



Socio-spatial analysis of Existing Trend and Future Prospects of Solid Waste Management in Patna

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Received : December, 2023

Accepted : January, 2024

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Abstract: Littering of waste and its management has become one of the serious issues generated due to rise in population in PMC area. It is an important aspect of urban planning which is given priority all around the globe however, in Patna, waste management has long been taken seriously, the accumulated waste is often unsegregated and the recyclable waste remains neglected. The number of GV points has increased manifold and inefficiencies in solid waste management is still a concern.

The study identifies the Garbage Vulnerable Points (GVPs), solid waste management (SWM) practices including the role of Safai Sathis by collecting primary and secondary data. ArcGIS Pro and Google Earth Pro has been used to map the study areas and Garbage Vulnerable Points.

Keywords: Solid waste management, Safai Sathi, waste collection, waste segregation, GVPs, PMC, Patna.

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Introduction:

The Patna Municipal Corporation (PMC) is the civic body responsible for SWM in the Patna, as per the Bihar Municipal Act, 2007 and Municipal Solid Waste (Management and Handling) Rules, 2000. PMC initiated an extensive door-to-door segregated (organic and inorganic) waste collection movement. Through this initiative, PMC area was provided with two bins, one for biodegradable waste (green colour) and the other for non-biodegradable waste (blue colour). Despite this, the unbearable stench and sight of garbage dumped on the roadside is not an uncommon sight to witness in the city. Heaps of garbage dot many residential areas in Patna, deteriorating the health of the people and destroying the scenic beauty of the city. However, if a good solid waste management system is implemented properly, it can be considered to be a game-changer and much-needed effort to change for the country's the most unclean state capital, Patna. Waste in Patna stems from households, hotels, commercial establishments, agricultural markets, and slaughterhouses. Improper disposal of

solid waste over several decades and open burning of garbage have led to environmental pollution and health problems in Patna. Hyper-consumption is a major problem arising mostly in urban areas where humans generate monumental amounts of waste, sizable portion of which is disposed in the landfills and through waste-to-energy incinerators. Waste accumulation in urban areas becomes the breeding ground for disease vectors like flies, mosquitoes, cockroaches, rats, and other pests, severely affecting the health of city dwellers. The landfill sites become prone to soil and ground water contamination due to leachate percolation. So, public awareness is necessary for proper waste management to conserve our environment and safeguard public health, with proper management and handling of solid waste, Patna can become a clean city to live in and a smart city in true sense.

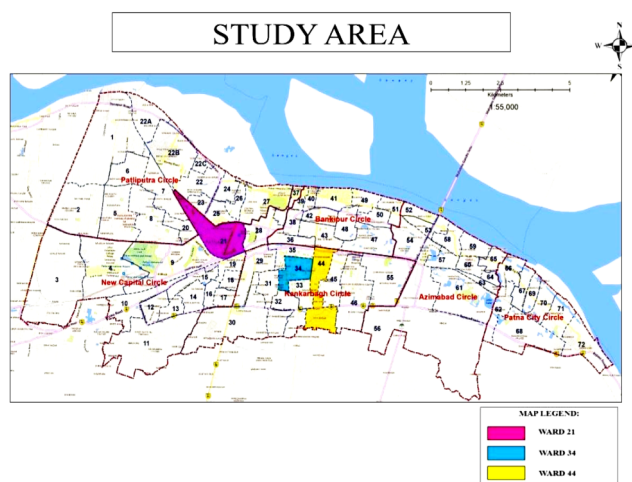
Review of literature:

The study “Municipal solid waste management and landfilling technologies: a review” (Nanda & Berruti,2020) points out that municipal solid waste is a renewable and economical resource that has high potentials to recover energy and valuable resources through waste-to-energy or energy-from-waste conversion and other valorisation techniques. Different waste-to-energy technologies including thermochemical and biological conversion can transform solid waste into fuel, incineration being the most preferred waste-to-energy technique. The enormous amount of solid wastes in Patna city are dumped in low-lying areas making land filling the most common method of solid waste disposal, leading to unsightly, unsanitary and generally emit foul odour that in turn would attract pests (Kumari, Ranjan & Sinha, 2011). Pandey (2014) points out dumping of waste by a vast number of daily commuters as well as rapidly growing population and increasing temporary population is a major challenge and has become big concern for PMC. According to Gupta et al. (1998) Inadequate guidelines and policies hinder municipal waste services, leading to challenges in collection, transportation, and disposal, it explores efficient management options, considering environmental impacts. Singh & Raj (2018) highlights the necessity for effective solid waste management practices in Patna which includes reduction, reuse, recycle and recovery in

article 'sustainable recycling in Patna'. So, it is crucial to unveil the SWM practices, identification of GVPs and role of *Safai Sathis* in the study area.

Study Area:

Patna also known as Patliputra is an age-old city and it is now the capital city of Bihar State. The city located at 25.611°N latitude and 85.144°E longitude, is governed by the Patna Municipal Corporation (PMC), subdivided into 75 corporation wards, organized into six circles, namely the New Capital Circle, Patliputra Circle, Kankarbagh Circle, Bankipur Circle, Azimabad Circle, and Patna City Circle. This research will focus on Ward no. 34, Ward no. 44 and Ward No. 21 along with the landfill sites of Patna Municipal Corporation.



Map 1. Map showing the study area

Objectives :

1. To study the public perception and participation in waste segregation.
2. To study the problems and challenges of 'Safai sathis' in the study area.
3. To map Garbage Vulnerable Points (GVPs) in the study area.

Research Questions:

1. What is hindrance in active participation of public in waste segregation at home?
2. What are the current waste management strategies being followed in the PMC?
3. How does lack of safety equipment make *Safai Sathis* more vulnerable to health issues?

Methodology:

The study involves traditional field survey method as well as geospatial techniques. The sample wards 34 and 44 have been selected because *Swachhta Survekshan* is done in these two wards and ward no. 21 has no GVPs identified by PMC. So, three wards have been taken into consideration for this study with sample size of 55 households and 30 *Safai Sathis* which are employed to collect waste and sweep in the concerned wards, so, total sample size in 85. Primary data has been collected through household survey and interview of *Safai Sathis* in the study area. The secondary data has been procured from PMC and maps from Patna Municipal Corporation Office, Google Earth Pro and Arc GIS Pro.

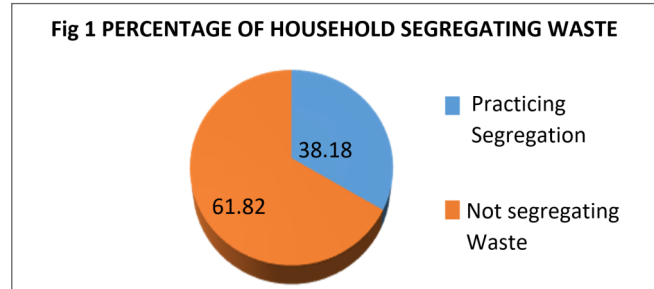
Findings:

Demographic profile of the Respondents: The survey involves 54.54% are male and 45.46% female respondents. The majority (49.09%) are aged between 20-30 years, 20% are belong to age group of 30-40 years, 12.72% are between 40-50 years and 18.19% belong to age group of more than 50 years. Around 60% of the sample respondents are graduates, while 21.81% have higher secondary education, 9.09% have secondary, 5.45% have primary education and 3.65% were school dropouts. 36.36% of the surveyed respondents are indulge in government services, 18.18% own business, 27.28% belong to category of students and 18.18% are engaged in other services. Majority of the *Safai sathis* are male who work on daily basis.

Status of Waste Collection and Segregation at household level: *Safai* express vehicles also known as 'Close Tipppers', visit door-to-door in 300 to 350 household's every day to collect waste in their designated ward. *Safai Sathis* segregate waste into dry waste (glass, paper, cardboard) and wet waste (kitchen and garden waste) categories.

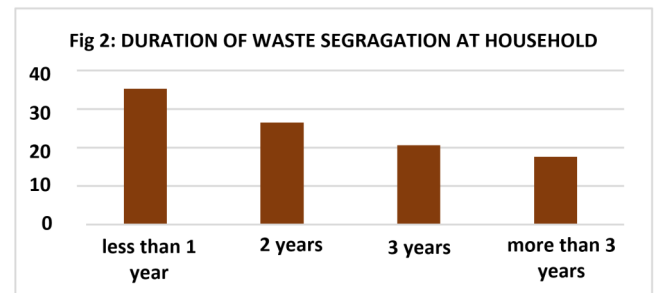
Waste segregation: Waste segregation is the technique of figuring out, classifying, dividing and sorting of waste products in order to reduce, reuse and recycle materials. PMC prioritizes an effective waste management system, fostering participation from household, organizations and institutions. The process begins at its origin, where waste generators are

educated on the importance of separating their waste into different categories- wet, dry, domestic and sanitary waste, aiming to minimize contamination and enhance waste treatment efficiency.



*Based on primary survey, 2023.

Public bins are colour- coded for waste disposal, blue for wet waste and green for wet waste. Almost 80% of the sample household generate both type of waste. Additionally, litter bins with the capacity of 40 to 120 litres are strategically placed in high- traffic regions across the city. Fig. 1 indicates that 38.18% people are segregating waste and remaining 61.82% are not. Reasons such as inadequate education about segregation practices and limited access to proper waste disposal could be a contributing factor for such discrepancy. It is evident from Fig 2 that out of 38% household which is segregating waste, only 38.24% have been practicing it for 3 or more years while rest has started recently, it also reflects the slow pace of such practice in the study area.



*Based on primary survey, 2023.

Role of *Safai Sathis* in collection, segregation and disposal of waste: *Safai Sathis* in Patna are assigned with the work of segregating waste at source. They are equipped with necessary training to separate the recyclable and non- recyclable waste while actively fostering awareness for household level waste segregation to mitigate the environmental impact of improper waste disposal. The waste collected at secondary point is transported to primary location i.e. Ramchak Bairiya (Fig. 3), which serve as the primary

processing facility for the garbage collected from different wards. Here, various method such as sorting, segregation, recycling and composting are employed as a part of waste management practices by PMC. The processed waste is then disposed, according to the policies and recommendations set with the aid of the PMC. Yet, the waste processing scheme at Ramchak Bairiya processing site has never been successful and it remains a challenge for the corporation.



Fig 3: Landfill site of Ramchak Bairiya (Taken by Author)

Frequency of visit of waste collection vehicles in the study area represents regularity and irregularity of the 'closed tippers'. 90% of the sample household agreed that waste collection vehicle visit on a regular basis in their locality while 10% find it irregular, which can be due to narrow or inaccessible roads, inconsistent waste collection schedules. It is a positive sign in SWM strategies of PMC.

Fig. 4, demonstrates that 36% of the *safai sathis* face the problem of littering which may be the outcome of improper waste disposal, 20% mark the problem of unsegregated waste which shows the lack of awareness among people about the consequences of unsegregated waste on human and environment, also 20% of the *Safai sathis* face the problem of frequent GVP this could be due to inefficient waste collection system. 17% reported the problem of unavailability of dustbins might result from insufficient civic planning in their working area and 7% faces other problems like unsafe materials like broken glass, sharp objects posing risk to their safety during waste collection.

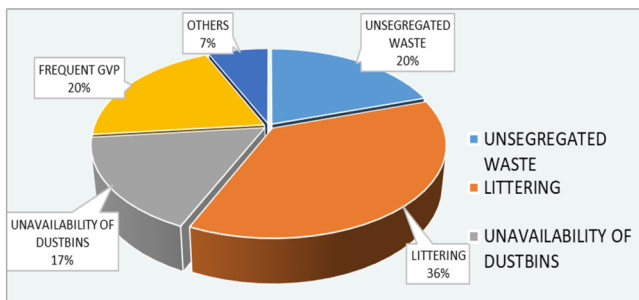


Fig. 4. Challenges faced by Safai Sathis

Access to Formal Training to The Safai Sathis:

Study reveals that from the total no. of respondents, 60% of the *safai sathis* have not received any formal training in waste collection/management and the rest 40% have received formal training in this field. This shows the lack of effort by the PMC to ensure that proper training is given to the *safai sathis*. This can be a contributing factor as to why waste management in Patna is not up to the standards. Due to the lack of training given to the *safai sathis* only few of its member would be able to grasp the technical know-how in the field of waste management.

Table 1. Accessibility of Safety Equipment for Safai Sathis

Access to safety equipment	No. of respondents	Percentage Share
Access to safety equipment	22	73
No access to safety equipment	08	27
Total	30	100

*Based on primary survey, 2023.

Table 1, shows the accessibility of appropriate safety equipment and uniforms to the *safai sathis*, where 73% of the respondents have access to safety equipment and uniforms and the rest 27% do not have any access to such equipment.

Table 2 Accessibility of Various Types of Safety Equipment for Safai Sathis

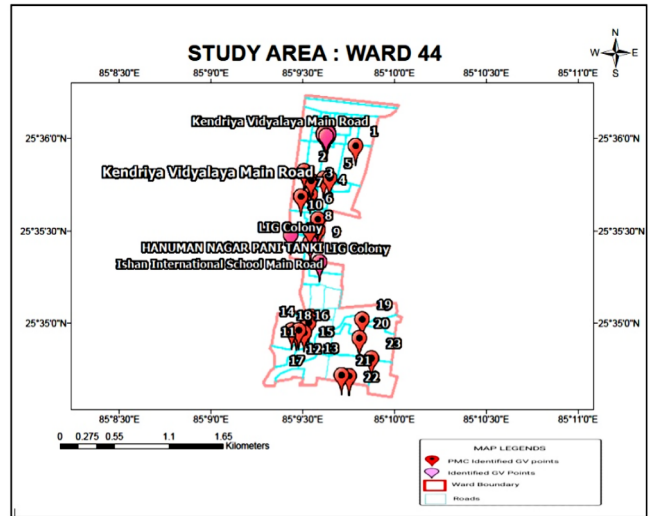
Access to safety equipment	No. of respondents	Percentage Share
Gloves	12	40
Boots	02	6.7
Mask	09	30
Helmet	03	10
Bandi	12	40
Blazer	01	3.3

*Based on primary survey, 2023.

Table 2 shows the accessibility of different safety equipments to *Safai sathis*. Those safety equipments included gloves (40%), boots (6.7%), mask (30%), helmet (10%), bandi (40%) and blazers (3.3%). This reveals that large no. of the respondents have received safety equipments in which gloves, mask and bandi were mostly provided.

Mapping of Garbage Vulnerable Points:

Garbage Vulnerable Points (GVP) are locations which witnesses the increased accumulation of garbage. This accumulation is caused due to unrestricted disposal of the household waste from the neighbouring area along roads and open spaces. Ward 34 and 44 as shown in map 2 and 3 respectively are wards that falls in the Kankarbagh circle and ward 21 as shown in map 4 is situated in the New Capital Circle of the Patna Municipal Corporation. The red line shows the ward boundary revealing its areal extent and the light blue line represent the major pathways of the shown wards. The pink placemark shows the PMC identified GV Points and the GV Points that has not been identified by PMC is shown with the help of red placemarks. These unidentified GV Points which have not been recognized by PMC have been found during the survey conducted. In ward 34, there are total of 4 unidentified GV points, in ward 44, total of 23 unidentified GV points and in ward 21, there are total of 7 unidentified GV points as shown in the map. The high contrast in the numbers of identified and unidentified GVP shows the inefficiency of PMC in identifying and tackling the problem of rapidly increasing number of GV Points. This also reflects on the lack of seriousness of the PMC in waste management.



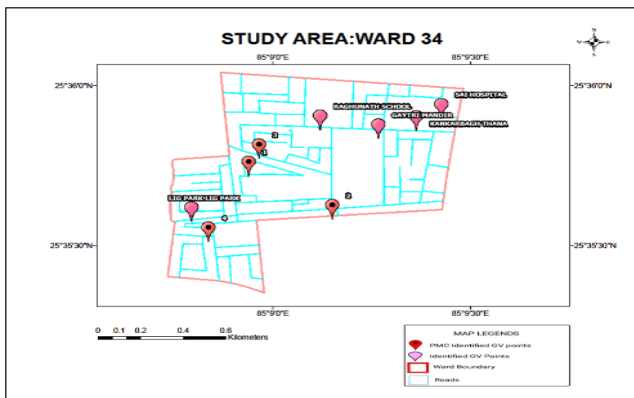
Map 4

Future Prospects: The PMC has approved Rs 2,432 crore budget for 2022-24, focusing on infrastructure development, waste management, and air pollution control, with a priority to remove 120,000 tons of waste from *Ramachak Bairiya* landfill which will receive Rs 5.5 billion while funds worth Rs 117 billion will be spent on waste-to-energy plants. The Bihar government plans to establish an integrated solid waste management plant in Patna City, utilizing advanced technologies like Waste-to-Energy plants, decentralized waste treatment schemes, Smart Bin Technologies, and Advanced Recycling Technologies. These developments aim to reduce waste dependency, increase recycling efficiency, and reduce the burden on central facilities, ultimately leading to a more sustainable and efficient waste management system.

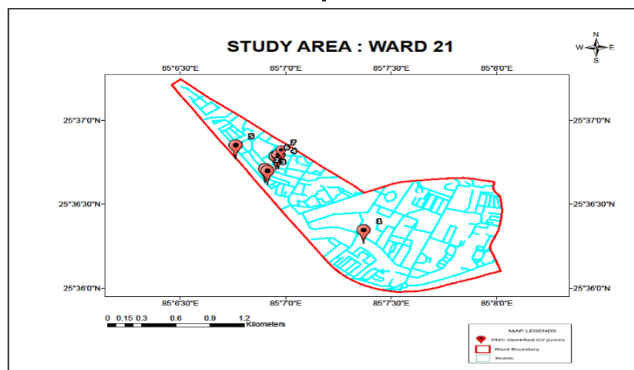
Conclusion:

Findings suggest that there is lack of awareness in regard to waste segregation for solid waste management and its recycling process as only 38.18% segregate their waste at household level. This is mainly because people do not perceive it important, laziness and inability to understand the seriousness of waste management despite provision of separate dustbins to practice waste segregation.

Most of the people who practice waste segregation believe that their segregated waste is not handled separately once given to the *safai sathis* or put in collection vehicle rather mix both recyclable and non-recyclable waste which ends up in landfills of the city.



Map 2



Map 3

Hence, people feel demotivated to segregate their waste. This provides answer to the first research question, "What is hindrance in active participation of public in waste segregation at home?"

The segregation of waste should start from the collection stage itself but people are mostly satisfied with the performance of waste collection vehicles and *safai sathis*. However, people have shown their dissatisfaction with the prolonged absence of sweepers in their locality. The perception of *safai sathis* do differ as they face many problems in the process of collection and dumping of waste. PMC claims that in every 50-100 meters litter bins has been installed in the areas of Patna. However, 45.46% of respondents do not have access to these, despite 54.54% i.e. 30 respondents out of 55 saying that public bins are available near their house. This contradicts the strategic plan of PMC of installation of litter bins every 50-100 meters. Several awareness campaigns were launched by PMC, one of them is the Cash for Waste scheme on the theme of waste to wealth for common people at the recently established Material Recovery Facility (MRF). However, from our observation in the MRF on June, 2023, we came to know that the MRF was not functioning for past two months. Another campaign, One Dream Patna Clean launched in September 2020 aimed at clearing all the vulnerable points in Patna. However, with the increase in population the number of GV points are rapidly increasing. Currently Bailing machine, soft plastic shredder, hard plastic shredder, gatta machine, conveyer belt, QRcode enabled garbage collection and monitoring softwares are being used in the study area. This provides answers to the research question- "What are the current waste management strategies being followed in the PMC?"

Majority of the *safai sathis* have undergone health issues like respiratory problems and skin infection while working most likely due to lack of proper safety equipment provided to the *Safai sathis*. There is a lack of the provision of medical facilities, formal training in waste collection/ management among Safai karmis. In a proper solid waste management process, safety, and health of the safai sathis should be given priority as 27% of the safai sathis have become vulnerable to health issues due to lack of equipment like mask, boots and gloves which will protect them from health issues like

respiratory problems, poking objects and skin diseases. Hazardous waste like radioactive waste and bio medical waste can also cause tremendous impact on safai sathis. Thus, there is lack of availability of safety equipments which makes them more vulnerable to serious health issues.

The survey results reveal that the future of solid waste management depends on every individual's dedication to solve the trash problem. In order to enhance city's trash management, Bihar intends to construct an integrated solid waste facility in Patna that will make use of cutting-edge technologies and decentralized waste treatment programs. Patna has serious problems with solid waste management due to its 2.5 million residents, outdated disposal procedures, and lack of segregation, that pose threats to public health and the environment. Every day, Patna produces 1000–1200 TPD of trash, of which 40% originates from residential sources, 60% from commercial ones, 49% from residential sources, and 12.5% from vegetable and putrescible fractions. The Bihar government intends to build an integrated solid waste management facility in Patna City, with a sizable processing and disposal facility located at Ramchak Bairiya (AIR, 2023). In an effort to increase recycling effectiveness and trash management, Patna is looking at smart bin and cutting-edge recycling technologies. Projects including anaerobic digestion and incineration could provide sustainable energy from organic waste.

Patna faces enormous challenges waste segregation and its recycling process, rapidly increasing GV points and safety of *safai sathis* while working. Hence, active public participation is required in SWM in Patna for its betterment. An unexplored aspect of waste disposal, that is the disposal of dead animals into rivers and other water bodies. It is an important issue that should be looked upon because it is not only related to waste management but also river water management. The Patna Waste Management Strategy should focus towards increasing waste disposal capacity, address littering, maintain material recovery facilities, encourage composting, implement penalties for illegal dumping, integrating waste management strategies into primary education and spread more and more awareness through active public participation.

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