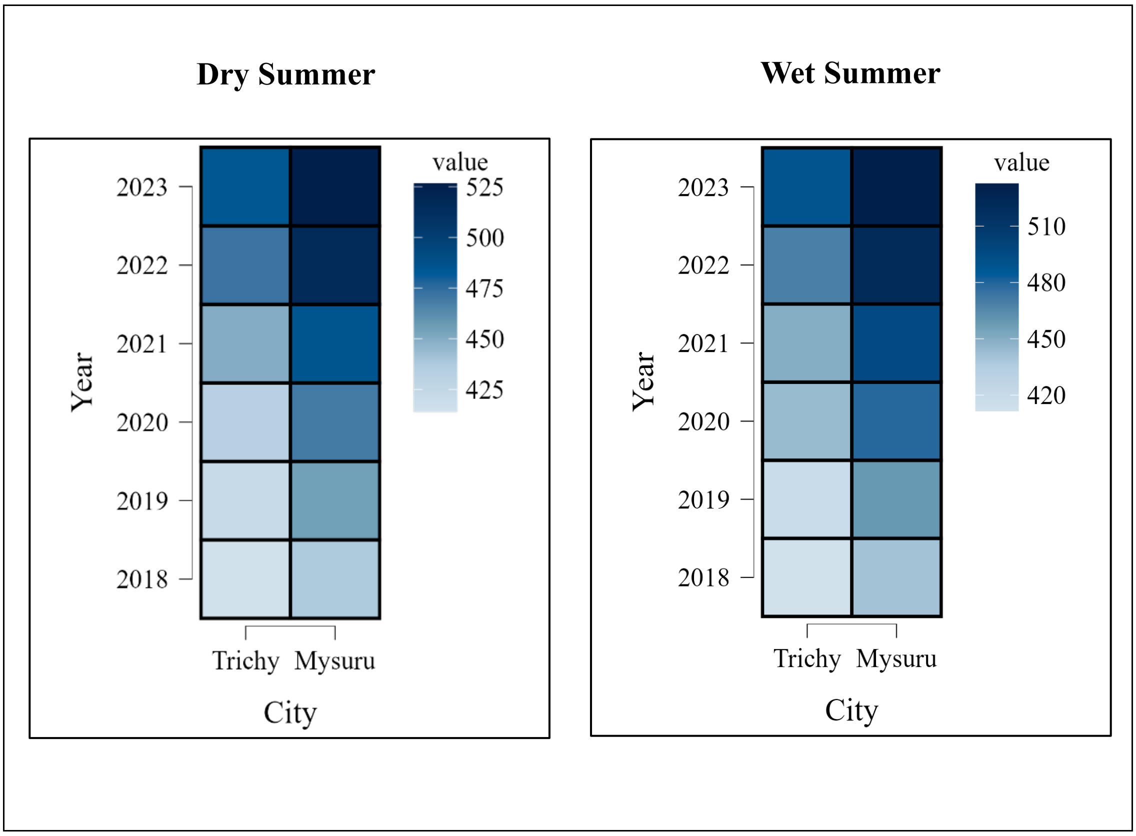


Figure 3: Trends in Waste Collection: Mysuru vs. Trichy (2018 - 2023)

The percentage difference in waste collection between Mysuru and Trichy from 2018 to 2023 reveals a dynamic trend shaped by factors beyond population size alone (figure 3). Mysuru consistently demonstrated higher waste collection rates throughout the observed period, maintaining a relatively stable difference between 6.39% and 8.74% in the pre-pandemic years. However, the onset of the COVID-19 pandemic (2020-2021) led to a narrowing of this gap, likely reflecting the impact of pandemic-related restrictions on economic activity and waste collection practices in both cities. Despite this temporary convergence, the difference widened again, peaking at 10.18% in 2022. This post-pandemic divergence, exceeding pre-pandemic levels, suggests a more rapid rebound or shift in the factors driving waste collection in Mysore compared to Trichy. The observed fluctuations underscore the complex interplay of economic, social, and behavioural factors that influence municipal waste management, particularly during periods of significant disruption.

The 2023 Swachh Survekshan report outlines noteworthy variations between Mysuru and Tiruchirappalli's waste management policies. Mysuru achieved a national ranking of 23rd due to its impressive performance in several waste management aspects. It achieved a door-to-door collection rate of 97%, a source segregation rate of 70%, and a waste processing rate of 94%. Mysuru's Zero Waste Management concept has been highly effective underpinned by effective governance and community involvement which focuses on raising awareness and enforcing segregation norms among residents. However, Tiruchirappalli, holding the top position in Tamil Nadu, ranks 112th nationwide. It exhibits a better level of segregation at 89%, but falls behind in processing at 76%. The findings indicate that Mysuru's resource recovery approach is robust, but its efforts in segregating waste need enhancement. On the other hand, Tiruchirappalli's emphasis on waste segregation is hindered by inadequate processing infrastructure even with a higher segregation rate, the city's reliance on centralized waste disposal methods and insufficient processing facilities leads to inefficiencies in handling segregated waste. Both cities can benefit from exchanging best practices with each other to achieve a more equitable waste management system.



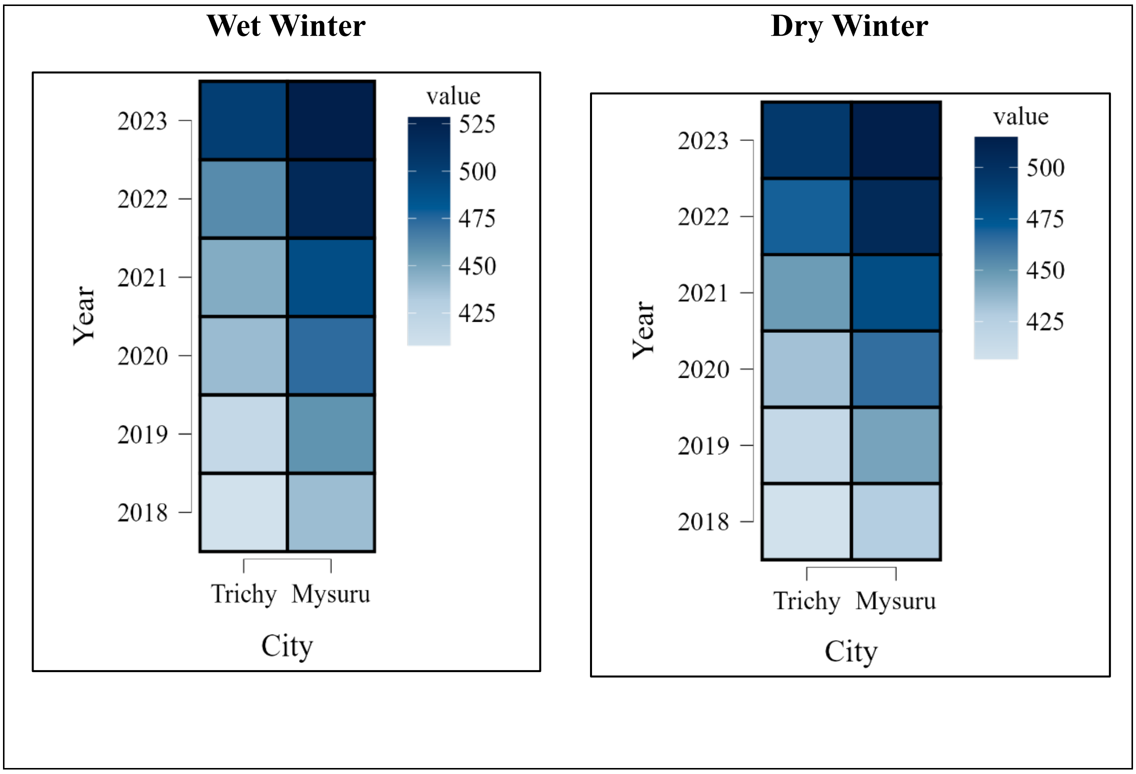


Figure 4: Comparing Waste Seasonality: A Heatmap Analysis of Mysuru and Trichy (2018-2023)

Both Mysuru and Trichy exhibit cyclical waste generation patterns as shown in (figure 4). While waste generation patterns likely fluctuate, analysis of waste collection in Mysuru and Trichy reveals cyclical trends, influenced by seasonal factors, local events, and external factors such as severe weather events, policy changes, and even global events like the recent pandemic. Seasonal variations significantly impacted waste collection in both Mysuru and Trichy, with higher waste generation typically observed during the dry summer (March, April & May) and wet winter (September, October & November) months. Both cities experienced lower waste collection during the dry winter (December to February), reflecting reduced consumption patterns.

- **Dry Summer (March, April, May):** Mysuru consistently shows higher waste collection during the Dry Summer months, with a significant rise from 437.77 tons in 2018 to 526.60 tons in 2023. Trichy follows a similar pattern but with lower volumes, starting at 413.93 tons in 2018 and increasing to 484.12 tons in 2023. This increase can be attributed to higher consumption during the summer holidays and more outdoor activities leading to more waste generation.
- **Wet Summer (June, July, August):** In the Wet Summer, Mysuru sees a steady increase in waste collection, from 440.77 tons in 2018 to 532.58 tons in 2023. Trichy also experiences growth, with waste collection rising from 411.60 tons in 2018 to 488.82 tons in 2023. Despite both cities experiencing rainfall, the waste collection during this season is relatively high, possibly due to less severe monsoon impacts and continued urban activity.

- **Wet Winter (September, October, November):** During the Wet Winter, Trichy's waste collection is notably influenced by the northeast monsoon, which brings heavy rainfall. This season sees a substantial increase in waste collection, starting at 407.94 tons in 2018 and reaching 500.43 tons in 2023. Mysuru experiences a significant increase in waste generation during the Dasara festival, driven by heightened tourist activity and large-scale events. However, the city manages to efficiently collect this additional waste through highly effective strategies. These include increased collection frequency, deployment of dedicated waste management teams, and targeted public awareness campaigns promoting responsible waste disposal, ensuring that waste collection keeps pace with the surge in waste generation during this period. While the volume of organic waste likely remains substantial, this period sees a higher proportion of recyclable materials, such as plastic bottles, food packaging, and paper products, used and discarded during the festival. This shift suggests a greater awareness and emphasis on recycling practices during such large-scale events. This concerted effort likely contributes to a more manageable waste stream despite the increased activity.
- **Dry Winter (December, January, February):** The Dry Winter season shows a similar trend in both cities, with waste collection steadily rising. Mysuru's collection increased from 427.33 tons in 2018 to 514.70 tons in 2023, while Trichy's collection grew from 406.77 tons in 2018 to 492.87 tons in 2023. This season typically involves year-end celebrations and New Year festivities, contributing to the higher waste collection during these months.
- The COVID-19 pandemic, particularly during 2020 and 2021, brought about a unique set of circumstances. While the generation of certain waste types, particularly single-used items, likely increased due to heightened hygiene concerns, the pandemic significantly disrupted waste collection services. This disruption is evident in the noticeably lower waste collection rates during those years. The Dry Summer months, coinciding with peak COVID-19 restrictions and lockdowns, witnessed a pronounced decline in waste collection. Additionally, the Dry Winter months also saw significantly reduced waste collection, reflecting the sustained impact of restricted urban activity and limitations on gatherings and tourism. This period reflected a combination of reduced economic activity, limitations on movement, and potential disruptions in waste management services, ultimately leading to lower overall waste collection compared to pre-pandemic and post-pandemic years. The pandemic years caused a slight dip in both cities, which quickly reversed as activities normalized in 2022, with waste collection exceeding pre-pandemic levels by 2023 highlighting the resumption of urban life.

Table 3: Projected Municipal Solid Waste Collection in Mysuru (2024-2030)

Future Trends in Mysuru's Waste Collection (2024-2030)					
		80% CI		**95% CI**	
Year	**Daily Average Waste Collection in tons (t)**	**Lower**	**Upper**	**Lower**	**Upper**
2024	543.44	535.36	551.51	531.08	555.79
2025	561.30	549.87	572.72	543.83	578.76

2026	579.16	565.17	593.14	557.76	600.55
2027	597.02	580.86	613.17	572.31	621.72
2028	614.88	596.82	632.93	587.26	642.49
2029	632.74	612.95	652.52	602.48	662.99
2030	650.60	629.23	671.96	617.92	683.27

A steady rise in Mysuru's daily average waste collection, increasing from approximately 543 tons in 2024 to 651 tons in 2030, a substantial 20% increase. The projections, presented with both 80% and 95% confidence intervals, demonstrate a high degree of certainty in this upward trend. For example, in 2030, there is a 95% probability that the daily average waste collection will fall between 618 and 683 tons. This projected surge in waste generation presents a significant challenge, particularly with the ongoing transition demand to Greater Mysore City Corporation, which will incorporate semi-urban and rural areas in near future, further straining existing waste management systems. This (table 3) forecasts show an increase in Mysuru's daily average waste collection, demanding a proactive approach to accommodate the anticipated increase and ensure equitable and inclusive waste management services across the expanded jurisdiction of Greater Mysore City Corporation.

Table 4: Projected Municipal Solid Waste Collection in Trichy (2024-2030)

Future Trends in Trichy's Waste Collection (2024-2030)					
		80% CI		**95% CI**	
Year	**Daily Average Waste Collection in tons**	**Lower**	**Upper**	**Lower**	**Upper**
2024	507.86	499.90	515.81	495.69	520.02
2025	524.16	512.90	535.41	506.95	541.36
2026	540.46	526.67	554.24	519.38	561.53
2027	556.76	540.84	572.67	532.42	581.09
2028	573.06	555.26	590.85	545.85	600.27
2029	589.36	569.87	608.85	559.55	619.16
2030	605.66	584.60	626.71	573.46	637.85

A forecast of Trichy's daily average waste collection (table 4), projecting a consistent upward trend from approximately 508 tons in 2024 to 606 tons in 2030, representing a notable increase of about 19%. The projections are provided with both 80% and 95% confidence intervals, indicating a high level of certainty in this growth trajectory. For instance, in 2030, there is a 95% probability that the daily average waste collection will fall between 573 and 638 tons. This projected growth in Trichy's daily waste collection underscores the escalating demands on the city's waste management system. The consistent upward trend, reaching an anticipated 606 tons per day by 2030, necessitates a forward-looking approach to infrastructure development and waste management strategies to effectively handle this projected increase and avert potential challenges soon.

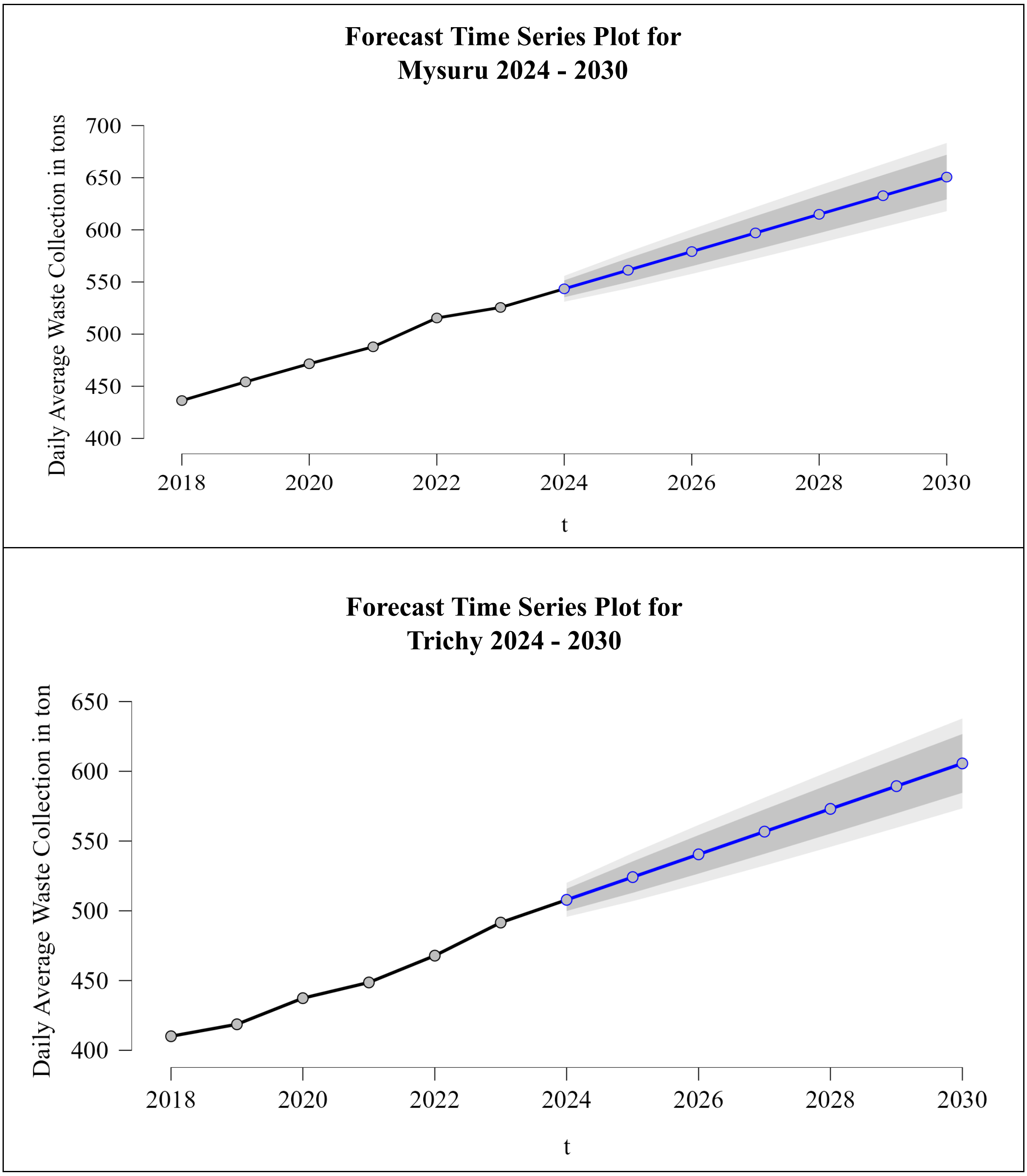


Figure 5: Projecting Municipal Solid Waste Collection: A Comparative Forecast for Mysuru and Trichy (2024-2030)

Autoregressive Integrated Moving Average models were employed to analyse historical daily waste collection patterns and forecast future trends in Mysuru and Trichy as shown in (figure 5). In both cities, ARIMA models effectively captured the observed upward trends. In Mysuru, the model revealed a statistically significant ($p = 0.002$) positive drift coefficient of 17.86 tons per year (95% CI: 10.87 - 24.86 tons), suggesting an average annual increase of 17.86 tons. Similarly, the model for Trichy identified a statistically significant ($p = 0.003$) positive drift coefficient of 16.30 tons per year (95% CI: 9.41 - 23.19 tons), indicating an average annual increase of approximately 16.30 tons in daily waste collection. Forecasts from both models, extending to 2030, project a continuation of these upward trends, underscoring the need for proactive waste management strategies in both cities. This study faced a challenge due to the absence of official government population statistics following the 2011 census. Nevertheless, to maintain accuracy in forecasting waste collection patterns for Mysuru and Trichy, the study relied on up-to-date population projections from credible sources like macro trends and world population review. These updated population data established a robust basis for employing the ARIMA model to predict future waste collection trends in both the urban areas. Although the ARIMA model effectively captures historical waste collection patterns, it mainly relies on past data and fails to consider potential external influences that could impact future waste collection practices. In the absence of official government population projections, the study employed reliable independent estimations to provide supported predictions. The results indicate an increasing need for effective waste collection systems as populations expand, especially considering the transition from Mysore city corporation to the Greater Mysore City Corporation and the rising urbanization in Trichy.

Forecasts for the average daily waste collection in Mysuru and Tiruchirappalli between 2024 to 2030 indicate substantial growth, highlighting the need for flexible waste management approaches to meet increasing requirements. Mysuru's decision-makers should explore the adoption of cutting-edge waste classification technologies, including optical sorting mechanisms and artificial intelligence-based waste recognition systems, to enhance source segregation and minimize contamination in recyclables. Furthermore, establishing anaerobic digestion plants could transform organic waste into biogas for energy production, thereby lessening the reliance on landfills. While Tiruchirappalli's focus on waste segregation is praiseworthy, the city could enhance its waste management capabilities by increasing its processing capacity. This could be achieved through the implementation of decentralized waste processing units at the community level. Such systems would reduce transportation expenses and improve local waste management effectiveness. Additionally, the city could benefit from the installation of smart waste containers equipped with sensors. These advanced bins would enable real-time monitoring of waste levels, allowing for the optimization of collection routes and schedules, thereby boosting operational efficiency. Furthermore, both cities should launch educational programs to raise awareness among residents about the importance of sorting waste and using proper disposal techniques. These municipalities can foster a collective sense of responsibility and encourage community participation in waste management efforts by collaborating with local organizations, including community groups, NGOs, and educational institutions. Additionally, conducting routine policy reviews and data-driven analyses will ensure adaptability in responding to changing waste trends, allowing Mysuru and Tiruchirappalli to effectively address their waste-related challenges.

Conclusion

This study provides a comprehensive analysis of waste collection patterns in Mysuru and Tiruchirappalli between 2018 and 2023, focusing on the disparities in their waste management systems and the challenges faced by both cities. Although the cities share commonalities in urbanization and socio-economic aspects, they have implemented different strategies to handle the increasing amount of waste influenced by the differing infrastructure and operational efficiencies of each city. Although Mysuru effectively manage its daily waste collection with its current infrastructure, the variations in waste collection metrics suggest the necessity for more scalable and flexible waste management solutions. Trichy demonstrated a consistency in waste management, although operating with relatively fewer resources. This indicates that the effectiveness of waste management is not entirely determined by the size of the infrastructure, but rather by how efficiently available resources are utilized and managed.

An important factor to consider is the decrease in the national rankings of both Mysuru and Trichy in the SBM. Despite this decline, both cities have upheld their leading position within their respective states, highlighting their unwavering dedication to cleanliness. Nevertheless, this decrease emphasizes the necessity for ongoing innovation and enhancement in their waste management systems. Waste management is a dynamic process that requires cities to adapt technological advancements. Adhering to obsolete methods will restrict the capacity to fulfil growing demands and environmental standards. A crucial insight from this study is that just increasing the capacity of landfills is not a viable answer to the issues of managing urban waste sustainably. Instead, communities should prioritize the optimization of the longevity of current infrastructure by implementing new methods that reclaim materials and reduce the amount of waste disposed. Mysuru can consider adopting modern waste processing systems to decrease its reliance on landfills and recover valuable materials from waste. These approaches decrease the amount of waste simultaneously adhering to global sustainability requirements by reducing environmental degradation.

On the other hand, strategies that promote waste reduction at the source, such as waste segregation, recycling, and composting, have been effectively implemented in Mysuru and offer pathways that can be adapted in other urban centres like Trichy. By focusing on reducing waste generation at the source, cities can complement their operational strategies and ensure long-term sustainability in waste management. The success of waste management systems is significantly influenced by political will and governance. The efforts to process and reclaim waste resources in Mysuru have encountered obstacles such as political intervention, delays in decision-making, and administrative challenges. The scalability of waste management systems in Trichy might be hindered by governance concerns. To effectively adopt advanced waste reduction and resource recovery approaches, it is crucial to have consistent governmental and public backing. Collaborative governance, policy reforms, and community participation are essential for maintaining long-term resilience in managing continuously growing urban waste generation. Both Mysuru and Trichy, by refining and adapting their waste management approaches, can serve as examples of how urban areas can navigate these complex challenges with a forward-thinking and sustainable approach. This study's findings underscore the temporal and seasonal fluctuations in waste collection, demonstrating their impact on waste management in Mysuru and Tiruchirappalli. Moreover, these findings can be utilized in other rapidly urbanizing cities in India and similar developing countries confronting waste management issues. By knowing the local contexts of waste generation and collection, policymakers and urban planners can develop sustainable strategies that successfully meet regional requirements and improve overall waste management efficiency.

Acknowledgement

Gratitude is extended to the authorities of the Mysuru City Corporation (MCC) and Tiruchirappalli City Corporation (TCC) for providing the crucial waste collection data spanning from 2018 to 2023. The corresponding author (IF170901) gratefully acknowledges the financial support from the DST-Inspire scheme, Government of India, which made this research possible.

References

Agrawal, A., Pandey, R., & Agrawal, M. L. (2013). Seasonal variation in composition and characteristics of indian municipal solid waste–A case study. *Recent Research in Science and Technology*, *5*(5).

Ahmed, N., Khuda, A., Chowdhury, S.J., Rezwana, T., Islam, M.S.U. and Sajjad, S., 2024. Youth-Driven, Community-Engaged Waste Management. *The Journal of Community Informatics*, *20*(1). https://doi.org/10.15353/joci.v20i1.5289

Aibar-Guzmán, B., Monteiro, S., David, F. and Somohano-Rodríguez, F.M., 2023. The Waste Hierarchy at the Business Level: An International Outlook. *Mathematics*, *11*(22), p.4574. https://doi.org/10.3390/math11224574

Aiguobarueghian, I., Adanma, U.M., Ogunbiyi, E.O. and Solomon, N.O., 2024. Waste management and circular economy: A review of sustainable practices and economic benefits. *World Journal of Advanced Research and Reviews*, *22*(2), pp.1708-1719. https://doi.org/10.30574/wjarr.2024.22.2.1517

Al Muqsit, F., Setiadi, R. and Lo, A., 2024. Waste Management in Heritage Tourism Area: Perspectives from Visitors and Waste Management Operators. *The Journal of Indonesia Sustainable Development Planning*, *5*(1), pp.15-26. https://doi.org/10.46456/jisdep.v5i1.524

Alabdraba, W.M., & AL-Qaraghully, H.A., 2013. Composition of Domestic Solid Waste and the Determination of its Density & Moisture Content: a Case Study for Tikrit City, Iraq. International Review of Chemical Engineering (IRECHE). https://www.researchgate.net/publication/261357543

Alao, M.A., Popoola, O.M., & Ayodele, T.R. (2022). Waste-to-energy nexus: An overview of technologies and implementation for sustainable development. *Cleaner Energy Systems*. https://doi.org/10.1016/j.cles.2022.100034

Ambastha, R., & Aich, S., 2019. Decentralized Community-Led Solid Waste Management. *Sustainable Waste Management: Policies and Case Studies*. https://doi.org/10.1007/978-981-13-7071-7_7

Anand, S.A. and Devi, S., 2023. Towards Sustainable Urban Solid Waste Management: A Comparative Analysis and Recommendations for India's Swachh Bharat Mission 2.0. *UTTAR PRADESH JOURNAL OF ZOOLOGY*, *44*(23), pp.295-301. https://doi.org/10.56557/upjoz/2023/v44i233790

Arunkumar, K., Nagaveni, S.J. and Suresh, K., 2024. Domestic Solid Waste Management-A Public Health Case Report and Review of Municipal Challenges in India!. https://doi.org/10.21203/rs.3.rs-4007464/v1

Butler, D.H., Dunseth, Z.C., Tepper, Y., Erickson-Gini, T., Bar-Oz, G. and Shahack-Gross, R., 2020. Byzantine—Early Islamic resource management detected through micro-geoarchaeological investigations of trash mounds (Negev, Israel). *PLoS One*, *15*(10), p.e0239227. https://doi.org/10.1371/journal.pone.0239227

Chauhan, R., Kaul, V. and Maheshwari, N., 2022. Indian indigenous knowledge system: Sustainable approach toward waste management. In *Emerging Trends to Approaching Zero Waste* (pp. 37-57). Elsevier. https://doi.org/10.1016/B978-0-323-85403-0.00002-5

Chen, C., Chen, J., Fang, R., Ye, F., Yang, Z., Wang, Z., Shi, F., & Tan, W. (2021). What medical waste management system may cope With COVID-19 pandemic: Lessons from Wuhan. *Resources, Conservation, and Recycling*, *170*(6509), 105600. https://doi.org/10.1016/j.resconrec.2021.105600

de Titto, E. and Savino, A., 2024. Human Health Impact of Municipal Solid Waste Mismanagement: A Review. *Advances in Environmental and Engineering Research*, *5*(2), pp.1-37. 10.21926/aeer.2402014

Debnath, B., Ghosh, A., Kumar, M., Shariff, A., Manoj Kumar, B. and Ghosh, S.K., 2020. Waste management challenges due to tourism in hilly areas in india: A case study of Chamundi Hills, Mysore. In *Sustainable Waste Management: Policies and Case Studies: 7th IconSWM—ISWMAW 2017, Volume 1* (pp. 309-320). Springer Singapore. https://doi.org/10.1007/978-981-13-7071-7_28

Diaz-Farina, E., Díaz-Hernández, J.J. and Padrón-Fumero, N., 2023. Analysis of hospitality waste generation: Impacts of services and mitigation strategies. *Annals of Tourism Research Empirical Insights*, *4*(1), p.100083. https://doi.org/10.1016/j.annale.2022.100083

Edjabou, M.E., Boldrin, A., & Astrup, T.F., 2018. Compositional analysis of seasonal variation in Danish residual household waste. *Resources Conservation and Recycling, 130*, 70-79. https://doi.org/10.1016/j.resconrec.2017.11.013

Fardin, H.F., Hollé, A., Gautier, E. and Haury, J., 2013. Wastewater management techniques from ancient civilizations to modern ages: examples from South Asia. *Water Science and Technology: Water Supply*, *13*(3), pp.719-726. https://doi.org/10.2166/ws.2013.066

JASP Team (2024). JASP (Version 0.19.0), https://jasp-stats.org/

Lonare, M.H. (2023). Implementation of Smart Segregation Bins Using IoT. *International Journal for Research in Applied Science and Engineering Technology*.

Maalouf, A. and Agamuthu, P., 2023. Waste management evolution in the last five decades in developing countries–A review. *Waste Management & Research*, *41*(9), pp.1420-1434. https://doi.org/10.1177/0734242X231160099

Mahajan, R., 2023. Environment and Health Impact of Solid Waste Management in Developing Countries: A Review. *Curr. World Environ*, *18*, pp.18-29. http://dx.doi.org/10.12944/CWE.18.1.3

Mangoro, N. and Kubanza, N.S., 2023. Community perceptions on the impacts of solid waste management on human health and the environment in sub-saharan African Cities: a study of diepsloot, Johannesburg, South Africa. *Development Southern Africa*, *40*(6), pp.1214-1233. https://doi.org/10.1080/0376835X.2023.2219698

Mejjad, N., Moustakim, M. and El Aouidi, S., 2023, October. Tourism-Related Food Waste: Opportunities and Challenges. In *Biology and Life Sciences Forum* (Vol. 26, No. 1, p. 4). MDPI. https://doi.org/10.3390/Foods2023-15080

Minhas, J. (2017). Solid waste management-Community perception, attitude and participation. *Asian Journal of Research in Social Sciences and Humanities, 7*, 121.

Mochammad, F.H., 2024. Bridging the Gap: Tailoring Waste Management Strategies for Sustainable Outcomes in Developing Countries. *Golden Ratio of Mapping Idea and Literature Format*, *4*(1), pp.33-52. https://doi.org/10.52970/grmilf.v4i1.344

Mysuru and Trichy population data - https://worldpopulationreview.com/cities/india/mysore and https://www.macrotrends.net/global-metrics/cities/21343/mysore/population

Oke, A.E., Aliu, J., Odia, O.A., Aigbavboa, C.O., Jamir Singh, P.S., Awuzie, B.O., & Samsurijan, M.S. (2023). A quantitative assessment of key drivers for environmental economic practices adoption for sustainable development. *Sustainable Development*.

Olawade, D.B., Wada, O.Z., Ore, O.T., David-Olawade, A.C., Esan, D.T., Egbewole, B.I. and Ling, J., 2023. Trends of solid waste generation during COVID-19 pandemic: A review. *Waste Management Bulletin*. https://doi.org/10.1016/j.wmb.2023.10.002

Oluwagbayide, S.D., Abulude, F.O., Akinnusotu, A. and Arifalo, K.M., 2024. The Relationship between Waste Management Practices and Human Health: New Perspective and Consequences. *Indonesian Journal of Innovation and Applied Sciences (IJIAS)*, *4*(1), pp.19-34. https://doi.org/10.47540/ijias.v4i1.1080

Perkumienė, D., Atalay, A., Safaa, L. and Grigienė, J., 2023. Sustainable waste management for clean and safe environments in the recreation and tourism sector: a case study of Lithuania, Turkey and Morocco. *Recycling*, *8*(4), p.56. https://doi.org/10.3390/recycling8040056

Rane A, A.K., Mae C, F.A., Jenelle I, N.J., Micheal E, N.J., & Louis G, L.B. (2024). Community-driven Waste Management Initiatives: Exploring Barangay Strategies for Cleaner and Greener Noveleta. *International Journal of Advanced Multidisciplinary Research and Studies*.

Ratnasari, S., Mizuno, K., Herdiansyah, H. and Simanjutak, E.G., 2023. Enhancing Sustainability Development for Waste Management through National–Local Policy Dynamics. *Sustainability*, *15*(8), p.6560. https://doi.org/10.3390/su15086560

Richter, A., Ng, K. T. W., Vu, H. L., & Kabir, G. (2021). Identification of behaviour patterns in waste collection and disposal during the first wave of COVID-19 in Regina, Saskatchewan, Canada. *Journal of Environmental Management*, *290*(16), 112663. https://doi.org/10.1016/j.jenvman.2021.112663

Sabol, G., Kiš, D. and Kalambura, S., 2022. Analysis of trends and challenges of a worldwide solid waste management with emphasis on Covid-19 pandemic-a review. *Tehnički vjesnik*, *29*(5), pp.1782-1787. https://doi.org/10.17559/TV-20220216083522

Saifi, N. and Jha, B., 2024. An Overview of Solid Waste Management Practices in Pune, Maharashtra, India. Nature Environment & Pollution Technology, 23(2). https://doi.org/10.46488/NEPT.2024.v23i02.027

Sajeev Krishna, R., Sridevi, S., Shyam, K., Tamilselvan, T., Ajay Rajan, R., Deisy, C. (2023). An Intelligent Smart Waste Management System Using Mobile Application and IoT. In: Sisodia, D.S., Garg, L., Pachori, R.B., Tanveer, M. (eds) Machine Intelligence Techniques for Data Analysis and Signal Processing. Lecture Notes in Electrical Engineering, vol 997. Springer, Singapore. https://doi.org/10.1007/978-981-99-0085-5_55

Salsabila, L., Ariany, R. and Koeswara, H., 2024. Fostering Community-Led Waste Management Through Dynamic Governance: A Case Study of Batam City. *Jurnal Bina Praja*, *16*(1), pp.187-200. https://doi.org/10.21787/jbp.16.2024.187-200

Sekhar Chakraborty, K., Bestel, S., Lucas, M., Roberts, P., Shirvalkar, P., Rawat, Y., Larsen, T. and Miller, H.M.L., 2023. To waste or not to waste: a multi-proxy analysis of human-waste interaction and rural waste management in Indus Era Gujarat. doi:10.1007/s12520-024-02046-w

Sengar, D.S., & Sharma Vyas, R. (2022). ENVIRONMENTAL VALUES IN HARAPPAN CIVILIZATION. *International Journal of Research -GRANTHAALAYAH*.

Shella, A.F., Ekayani, M. and Sapanli, K., 2024. Tourist-Based Waste Management with Deposit Refund Implementation in Manggar Beach Area, Balikpapan Indonesia. *Journal La Lifesci*, *5*(3), pp.234-243. https://doi.org/10.37899/journallalifesci.v5i3.1395

Singh, K., Kumari, V., Kumar, R. and Gupta, A., 2024. Recent Trends and Strategies in Waste Management: A Comprehensive Analysis of India's Waste Scenario. In *Integrated Waste Management: A Sustainable Approach from Waste to Wealth* (pp. 13-35). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-97-0823-9_2

Singh, S. and Ghosh, R., 2023. Garbage Disposal: A Study on the Awareness and Behaviour Regarding Waste Segregation. *MediaSpace: DME Media Journal of Communication*, *4*(02), pp.6-10. https://doi.org/10.53361/dmejc.v4i02.02

Singhal, A., Gupta, A. K., Dubey, B., & Ghangrekar, M. M. (2022). Seasonal characterization of municipal solid waste for selecting feasible waste treatment technology for Guwahati city, India. *Journal of the Air & Waste Management Association*, *72*(2), 147-160. https://doi.org/10.1080/10962247.2021.1980450

Sliusar, N., Polygalov, S., Ilinykh, G., Korotaev, V., Vaisman, Y.I., & Stanisavljević, N.S., 2020. Seasonal Changes in the Composition and Thermal Properties of Municipal Solid Waste: A Case Study of the City of Perm, Russia. *Environmental Research, Engineering and Management, 76*, 54-64. https://doi.org/10.5755/j01.erem.76.2.22919

Somani, P., 2023. Health Impacts of Poor Solid Waste Management in the 21st Century. 10.5772/intechopen.1002812

Swachh Survekshan 2023 Urban report card, https://ss2023.sbmurban.org/#/scorecard

Urbańska, W., Słowikowski, M., Janda, A., & Osial, M. (2023). Sustainable Municipal Waste Management during the COVID-19 Pandemic—A Case Study of Poland. *Resources*, *12*(7), 76. https://doi.org/10.3390/resources12070076

Zia, A., Batool, S.A., Chauhdry, M.N. and Munir, S., 2017. Influence of income level and seasons on quantity and composition of municipal solid waste: A case study of the capital city of Pakistan. *Sustainability*, *9*(9), p.1568. https://doi.org/10.3390/su9091568

Orchid Of the Autor's

Kavya P Siddeshwar: https://orcid.org/0000-0001-9768-4266