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Improving Municipal Solid Waste Management Through NGO Intervention: Evidence from Jaipur City

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Abstract

Urban growth and evolving consumption habits have greatly contributed to the amount of municipal solid waste produced in Jaipur, posing significant environmental and human health risks. Even though collection efficiency has been improved under the municipal administration, the problem of improper source separation, dependence on landfill, poor resource recovery, etc., persists. Within this regard, non-governmental organisations (NGOs) have also become relevant stakeholders in filling the policy-practice gap through decentralised and community-based waste management methods. The following paper discusses how NGO intervention may be used to enhance the municipal solid waste management in Jaipur, with specific adaptations to the efforts made by organisations like Ecowrap and Parvaah. The study is rooted in field observations, secondary data sources, government reports, and the examination of the NGO-led models, which deal with source segregation, door-to-door collection, recycling, and composting practices. The evidence shows that technology-based systems, including the use of IoT to implement segregation and decentralized collection models used by Ecowrap, have improved efficiency and minimized landfill costs through diverting large volumes of waste materials off disposal facilities. Likewise, the interventions provided by Parvaah based on awareness have helped in behavioral change at household level through availability of waste segregation, and sustainable disposal methodology. The paper has found that the introduction of NGOs leads to a high level of community involvement, rates of resource recovery, and environmental returns, and creates livelihoods, especially among marginalized groups. Nevertheless, issues of financial sustainability, scalability and coordination with municipal systems continue to be of concern. The paper has made a conclusion that the overall efficiency and sustainability of solid waste management in Jaipur can be increased by combining NGO-centered integrated models of decentralization with formal municipal systems, which can be applied in other urbanizing cities of India.

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1. INTRODUCTION

The growth and rapid urbanization rates, economic growth, and the shift in consumption patterns have contributed to the fact that the production of municipal solid waste (MSW) in Indian cities increased significantly. Recent estimates by Central Pollution Control Board (CPCB) reveal that an estimated over 1.5 lakh tonnes of solid waste is produced in urban India on a daily basis out of which a significant percentage is not treated or disposed of in a proper manner (*CPCB | Central Pollution Control Board*, n.d.). The scenario is highly damaging to the environment, as it implies groundwater pollution, air pollution due to open burning, and provision of elevated greenhouse gases. The strain on the already existing waste management systems in large fast growing urban areas has also highlighted the essential loopholes in collection rates, the use of separation and scientific purging systems(Tukahirwa et al., 2010). The capital of the state of Rajasthan, Jaipur, is a major example of urban transformation in this situation. Jaipur is the city known to have a rich cultural background and an increasing tourism sector, which has also seen a consistent increase in population and business in the last ten years. Consequently, the city has experienced massive waste production wherein municipal approximations reveal that there is over 1,500 tonnes of waste daily produced in the city (Gurjar et al., 2025). Though the Jaipur Municipal Corporation (JMC) has worked towards improving door to door collection(*Nagar Nigam Jaipur*, n.d.) and transportation systems through national missions like Swachh Bharat Movement, there are still challenges that persist(*Swachh Bharat Mission - Gramin, Department of Drinking Water and Sanitation*, n.d.). These involve poor segregation of sources, reliance on landfills e.g. Langadiyawas, and poor recycling and resource recovery. Traditional MSW management in Jaipur is mostly based on centralized approach, in which mixed waste is assembled and moved to dumping sites with ad-hoc separation at the sources. Such practice does not only diminish the material recovery option but also imposes cost and environmental hazards. There is also a lack of permanence in behavior modification on a household level thus making municipal interventions more difficult. The policies have structures that focus on segregation and a decentralized mode of processing but application at the ground level tends to be inconsistent because of institutional, financial, and social limitations.

It is against this background that non-governmental organisations (NGOs) have become important players in enhancing the city waste management systems(*The Role of Non-Governmental Organizations in Residential Solid Waste Management: A Case Study of Puducherry, a Coastal City of India - Ramamoorthy Rajamanikam, Gopalsamy Poyyamoli, Sunil Kumar, Lekshmi R, 2014*, n.d.). NGOs are an important stakeholder when it comes to raising awareness, promoting source level segregation, and decentralized waste processing as they can work with communities directly. There are organizations like the Ecowrap and Parvaah(*Parvaah*, n.d.) in Jaipur that have developed some new methods that can supplement the work of the municipal. An example of such solutions is Ecowrap(*Home - Waste Management Service Company | India's First Source Segregation Focus Start-Up*, n.d.), which combines technology-based innovations like smart segregation and tracking of data to streamline the effectiveness of garbage collection and recycling. Parvaah, conversely, is dedicated to community activities, sensitization, and environmentally sound lifestyle activities in order to create sustainable behavioral modifications among the residents. The growing presence of NGOs can be seen as a wider change to decentralized and participatory approaches to waste management. The focus of these models is the recovery of resources, the principles of a circular economy, and community ownership, which means a reduction in the use of landfills and a better quality of the ecosystem. Recent research findings indicate that NGO-based interventions may elevate the segregation levels, minimize the waste discharge into the environment, and develop livelihood creation in the informal sector to a considerable degree. Yet, the success of such interventions is predetermined by the variety of factors, among which are institutional assistance, financial sustainability, and alignment to the community governments. Although the contribution of NGOs is increasingly becoming acknowledged, there is still need to have the systematic analysis made as to their role in the context of particular urban environment like Jaipur. The available statistics tend to concentrate on big metropolitan cities whereas medium and large cities with distinct socio-economic features get relatively lower attention. The city of Jaipur has a unique scenario with conventional urban forms and contemporary waste management issues colliding, therefore the need to understand the functioning of NGO run initiatives in an ever-changing space is necessary. Thus, this investigation will examine how NGO intervention can be used to enhance the management of municipal solid waste in Jaipur city. The study aims at analyzing the level of community involvement, waste sorting, and recovery of resources done through the NGOs. It also aims to establish strengths and limitations and future potential of NGO mediated models in realization of sustainable and efficient results of waste management. Through this, the research study gets involved into the wider discussion of urban environmental governance and also offers practical advice to the policy-makers, city governments, and other civil society players that are geared towards achieving sustainable urban development(Tukahirwa et al., 2010).

2. Methods

2.1 Documentation of Existing Practices

The current research work is based on a combined methodology to report and assess the current municipal solid waste management in the city of Jaipur with special attention to the NGO-based measures. Primary and secondary sources of data were used to make sure that they have a comprehensive understanding of the operational, institutional, and community level dynamics.

Primary information was gathered by making field visits within the residence wards that were selected in Jaipur. These visits included direct observation of waste handling procedures such

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as source segregation, door to door collection, transportation and middle level processing. Particular emphasis was put on those areas in which NGO-led initiatives have been running, especially those primarily sponsored by such organization as Ecowrap and Parvaah. Informal interviews and engagements were conducted with sanitation workers, municipal officers, NGO officials, and residents to get their roles, perception, and level of involvement in waste management activities.

The secondary data were acquired by using the official records and reports of Jaipur Municipal Corporation and national-level data published by Central pollution control board. Further data were collected using NGO reports, project reports and policy frameworks in the Swachh Bharat Mission. These sources gave a clue about the rate of waste production, collection efficiency, availability of infrastructure and the status of the policy implementation. The discussion involved the primary steps in the chain of waste management such as waste production, source segregation, collection, transport network, recycling and disposal. Special concern was made to how NGOs can contribute towards better service delivery and community involvement. The practices conducted by NGOs were evaluated against conventional municipal systems in the efficiency and environmental outcomes in comparison with social acceptance through a qualitative assessment structure.

Besides, a strengths, weaknesses, opportunities, and threats (SWOT) analysis was conducted to assess the sustainability and scalability of NGO interventions in Jaipur. This mode of analysis allowed finding operational benefits along with institutional and financial limitations related to decentralized waste management models.

2.2 Description of Study Site

The research was carried out in Jaipur city, the capital city of Rajasthan, the north-western region of India. Jaipur is a rapidly developing urban center in the country that is marked by the presence of both the historical background and the growth in the sphere of tourism as well as by the high rate of urbanization. The population of the city has been growing tremendously in the last ten years, and it has led to the overstraining on the urban infrastructure, especially the management of municipal solid waste(*Jaipur District Population Census 2011 - 2021 - 2026, Rajasthan Literacy Sex Ratio and Density*, n.d.). The Jaipur Municipal Corporation (JMC) is an administrative body in charge of waste collection, transportation and disposal activities within Jaipur. The city is further segmented with several wards all characterized with distinct differences in terms of population density, land use patterns and socio-economic attributes. To suit the objectives of this study, mixed-income areas were chosen as residential areas to be included to cover varied waste generation and management practices.

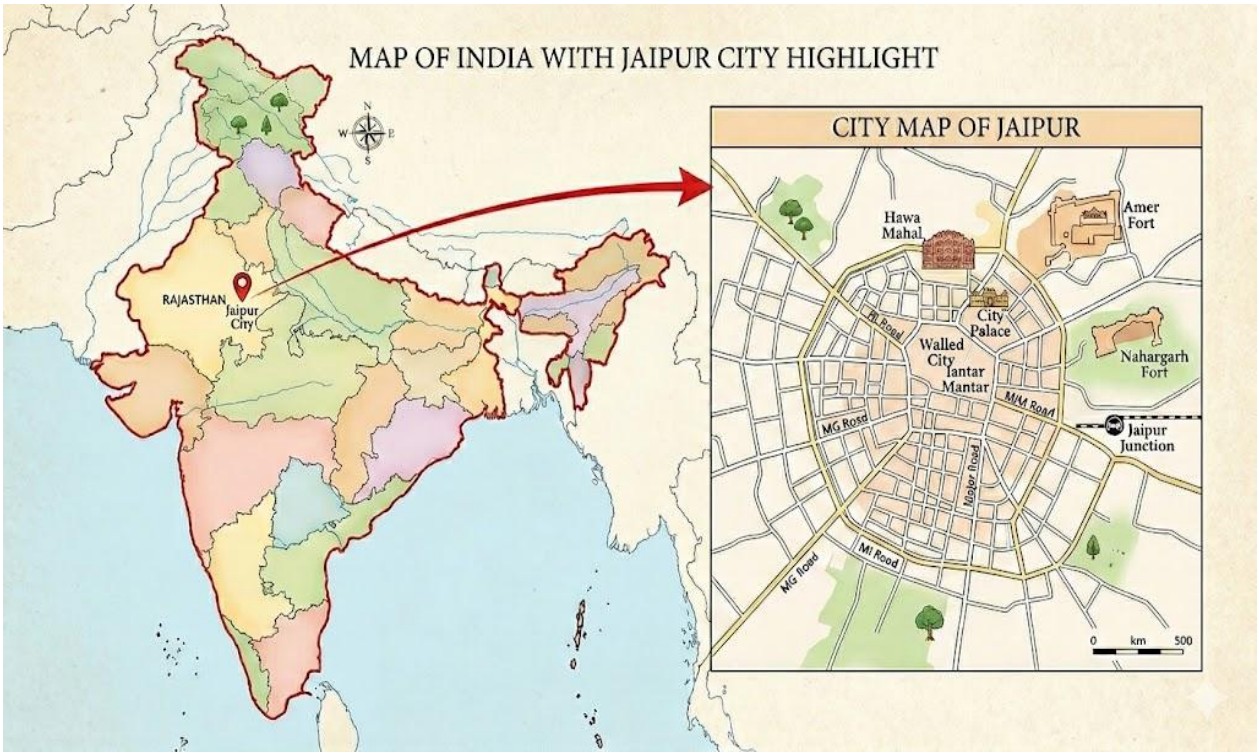

Fig 1: Map showing Jaipur City

Jaipur accumulates a significant amount of solid waste that is produced daily and it has been estimated to be more than 1,500 tonnes per day. Much of this waste is deposited by the use of

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landfills (more specifically, the Langadiyawas dumping location) where the issues of leachate management, open dumping as well as degradation of the environment have been widely reported(Saini & Kaur, 2018). Although the scope of waste collection continues to be expanded, and the concept of segregation is becoming isolated, the overall system remains limited in the context of resource recovery, as well as scientific processing.

Fig 2: Real image of dumping site(Limited, n.d.)

The chosen areas of study are neighborhoods where there are active interventions of NGOs being used to enforce decentralized waste management activities. These spheres present an appropriate setting to study the interplay of municipal systems and community-based interventions. The existence of NGOs like Ecowrap and Parvaah has added to the localized changes in segregation of waste, recycling and increase in awareness. Jaipur has a socio-economic mixture, dissimilar degrees of awareness, and infrastructure accessibility, which makes it the right case study to determine the efficacy of NGO interventions in the solid waste disposal of urban areas. The study location therefore provides good information in the obstacles and chances that are both involved with the process of moving to a more sustainable and participatory waste management system.

3. RESULTS AND DISCUSSION

3.1 Overview of Existing SWM in JMC Municipality

Jaipur municipal solid waste management (MSWM) system is majorly governed by Jaipur Municipal Corporation (JMC) charged with collection, transportation, processing, and disposal of the waste found in the city. The municipal authority has been undertaking many projects in the recent years on the national programs such as Swachh Bharat Mission to enhance its waste management services including adding the door-to-door collection services and creating publicity on the waste management services. Nonetheless, the system as a whole can be characterized by both improvement and structural difficulties. Jaipur is a city that tolerates a lot of municipal solid waste and estimated to be above 1,500 to 1,800 tonnes per day going by the current municipal and national reports. Although collection coverage in cities is relatively close, a large part of the collected waste is mixed at the point of origin, thus restricting the effectiveness of downstream processing. As it is observed in the field, households have grown conscious of segregation practices, though there still is a weak implementation since behavioral inertia, absence of monitoring and insufficiency of enforcement mechanisms. The currently existing waste management system in Jaipur is mostly centralized whereby mixed waste generated or produced by households and commercial facilities go to specific transfer stations then transferred to landfills. The waste in the city is disposed of mainly on the Langadiyawas dumping site. Waste that has been deposited may not be segregated at this site resulting in various environmental issues including leachate, bad smell and the eventual open burning. These activities cause

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air and soil pollution as well as health hazards to the surrounding populations.

The efficiency of the MSWM in Jaipur is also challenged by infrastructure constraints. Even though most wards now have a door-to-door collection, there are differences in the level of service that are observed across the localities. Sectional services are usually frequent and efficient in high-income and central urban areas and are not very frequent and with poor collection and improper waste management in peripheral and densely populated areas. Community bins and open dumping points are still in use in certain areas thereby leading to littering and secondary dumping. The second acute problem is the lack of scientific processing and resource recovery capacity. Although there are composting plants and material recovery plants, the use of these remains unoptimal because there is lack of segregation at the source. With this, much of the recyclable and biodegradable waste goes to waste. The information provided by Central Pollution Control Board supposes that Indian cities usually recycle only a small part of their potential and Jaipur is no exception. The participation in informal sectors such as waste pickers and scrap dealers also has a considerable role as recovery of valuable materials; nonetheless this contribution is not usually taken seriously and incorporated in the formal system. The supposition of operation issues in the municipal context also affects the efficiency of waste management. These are financial resource constraints, manpower constraints and technical expertise constraints. Moreover, no one can gauge the information of various stakeholders such as the municipal authorities, companies that can offer services, and community based organizations; hence, it creates inefficiencies in the delivery of services. Accountability and monitoring structures are also somewhat weak and this has an impact on consistency and quality of waste management activities. In spite of these constraints, the current trends show a slow transition to more sustainable operations. The entry of non governmental agencies and the authentic entities have brought with it fresh methodologies in terms of decentralized waste management, residential segregation schemes and technology facilitated surveillance. These solutions have proved to supplement what communities do and fill gaps within the current system.

In general, the existing MSWM framework in Jaipur is an intermediate stage, with both old, traditional, centralized processes and new, decentralized and involvement-oriented frameworks. Though major efforts have been made on the expansion of the collection services, there is still no effective segregation and resource recovery to support environmental sustainability. Such a backdrop makes the investigative interest into other alternative and complementary policies, especially one that are motivated by NGO interventions, which are discussed in the following paragraphs.

3.2 An Overview of Ecowrap and Parvaah NGO Waste Management Practices

The increased complexity of solid waste management in Jaipur has prompted the development of the non-governmental organizations that have the effect of supplementing the municipal ones by producing decentralized, technology-oriented, and community-based responses to the complexity. Two of these are Ecowrap and Parvaah, which are two different models of NGO intervention in urban waste management but are complementary.

Ecowrap: Technology-Driven Waste Management Model

Ecowrap is an environmental solutions organization based in Jaipur that revolves around the use of technology and sustainable systems of waste management. The organization was formed based on the idea to make the ecosystem a zero-dump and, therefore, it has a holistic approach, including waste segregation, collection, recycling, and upcycling.

The highlight of the Ekowrap model is that it relies on the newest technologies, including Internet of Things (IoT), artificial intelligence (AI), and data analytics to make the operations more efficient. These technologies make it possible to monitor the process of the collection of wastes, the optimization of the route, and the process of the household and commercial level of the segregation. The organization encourages a detailed hierarchy of source segregations, which in most cases divides waste into various streams in order to maximise recovery prospects and lower the reliance on landfills. Another program highlighted by Ecowrap is the incentive based participation whereby homes and businesses are motivated to separate wastes by monetization schemes. The materials like paper, plastic, metals that can be recycled are bought back by the users, thus forming an economic incentive on proper waste management. The organization also encourages upcycling in addition to the recycling, whereby waste materials are transformed into value-added products including furniture, decorative products and utility goods. This not only contributed to less waste, but also created job opportunities to other artisans and design students in the area. Ecowrap has a combined platform that links waste producers with recyclers via a reverse supply chain bringing the materials in an effective and sustainable way.

More so, Ecowrap has shown its ability to scale down to thousands of households and commercial units in Jaipur. The flexibility of its model in the residential and commercial waste streams is indicated by its participation in large events and institutional partnerships. The methodology of the organization emphasizes how the digital innovation may be used to convert the old-fashioned waste management to the operation that is based on the information and becomes more resourceful.

Parvaah: Community-Centric Waste Management Approach

Unlike the technology-based model of Ecowrap, Parvaah uses a community based and awareness based model of waste management. The organisation concentrates on behaviour change, educating the environment, and participatory measures as some of the main initiatives to facilitate sustainable management of waste in Jaipur. The significance of the segregation of the source on the domestic level is underlined by Parvaah where the inhabitants of the household have been advised to separate the waste into wet (biodegradable) and dry

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(recyclable) categories as a basic unit in the waste management chain. This strategy is promoted with the help of the regular awareness programs, workshops and community involvement programs intended to develop ecological responsibility in the citizens. The organization collaborates with the local communities, schools, residential groups, etc. to spread sustainable practices through composting, decay reduction, and responsible consumption. Parvaah aims at facilitating direct contact with residents to achieve long-term behavioral change as opposed to utilizing infrastructural or technological solutions alone. The model introduced by Parvaah also emphasises the tread of the grassroots of operation which means that local stakeholders contribute to the waste management activities. This involves promoting decentralized measures like home composting and less dependency on the municipal collection systems. The activities of the organization help in enhancing social aspect of the waste disposal by connecting the environmental sustainability with the social awareness and responsibility of the communities.

Comparative Insights and Discussion

Analysis of Ecowrap and Parvaah demonstrates two mutually supporting directions of the improvement of municipality solid waste management in Jaipur. Ecowrap is a data-driven technology-based efficiency model, with its emphasis on large-scale collection systems and operations, material recovery via recycling and upcycling. Parvaah on the other hand is a representative of a behavior change and a community-based model whereby it focuses on the issue of awareness, participation and sustainable lifestyle modifications. The two strategies are filling vital gaps within the current municipal system. Whereas Ecowrap makes the operations efficient and resources are reused, Parvaah makes people operate better and also increase sustainability by long term engagement through behavioral change. Collectively, these frameworks prove that technological innovation and community involvement are needed when it comes to effective waste management. The fact that these NGO-driven efforts have taken place in Jaipur suggests that there is a slow move toward decentralized and participative waste management frameworks. Such interventions decrease the load on city infrastructure along with the protection of the environment, preservation of resources, and social empowerment. Nevertheless, the institutional integration, financial sustainability and a policy support by the municipal authorities are the factors that will contribute to their long-term success.

Table 1: Classification Framework for Residential Solid Waste (Jaipur)(*A Methodological Approach for Urban Sustainability Assessment of Indian Cities: A Case of Jaipur | Journal of The Institution of Engineers (India): Series A | Springer Nature Link*, n.d.)

Categories of Waste	Material Composition
Kitchen (Biodegradable) Waste	Food scraps, vegetable peels, fruit waste, tea leaves, leftover cooked food, eggshells
Recyclable (Dry Waste)	Paper, cardboard, plastics, glass bottles, metals, and packaging materials
Garden Waste	Leaves, grass clippings, small branches, plant trimmings
Sanitary Waste	Diapers, sanitary napkins, tissues, bandages
Household Hazardous Waste	Batteries, paints, chemicals, cleaning agents, e-waste, bulbs

Table 1 establishes a structured classification of residential solid waste into five major categories: biodegradable (kitchen), recyclable (dry waste), garden waste, sanitary waste, and household hazardous waste. This classification represents the heterogeneous character of the urban waste streams and underlines the significance of source-level segregation as a prerequisite of the efficient downstream processing. As the biodegradable fraction is large, it means that composting has high potential, whereas the recyclable fraction suggests that it is possible to obtain the use of the material as well as implement a cyclical use of resources(*Waste Management Issues and Challenges: A Case Study of Urban Town of Kashmir, India | Discover Hazards | Springer Nature Link*, n.d.).

Table 2: Collection Methods for Different Waste Generators

S. No.	Waste Source	Collection Method
1	Residential households	Daily door-to-door collection using auto-tippers/tricycles
2	Apartments	Centralized collection at ground floor using segregated bins
3	Small shops	Daily collection by municipal/NGO vehicles
4	Institutions (schools, offices)	Scheduled collection (2–3 times/week)
5	Hotels & restaurants	Daily collection with separate wet and dry waste handling

Table 3: Levels of Residents' Participation in Waste Management (Jaipur Sample Area)(Suryawan & Lee, 2025)

Category	Number of Households	Percentage (%)
Source-segregated waste	132	44%
Mixed waste	138	46%
Non-participants (open dumping)	30	10%
Total	300	100%

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Table 2 explains the collection systems that have been adopted among various waste producers in Jaipur. It demonstrates that door to door collection is the main form of the system in residential localities underpins with the centralized collection points in apartments and bulk generators in the institutions and commercial establishments. This difference in the frequency and mode of collection demonstrates that the waste production patterns in various sectors of cities vary. It, however, also implies that the factors, which affect service efficiency, include population density, availability of infrastructure, and organizational co-ordination. The pattern of participation as shown in Table 3 indicates that around 44% of the households engage in segregation of sources, whereas 46% of the households continue to discard mixed waste and about 10 percent households are out of the formal collection system. The distribution shows that the awareness and intervention programs, especially those conducted by NGOs, are moderately successful. Simultaneously, it points out to the enduring behavioral and institutional obstacles that restrict the ubiquitous application of segregation measures.

Table 4: Monthly Generation of Residential Solid Waste (Jaipur)(*The Effects of Interventions Using Support Tools to Reduce Household Food Waste: A Study Using a Cloud-Based Automatic Weighing System*, n.d.)

Month	Kitchen Waste (kg)	Recyclables (kg)	Garden Waste (kg)	Hazardous (kg)	Mixed Waste (kg)	Total (kg)
Jan	2100	1350	720	140	4500	8810
Feb	2050	1300	690	135	4400	8575
Mar	2150	1380	710	145	4550	8935
Apr	2200	1400	730	150	4600	9080
May	2180	1420	720	148	4580	9048
Jun	2120	1360	700	142	4480	8802
Average	2133 ± 55	1368 ± 45	712 ± 15	143 ± 5	4518 ± 60	8875 ± 110

Table 5: Two-Way ANOVA Test of Mean Waste Generation(Saadi et al., 2025)

Source of Variation	SS	df	MS	F	p-value	F crit
Months	24500	5	4900	2.1	0.1	2.7
Waste Categories	7.1E+07	4	1.8E+07	8500	<0.001	2.85
Error	41000	20	2050	—	—	—
Total	—	29	—	—	—	—

- *Monthly variation = not significant*
- *Category variation = highly significant*

Table 4 would give a description of monthly trends in waste generation. The data show that the highest part of the waste stream is a kitchen waste, next is a recyclable and a garden waste but the percent of the hazardous waste is rather insignificant. The comparability in the total amount of waste produced monthly indicates that there is uniformity in the consumption habits of urban households. The latter can also be supported by the statistical analysis in Table 5, where the two-way ANOVA shows that differences in the level of waste generated in different months cannot be statistically significant, but the differences in the level of waste generated in different segments are extremely significant. It means that the amount of waste is fairly constant but its structure changes according to the consumption patterns and seasonal conditions.

Table 6: Composition of Hazardous Waste (Jaipur)(Sharma & Jain, 2019)

Month	Household Chemicals (%)	E-waste (%)	Sanitary Waste (%)
Jan	50	35	15
Feb	48	37	15
Mar	52	33	15
Apr	51	34	15
May	53	32	15
Jun	49	36	15
Average	**50 ± 2**	**34 ± 2**	**15**

Table 7: Recyclables, Market Value & Revenue (Jaipur)(Olivier, 2011)

Recyclable	Avg Quantity (kg/month)	% Share	Rate (₹/kg)	Monthly Revenue (₹)
Mixed paper	460	34%	3	1380
Cardboard	155	11%	5	775
White paper	220	16%	7	1540
Plastics (LDPE)	160	12%	6	960
Plastics (HDPE/PET)	70	5%	15	1050
Glass	135	10%	2	270
Metals	45	4%	20	900
Others	123	8%	5	615

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Total	1368	100%	—	**7490 ₹**

Table 6 shows the breakdown of the hazardous waste with the majority of the content made up of household chemicals and electronic wastes, and a smaller but stable portion made up of sanitary waste. This observation is related to increasing consumption of consumer goods and electronic appliances in urban families that, in turn, pose new challenges of safe disposal and treatment because there is no specific infrastructure. Table 7 captures the economic aspect of the waste management by revealing the quantity, composition and market value of the recyclable materials. The statistics show that paper and plastic waste constitutes the biggest proportion of recyclables, which are succeeded by glass and metals. Recycling activities when it comes to monthly revenue have been estimated to have enormous potential in economic terms when there is supporting organized systems like those initiated by NGOs. This does not only result in financial sustainability but also values as a result of waste being realised (participation by the community).

Table 8: SWOT Analysis of NGO Performance in Jaipur (Ecowrap & Parvaah)(Coello-Choez et al., 2026)

Strengths	Weaknesses	Opportunities	Threats
1. Well-structured operational framework adopted by NGOs such as Ecowrap and Parvaah ensured systematic implementation of waste segregation, collection and processing activities at the community level; 2. Regular door-to-door collection and awareness campaigns improved public participation in source segregation practices across residential areas of Jaipur; 3. Promotion of environmentally responsible behavior through workshops, campaigns and school-level engagement created long-term community awareness; 4. Integration of technology (IoT-based tracking, digital monitoring) by Ecowrap enhanced efficiency in waste collection, route optimization and data management; 5. Implementation of resource recovery practices such as recycling, upcycling and composting reduced waste burden on landfill sites such as Langadiyawas; 6. Partial revenue generation through sale of recyclables and value-added products contributed to financial sustainability; 7. Creation of employment opportunities, especially for informal waste workers and marginalized groups, improved socio-economic conditions; 8. Improved urban cleanliness and aesthetic conditions enhanced the city image, particularly in residential and commercial zones.	1. Limited technical capacity for handling hazardous, sanitary and electronic waste streams, resulting in continued dependence on municipal disposal systems; 2. High operational costs associated with decentralized collection and processing systems, particularly in technology-driven models; 3. Lack of a structured user fee system reduces financial independence and long-term sustainability of NGO operations; 4. Inconsistent participation of households in segregation practices due to behavioral resistance and lack of continuous monitoring; 5. Dependence on external funding, grants or partnerships limits scalability of NGO initiatives; 6. Limited integration with formal municipal waste management systems leads to duplication of efforts in some areas.	1. NGO-led models provide a foundation for decentralised and community-based waste management systems in Jaipur; 2. Increasing public awareness under initiatives like Swachh Bharat Mission creates favorable conditions for expanding segregation practices; 3. Opportunities for integrating informal waste sector into formal recycling systems, improving efficiency and livelihoods; 4. Expansion of circular economy practices such as recycling, composting and upcycling can reduce landfill dependency; 5. Adoption of digital technologies for monitoring and data-driven decision-making can enhance operational efficiency; 6. Potential collaboration with Jaipur Municipal Corporation for scaling NGO initiatives across multiple wards; 7. Growing market demand for recycled products and organic compost provides economic incentives for expansion.	1. Financial and administrative uncertainty due to reliance on municipal approvals and irregular funding support affects continuity of NGO operations; 2. Frequent policy changes and bureaucratic delays hinder effective coordination between NGOs and municipal authorities; 3. Resistance from certain sections of society toward behavioral change in waste segregation reduces program effectiveness; 4. Competition with informal scrap dealers may reduce the quantity of recyclables available for organized recovery systems; 5. Absence of dedicated treatment facilities for hazardous and e-waste weakens the overall sustainability of NGO-led waste management systems; 6. Rapid urbanization and increasing waste generation in Jaipur may outpace the capacity of existing NGO interventions if not scaled appropriately.

Lastly, Table 8 gives an overall SWOT analysis of the performance of NGOs in Jaipur with reference to the organization of Ecowrap and Parvaah. Among the strengths brought out in the analysis are better segregation practices, integration of technology, community involvement, and creation of jobs. Nonetheless, it also finds key faults in the areas of financial dependency, a lack of technical potential to process specific waste streams, partial municipal integration. The opportunities include scaling decentralized models, advocating practices of the circular economy, and reinforcing the cooperation with the Jaipur Municipal Corporation. Meanwhile, any of the threats like uncertainty in policies, the high rate of urbanization, and competition with the informal sector can compromise the long-term sustainability of these initiatives. On the whole, the general understanding of these tables is to suggest that the system of waste management in Jaipur is at the stage of transition when classic centralized methods are still present with new models of decentralized and participatory ones. Although

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the NGO interventions have led to an appreciable way in the areas of segregation, awareness and restoring the lost resources, more institutional support, more involvement of people, and incorporation of technological solutions and community-based solutions are the elements that would lead to a complete sustainable system.

The statistical report (Table 6) has valuable information regarding the trend in waste production in Jaipur. The statistical significance of the two-way ANOVA shows that there is no statistical significance in the difference in total amount of waste produced in the various months ($27.10 - 0.10 > 0.05$) indicating that the production of waste in the household is relatively stable with time.(Cruz Navas & Saiz-Álvarez, 2025) Contrarily, the difference between waste types is observed to be very significant ($p < 0.001$) developing that indeed there is a strong difference between the composition of waste types of biodegradable, recyclable, and hazardous. It means that the amount of waste created does not change significantly but its composition is dynamical and should be managed according to specific methods of the category to recover resources effectively. The SWOT analysis in Table 8 reinforces more the perception of waste management by NGOs undertaken in Jaipur. This analysis shows that these organizations like Ecowrap and Parvaah have major strengths like well-organized operational structures, increased community involvement, technological innovations, and well-organized recycling and composting programs. These have been the strengths that result in better segregation and landfill burden. Nevertheless, the analysis also singles out such weaknesses as lack of technical strength to manage hazardous and e-waste, reliance on external funding, and a lack of integration with the municipal systems. Simultaneously, the SWOT analysis reveals some significant opportunities, such as the growth of models of decentralized waste management, the use of digital monitoring, and increased cooperation with Jaipur Municipal Corporation. On the other hand, there are still a number of threats, including financial and administrative challenges, irregular citizen engagement, rivalry with the informal recycling industry, a lack of proper treatment facilities to treat specialized waste streams. Altogether, the summative representation of the ANOVA findings with SWOT analysis shows that as much as technical and organizational components of waste management are changing positively through the agency of NGOs, the whole process of waste management will be strengthened through institutional support, enhancement of financial mechanisms, or the presence of total waste processing facilities. Waste management in Jaipur spearheaded by NGOs has excellent community participation, better segregation and recovery of resources (strengths) yet has weaknesses of financial dependency and low technical capacity. It provides the possibilities of decentralized growth and the circular economy, and the disadvantages consist of uncertainty in policies, the low rate of citizens involvement, and the insufficiency of treatment infrastructure (threats)(*An Analysis of Dune Management on the Kenfig, Culbin and Sefton Coasts in the UK Using the SWOT Framework | Environmental Management | Springer Nature Link*, n.d.).

3.3 Present Status of Waste Management

The current situation regarding the management of the municipal solid waste in Jaipur represents a crisis of transition characterized by positive and negative developments. The Jaipur Municipal Corporation has also increased the services in door to door waste collection in the recent years and implemented the national programs like Swachh Bharat Mission with the awareness campaigns. These endeavors have caused a better coverage in the collection of a good number of urban wards and the implementation of waste management into the limelight of the populace. In spite of these developments, there are a number of endemic challenges in the system. One issue is the fact that there is little source segregation at the household level. Even though the situation has become less aware, uniform segregation into wet and dry waste is not evenly distributed among various socio-economic groups. Thus, much of the gathered trash still ends up being mixed thereby lowering the effectiveness of the recycling and composting processes. Use of land fill locations especially Langadiyawas dumping location is still a serious matter and environmental issues like pollutive leachate, stenching foul odor and open burning are still evident. The intervention of the non-governmental organizations has brought positive transformations within the localized spheres. Pioneered by Ecowrap, the technology-based waste monitoring and organized recycling organizations proved to be successful, and the community-level awareness and behavior change were coordinated by Parvaah, following the regular engagement program. These measures have enhanced segregation principles and lessened wastage spillage in individual districts. Nevertheless, they are covered very little as compared to the size of the city at large. The second significant aspect of the existing system is the presence of the informal sector such as waste pickers and scrap dealers who play a significant role in recovered materials. Although they do this, this sector to a large extent works beyond the institutional frameworks and hence this creates inefficiencies as well as missing integration opportunities.

In general, the current system of waste management in Jaipur is showing mixed results, with the areas of collection being more efficient but the success of segregation and scientific treatment being minimal. The monolithic managerial schemes and the annular NGO schemes curb the aspect of improved coordination and unification to ensure sustainable results.

4. CONCLUSIONS

The paper has explored the contribution of NGO intervention towards the overall enhancement of municipal solid waste management in Jaipur, particularly in operation practices, community involvement, and recovery of resources. The results show that although the municipal system has been successful in terms of expanding the collection services, it still experiences major issues pertaining to the source segregation, landfill reliance, and efficient use of the waste products.

The initiatives conducted by NGOs (especially those carried out by Ecowrap and Parvaah) have proved capable of filling these

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gaps with decentralized, participative, and innovative strategies. These organizations have helped to increase the quality of segregation, a greater awareness of the people and recovery of resources by recycling and composting. Their interventions point out the essence of integrating the use of technology and the community to attain effective waste management.

The statistical analysis proves that the intensity of waste production does not really change with time, but the example of its structure is highly variable, and this is why it is essential to create category-specific methods of managing waste. Moreover, the SWOT analysis shows that NGO models have great operational and social strengths that are bound by financial constraints, lack of technicality and institutional challenges. The research confirms that the town cannot manage solid waste sustainably in Jaipur without the involvement of the municipal authorities. Rather, it demands a collective strategy, which involves the integration of powers of municipal authorities, NGOs, and communities. The source segregation is vital, decentralization of the processing system, incorporation of informal sector, and stable financial and policy provision must be taken to facilitate long-term sustainability. In a wider context, the Jaipur experience proves that models mediated by NGOs can be effective additions to traditional types of waste management systems in fast urbanizing cities. Such models, with proper institutional support and scalability, could make a lot of impact in terms of environmental sustainability, resource conservation, and better living conditions in cities.

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