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Assessment of solid waste management practices: Study of Burdwan Town, West Bengal

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Abstract Pile of urban solid waste is one of the worst consequences of rapid urbanization especially in developing countries and managing them is even bigger a problem here. Being an old city, Burdwan town of Purba Burdwan district of West Bengal is no exception. Due to the infrastructural drawback, inefficient planning and policy action, and negligence from the citizens and the municipal waste workers, in almost every ward of the Municipality, one can find waste dumping along the road and drainage sides. This not only hinders aesthetics but appears to be a breeding ground for all unhygienic diseases, air pollution, and water pollution which makes the children suffer most. In such a severe condition, this paper tries to seek the status of the municipal waste management practices, the reasons behind its current scenario and suggests some infrastructural boosts to optimize the waste-stagnated situation through GIS Network Analysis techniques for this study, both the primary and secondary data were used via different methods of questionnaire surveying and data provided by the Municipal authority respectively. We tried to capture the perceptions from all the stakeholders involved and finally, the conflicting words from all the parties have brought an outcome.

Keywords Waste management · Network analysis · Community participation

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Introduction

Solid waste is trash that results from human or animal activity that is discarded because it is undesirable and pointless. It is typically produced by commercial, residential, and industrial activity in a certain region and can be managed in several ways. Comprehensive management of solid waste disposal is necessary to provide optimal environmental standards. (Pulp & Paper Technology, 2023)The collection, handling, and disposal of solid waste that has been abandoned because it has reached its useful life or is no longer needed is known as solid-waste management. Inadequate management of municipal solid waste can result in unhygienic conditions, which can then cause environmental contamination and vector-borne disease outbreaks—diseases carried by rodents and insects. (Nathanson, 2023) There are several types of solid wastes, like municipal, medical, industrial electronic, etc. (Pulp & Paper Technology, 2023)Removal and management of Municipal Solid Waste (MSW) comes under the conservancy services of a Municipal body or a Town by which a

city gets itself garbage free. (Kumar & Goel, 2009) The towns and cities in developing nations are acting as the breeding grounds of solid waste generation as an outcome of immense population growth and haphazard urbanization. On the other hand, poor solid waste management has become a burden for governments in the cities of Asia and Africa, as it is critical to public health, safety, and the environment. Uncollected rubbish piles in the streets, obstructed drainage channels, or deposited in watercourses constitute a significant public health risk, and unmanaged disposal of waste can harm water supplies and pose serious environmental health risks to people who live nearby. Workers in solid waste and rubbish collection confront severe occupational health and safety risks. (Ferronato & Torretta, 2019) Thus, solid waste must be handled in a way that minimizes environmental and human health concerns, which has consequences for its storage, collection, and safe disposal. Every year, the world produces 2.01 billion tons of municipal solid garbage, at least 33 percent of which, to put it very conservatively, is not managed in a way that is safe for the environment. In the future, trash production is predicted to reach 3.40 billion tons worldwide by 2050, more than twice the rate of population growth during that time (World Bank, 2017). India is one of the top 10 nations in the world for producing municipal solid waste (MSW) because of its fast urbanization, strong economic growth, and higher rates of urban consumption. The Energy and Resources Institute (TERI) said that India produces more than 62 million tons (MT) of trash annually (International Trade Administration, 2023). The National Action Plan for Municipal Solid Waste Management Act 2000 and Solid waste management rules, 2016 (India) both put an emphasis the duty of an Urban local body to deal with the municipal solid waste management starting from its generation to its recycling processes. (Ministry of Environment Forest & Climate Change, 2016).

Considering the backdrop for this study, Burdwan Town of Burdwan-I Block of District East Burdwan has been selected. The pattern of urbanization that has taken place in the study area, is unplanned and thus unscientific giving birth to various socio-environmental problems like unscientific dumping of wastes, traffic congestions, water logging and pollution(Laha, 2019). The lifeline of the town, River Banka, has been turned into a complete dump yard at many places within and beyond the Municipality's boundary over the last few decades due to dam construction, irrigation, and huge population pressure, and their insensitive behavior towards the river (Sen, 1976). The adjoining Sapjala khal has likewise become a landfill. The roadside, drain side, and vacant lands have all become dumps or rubbish disposal areas. Excessive plastic usages have made the scenario even worse. In such a case, this paper aims to seek the reasons behind such a mess and mesh of wastes. While digging deep into the causes, the study also tries to assess the Urban Local Body's current activities at the conservancy services with special reference to solid waste management and suggest how to manage the waste in a better way.

Study area

The Burdwan Municipality and its evolution as an urban center

The Burdwan Municipality, dominated by tropical climate, is surrounded by Belkas Panchayet in the West, Rayan, and some part of Baikunthapur II in the East, remaining part of Baikunthapur II and Raina (P.S) in the South, and Belkas Panchayet in the North, accordingly, are its boundaries. Bardhhaman Municipality is the only Class-I town in the East Bardhhaman district, as well as one of the six old towns and the district headquarters of the previous Bardhhaman District. Bardhhaman town was the gift of river Damodar and its various paleo-channels like Banka, Bahula, Gangoor and Balluka. Geomorphologically Bardhhaman town is in the '*Doab*' region (inter-fluvial tracts) of Damodar, Banka and Khari rivers (Ganai & Sarkar, 2018).The Burdwan Municipality holds a population of approximately 3 lakhs 14 thousands in the last census of 2011 and currently the population is estimated upto 4 lakhs 32 thousands (in number) as of 2023. This town originated as an agricultural market, as well as agro-based industry such as rice mills, for the neighboring lush rural region. The service sector has grown in importance in this town's economy throughout time as educational, healthcare, transport, and marketing facilities have

developed. Since 2000, the town has been growing vertically to cater these migrators (Laha, 2019).

Degeneration of the Main River (Banka) and Drainages due to waste

The Banka River almost cutting the Burdwan Municipal Jurisdiction into two halves of North and South, (Fig. 1) is of no exception- it is the smallest non-perennial river originating from the Western part of the district with a length of 96 miles and a catchment of 253 sq. km, which used to be a very prominent drainage until 1960 (Sen, 1976). While this river could have been the best way out to channelize excess rain water, the excessive rate of urbanization along the riversides is hastening the degeneration of channel banks thus lessening river discharge, especially from the influx of urban waste water During the field visits, it was clearly evident that there are a thousands of migrators who have illegally (not having their papers of land) came from surrounding areas like Galsi, Budbud for jobs or other income sources and even from far beyond the border from Bangladesh many decades ago, settled at both the banks of Banka which actually are the land parcels of either Government or Eastern Railway and have been living there for generations and now refuse to vacate the land. By throwing their waste directly into the river,

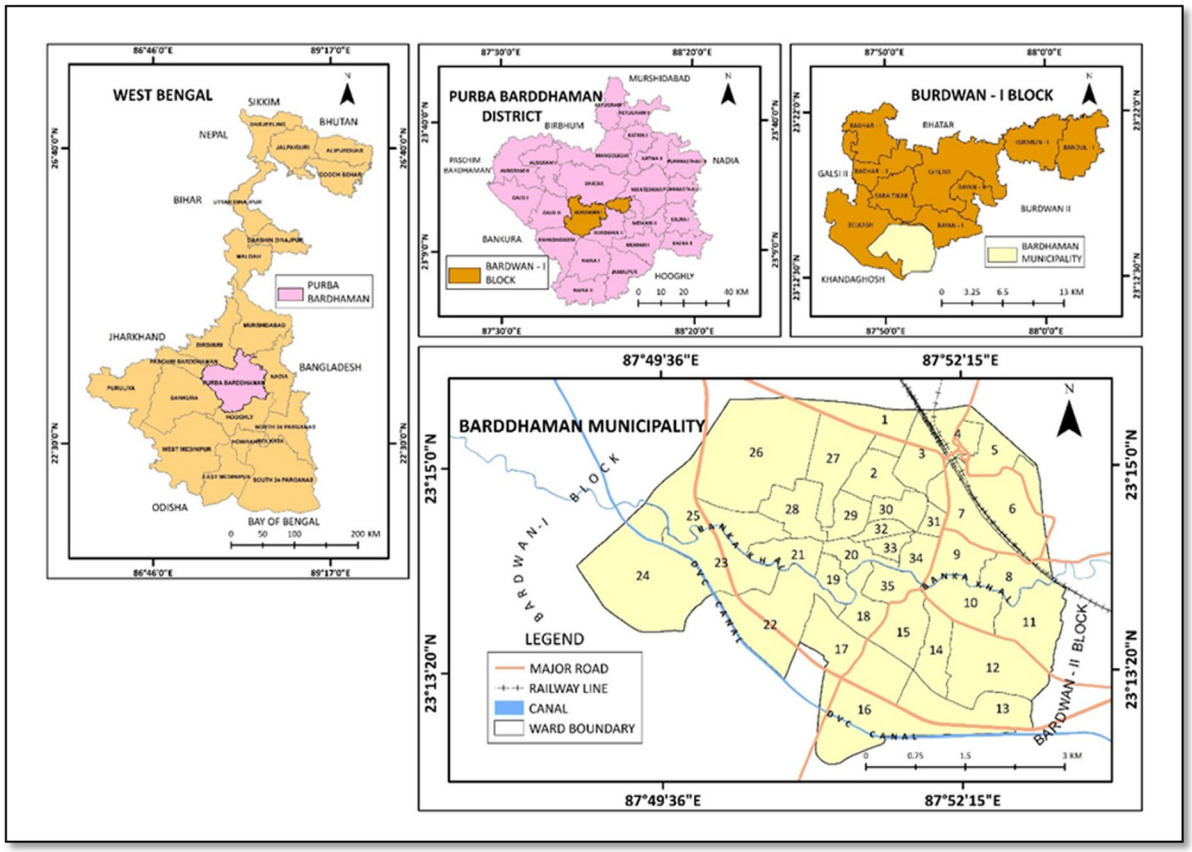


Fig. 1 The location of the study area in correspondence with the location of District Purba Bardhhaman and the State of West Bengal. *Source*: For the map of West Bengal- Administrative Atlas-West Bengal, 2011: by Office of the Registrar General & Census Commissioner, India (http://censusindia.gov.in/2011census/maps/atlas/West%20Bengal.html)- accessed in Januray, 2019. For the map of Purba Bardhhaman District and Burdwan-I Block—Official Web Portal of Purba Bardhhaman District () accessed in September, 2019. For the map of Burdwan Municipality- Municipal Office of Burdwan Municipality, 2018

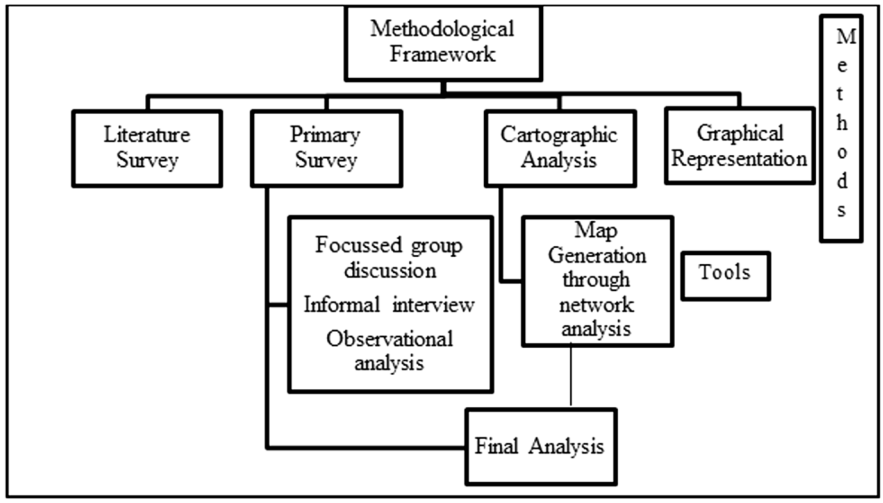


Fig. 2 The methodological framework for the current study

Fig. 3 The neon green points are showing the stations surveyed for the commoners and the red ring pins are showing the location of the waste workers' interviews.(retreieved in May, 2023)

washing clothes and doing daily chores in the river has not only impacted the quantity and the quality of the river but it has also contributed to the river erosion very much on a local scale. On the other hand, in the Municipality area, urban drainage systems tend to perform poorly, mostly as a result increased population and haphazard urbanization. Solid garbage (such as plastic, packages, and aluminum cans) clogs most open surface drains. Therefore, regular flow is severely hindered. In the monsoon season, this stagnant liquid waste causes foul odors, pathogens, and urban floods (Dutta & Mistri, 2016).

Data and methodology

The data presented in the paper are collected from both the sources of Primary and Secondary data. Primary data includes the conversation with the citizens, waste workers and Municipal Officials in the form of focused group discussion and informal interview respectively and with the observational participation during field survey that took place in the month of April 2023. The secondary data which were needful for further map generation and graphical interpretation includes the sources, type of the wastes, the amount of the waste generation, collection etc.- are provided by the Municipal Authority, Burdwan Municipality from 2021–2022 (Fig. 2).

The focused group discussion

It is a unique approach to gather data because they encourage interaction among participants in a spontaneous way. They are mixed in nature because they have walked from different strata of society based on the educational and economic profiles. This leads to more comprehensive and in-depth data compared to individual or group interviews. The process involves investigating the individual thoughts and feelings of group members on a particular topic. Proper preparation before the session is important to ensure relevant and detailed data is collected. Overall, focus groups are a valuable tool for gathering rich and varied data through social interaction among participants (Gundumogula et al., 2021). For surveying the citizens, Focused Group Discussion method of interviewing was selected based on a particular kind of groups from various parts of the Municipality in terms of objectives, demographics, operating methods and situations (Fig. 3). (Pierce et al., 2009). The method was developed as a qualitative data collection method and as a way to connect local knowledge to scientific study (Nyumba et al., 2018). After going through the available literature, reports published by Burdwan Development Authority (BDA) and a pilot survey made prior to the study, the wards and subsequent groups were chosen out of 35 wards of the Municipality, depending on the population density of the wards, the magnitude of waste generation, frequencies of collection, and keeping the centrality of development and the peripheralization of the wards in consideration. A beforehand questionnaire was prepared for the interviewer and the role of moderator was assigned to one person. The groups are of two types: A) the citizens B) The Municipal Workers. (The regular Municipal workers, who collect wastes, sweep the roads at every morning, and clean the drains) For both the cases, the sample groups were heterogeneous in term of age and sex so that the inter-generational insight can be understood, and it ranges between 4–8 persons. Let us have a look at the details of the respondents' especially demographic aspects of the citizens and the waste workers of the FGDs. (Table 1).

Semi-formal interviews

This type of interviews are considered as neglected yet one of the important tool to extract naturalistic data. (Swain & King, 2022)The interviewer speaks with people in the field informally, without using any kind of planned interview guide. The investigator attempts to recall his or her talks with informants and employs jottings or quick notes recorded in the field to aid in remembering and writing of notes from field experiences. (Robert Wood Johnson Foundation, 2008).

Field observation/ Observational analysis

Observation is a way to get information by looking at behavior, events, or physical traits in their natural environment may be in an overt or covert

Table 1 The demographic dynamics of the respondents

FGD (Focused Group Discussions) No. (Dwellers)	Number of Participants	Area Surveyed	Gender
FGD-1	7	Railway Loco Colony (Ward No.6)	Male-2 Female-5
FGD-2	8	Edilpur (Ward No.24)	Male-4 Female-4
FGD-3	8	Ashram Para (Ward No.6)	Male-3 Female-5
FGD-4	6	Khosbagan (Ward No 10)	Male-6 Female-0
FGD-5	5	Rath Tala (Ward No.23)	Male-4 Female-0
FGD-6	8	Becharhat Colony (Ward No.13)	Male-3 Female-5
FGD (Focused Group Discussions) No. (Waste Workers)	Number of Waste Workers	Area Surveyed	**Gender**
FGD-1	5	Becharhat Colony (Ward No.13)	Male-3 Female-2
FGD-2	4	Near Sarba Mangala Mandir (Ward No.29)	Male-4 Female-0

Focused Group Discussions, 5th to 9th April 2023

way. (CDC, 2018) While talking to the individuals, some covert observation are recorded regarding their surroundings and their expressions, the amount of the emphasis put on a particular word etc.

The graphical representation and map preparation

This section of the paper is done with the help of MS-Excel, 2017 after the data provided by the Burdwan Municipal Authority. Maps are executed through Network Analysis in ArcGIS Version 10.4 using the base and the road maps provided by the Municipality.

Results

From the perspective of the municipal officials: (As per report and semi-formal interviews)

i. As per Municipal Solid waste Rule 2016, the Municipal administration has taken different measures for up gradation of Solid Waste Management work time to time.
ii. Collection of garbage from house to house has already been implemented and in the meantime 70% of the wards have been covered under this system. This Municipality has got its own land where the collected garbage is transported and stored by dumping.
iii. The method of Segregation of biodegradable and non-bio-degradable waste at source level on and from 22/03/2020 as per order of State Govt. and the process is going on. Municipality is looking for a partner after the contract of TAAS agency got over, who has got experience and resourceful persons in disposal of Solid, and bio-medical Waste and can work using the Municipal manpower, vehicle etc. with reasonable charge to be paid by this Municipality. Medicare, a non-Govt. organization (approved by W.B.P.C.B.) tendering the service of collection and disposal of Bio-medical waste of all Nursing Home, Hospital and Pathological center within Burdwan Municipal area.

iv. A mechanical Sweeper has since been introduced on a trial run for effective and efficient management of solid waste in the Municipal Area.
v. Besides, measures are being adopted for handling and disposal of solid and bio-medical waste in a scientific and hygienic way as per guidelines of the Act and Rules. 3 nos Movable compactor, 5 nos stationary compactor with 1 nos Hook Loader, 1 Nos Hydraulic Dumper, 2 nos 2.2 cum fuel operated Tipper, 7 nos Battery operated Tipper and 1nos Tractor with trolley are engaged for collection & disposal of solid waste through department directly.
vi. Private agencies are also engaged for collection and disposal of solid waste from the rest part of the Municipal area daily. (*Reference for point **i to vi**-Administrative report of burdwan municipaliyt, 2021)*

From the citizens' perspectives: (Including the Municipal Waste Workers')

i. Though the Municipal Officials has shown the adminstratice reposrt of Burdwan Municipality, 2021–22 or shared some promising visions, but during the field survey or from the citizen's view point the scenario was quite opposite. It is even evident if someones travels to any part of the Municipality they can see the dumps here and there.
ii. While discussing with the citizens dewlling in Railway Loco Colony (Ward No.6),Edilpur(Ward No.24),Ashram Para (Ward No.6) and Becharhat Colony (Ward No.13) –who suffer most due to this unmanagned and untreated wastes on the road or drainside,complained about issues related to the solid waste management infrastructure, man power and citizens' attitude in this sector.
iii. The waste workers also did not leave the chance to vent out the grief regarding their health issues. These will be elaborated in the Discussion Section (Sect. 4).

Discussion

History of solid waste management in Burdwan Town

Burdwan town was a lovely residence under the reign of the *Jamindars* because it was clean, quiet, and pollution-free. The *Jamindars* took considerable care in making Burdwan a modern metropolis, notably Sir B.C. Mahatab and his son Sir U.C. Mahatab. The group of individuals created a sewage system using science. They built the first water purifying system in Lakurdi. Burdwan residents never experienced water logging during their existence in the town, at any location. But in today's life, people frequently had to walk through or wade through muddy water since most of the drains had clogged and the whole sewer system was in disrepair, even if it drizzles at some part of the Municipality. Burdwan Municipality didn't have a distinct conservatory department at the beginning or area since there weren't many people there and most of them lived near Raj palace in Burdwan. The locals were used to using traditional earthen pots, sal leaves, and other materials for sewage disposal, as we described at the beginning. Paper bags (or "*Thonga*"). Because the clay pots, sal leaves, and paper packages were biodegradable, there was no such thing as solid garbage. They gather to discuss the lack of a dedicated conservatory section. The early beginnings of the Burdwan Municipality, most of the rubbish is on the road or on the side. It also spreads bed odors and infections. The sanitation facilities were deplorable. In Burdwan, there were several unclean latrines. People used to carry feces and urine on their heads. Most of the roads are unpaved and narrow. The locals have a drinking water shortage. The current municipal board has taken the required steps to address the previous issue. Since 1981, the municipality has been carrying out several development projects to enhance Burdwan town. There were just a few metallic roadways nearby at the time. There were just a few metallic roads near Burdwan town at the time, and the remaining roads are non-metallic. There was a paucity of water and no electricity. People were not aware of the waste management system at the time. People's awareness grows throughout time, as does the growth of municipal conservation

services. The number of technical service professionals, trucks, equipment, and infrastructure is growing. The labor union's responsibility, the State Government's grant for trash management, and the municipality's portion of waste management income all rose (Mondal, 2015).

Present scenario from the municipal desk

Many urban local authorities' municipal solid waste management services fall significantly short of expectations due to poor organizational frameworks and insufficient resources. In light of the Municipal Solid Waste (Management and Handling) Rules, 2000, there is a sense of pressure throughout India for positive reforms in the municipal solid waste management system (Singh & Kalamdhad, 2016). In case of Burdwan Municipality, the municipal official seemed quite hopeful regarding the progress they are making in solid waste sector as they have started the process of segregation of waste at source in some wards.

The above image shows how efficiently the Municipality tries to cater for the maximum area by dividing the whole area into some routes of collections, namely from route-A to route-H. The no of Land Vats (LV) and Trolley Vats (TV) those were engaged in these routes are shown in Figs. 4 and 5 As far as the composition of municipal solid waste is concerned, it forms mainly due to the household wastes which included large number of plastics and other non-biodegradable stuffs (Fig. 6). The waste from the market areas is the second highest proportion followed by the waste from trade and commerce or industries. During the field study, the wastes from the vegetable markets were found to be left here and there open on the streets and a few drainages from the industries situated on the bank of River Banka happened to be linked in Banka, but most of them have become clogged due to unfiltered wastes. If the profile of the waste generation/

Fig. 4 Showing the routes of land vat and trolley vat (Route-A B C, D E (dotted with black), F G H) (Retrieved in the month of April, 2023)

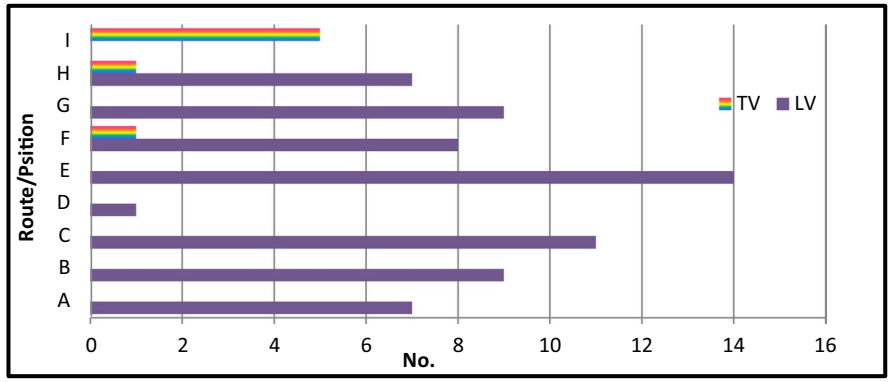


Fig. 5 Number of land vats and trolley vats along with the route divisions Source: Burdwan Municipality, 2023

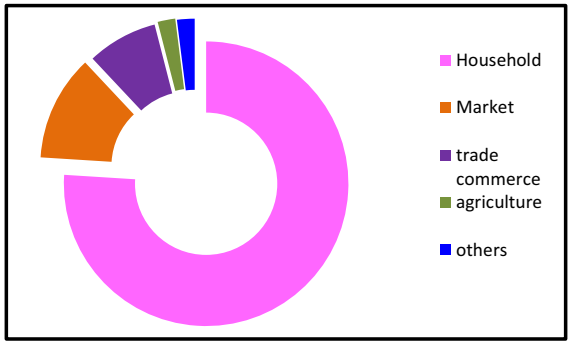


Fig. 6 Source of wastes under Burdwan Municipality, 2020 Source: Burdwan Municipality, 2023

day and consequent collection is analyzed, it might be inferred that at least 1/3rd of the waste, (1/2 in some wards) go under the section of 'not collected' and dumped here and there. (Fig. 7) It is also seen that the wards which generate more waste than the average value, some of them are situated adjacent to the river Banka. (Table 2) This on the other hand, might signify that they have a greater chance of littering the river than the rest of the wards. Even the proportion of non-degradable wastes such as plastic, artificial polymer, electronic waste and the hazardous wastes like batteries, pesticides, motor oils released by these wards are much higher than its average value of all the wards. The ward no 28 has been put as a role model for waste collection and management since the very beginning due to the efficiency of its workers. Each word has 3–4 people engaged in the cleaning of drains and roads and 2 people for sweeping of the roads. The Municipality has taken its baby steps towards recycling the products through an agency recruited by KMDA (Kolkata Metropolitan Development Authority), namely TAAS for the project 'Legacy', which is currently on going in the wards for solid waste management as conversed with the chief-handling officer of Municipal Solid Waste of Burdwan Municipality.

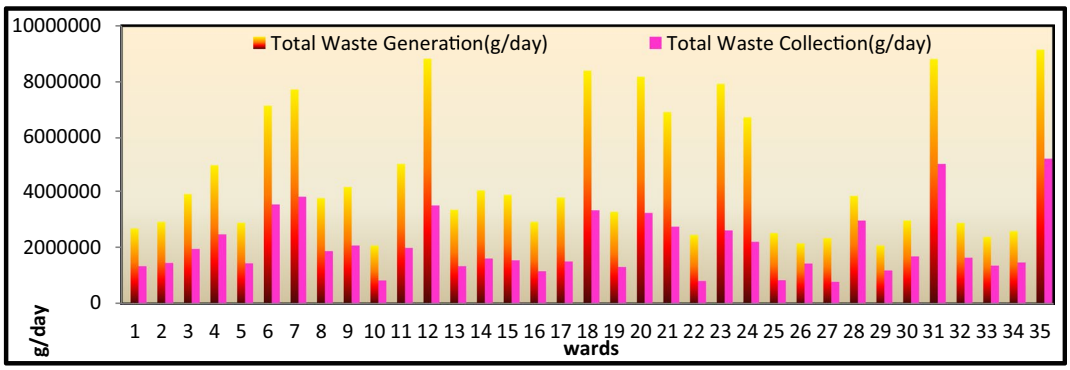


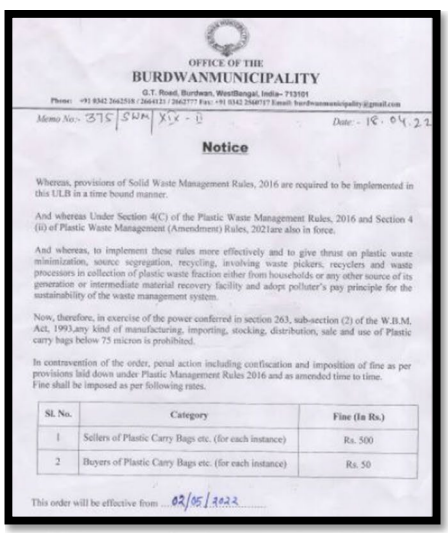
Fig. 7 The amount of waste generated and collected, 2021 Source: Burdwan Municipality, 2023

Table 2 Proportions and types of Municipal Solid waste generation, 2022

Ward No	Biodegradable waste (g/day)	Non-Biodegradable Waste(g/day)	Hazardous Waste(g/day)
1	2295000	378000	27000
2	2352000	529200	58800
3	3320000	602250	15450
4	4083600	846600	49800
5	2473500	407400	29100
6	5680000	1374506	68681
7	6145645	1483245	65565
8	3076840	667898	53260
9	3553256	608464	38000
10	1680000	404250	15000
11	4125767	882696	15750
12	7154399	1617000	37303
13	2722900	556200	98597
14	3373392	664480	30900
15	3184924	628151	92328
16	2378000	493000	66924
17	3215577	569628	29000
18	6840540	1398288	140172
19	2805000	478000	16000
20	6657000	1466000	34100
21	5546000	1236100	117900
22	2025000	419100	24700
23	6232000	1593950	67550
24	5422605	1215329	63365
25	2082000	431800	25400
26	1768550	390600	10850
27	1888000	448400	23600
28	3212100	638550	19350
29	1680000	315000	105000
30	2290247	443712	251734
31	7078000	1320000	400985
32	2436000	319000	145000
33	1968000	408000	24000
34	2158000	364000	78000
35	7520300	1459100	151000
Total =	**130424142**	**27057897**	**2490164**
	118 T 280 kg 518 g	27 T 77 kg 997g	2 T490 kg 164 g
Average=	3726404.057	773082.7714	71147.54286

Burdwan Municipality, 2023 (the highlighted values are above average values).

Image.1: (Left)The Notice for waste segragation at source by the Municipality and Image.2:(Right) Compactor station(UNIT-2); Source: Field Survey, April, 2023



OFFICE OF THE
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Memo No:- 375/SWM/XSX-U Date:- 18.04.22

Notice

Whereas, provisions of Solid Waste Management Rules, 2016 are required to be implemented in this ULB in a time bound manner.

And whereas Under Section 4(C) of the Plastic Waste Management Rules, 2016 and Section 4 (ii) of Plastic Waste Management (Amendment) Rules, 2021are also in force.

And whereas, to implement these rules more effectively and to give thrust on plastic waste minimization, source segregation, recycling, involving waste pickers, recyclers and waste processors in collection of plastic waste fraction either from households or any other source of its generation or intermediate material recovery facility and adopt polluter's pay principle for the sustainability of the waste management system.

Now, therefore, in exercise of the power conferred in section 263, sub-section (2) of the W.B.M. Act, 1993,any kind of manufacturing, importing, stocking, distribution, sale and use of Plastic carry bags below 75 micron is prohibited.

In contravention of the order, penal action including confiscation and imposition of fine as per provisions laid down under Plastic Management Rules 2016 and as amended time to time. Fine shall be imposed as per following rates.

Sl. No.	Category	Fine (In Rs.)
1	Sellers of Plastic Carry Bags etc. (for each instance)	Rs. 500
2	Buyers of Plastic Carry Bags etc. (for each instance)	Rs. 50

This order will be effective from ... 02/05/2022 .....

Image.3:(Left) The Notice on Plastic Ban issued on the April, 2022 by the Municipal Authority and Image.4: (Right)The Land Fill site; Source: Field Survey, April, 2023

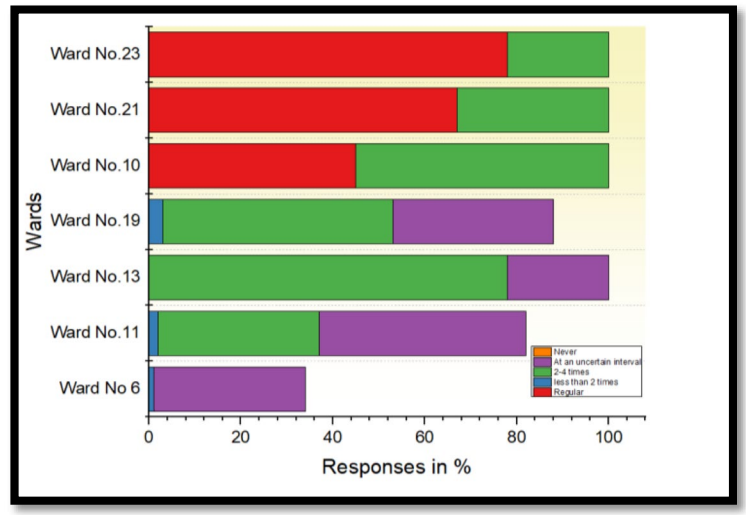

Fig. 8 Frequencies of waste cleaning by the municipal authority. Source: Primary Survey, April, 2023

From the citizens' viewpoint

Citizen or the community is the backbone of any civic system-without their existence and cooperation, no programmes can achieve their goals. It is always desirable to improve individuals' participation in producing minimal waste and their sense of responsibility for the waste materials produced, through careful instructional preparation and notifying all segments of society (Alipour et al., 2015). While discussing their issues regarding solid wastes, they came up with some points:

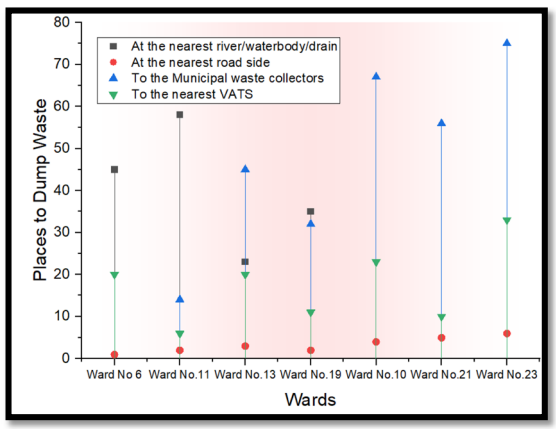

Fig. 9 The places to dump the wastes. Source: Primary survey, April, 2023

1. There is no cleaning that takes place everyday, even if they sweep the main roads regularly, they do not do it for the side lanes. (Figs. 8 and 9).
2. Plastic is a major component of the wastes, which clogs the drains fast and that is why giving them a condition waterlogging in most of the time in the year and flooding in rainy seasons.
3. The fellow citizens lack the basic civic senses, at times they dump larger wastes like mattresses, chairs coming from faraway wards (Fig. 9).
4. There are several parcel of lands owned by individuals, who do not stay in the Municipality area anymore, eventually those lands has become dumpyards. And as they are personal propertiies there is a continuos tiff goes on between the local people and waste workers that who would be the cleaning authority in absence of owner.
5. The wet silts are picked up from the drains and is left as it is at the side of the drains for much longer period of time than it should have been.
6. The dumped wastes spread pungent odur and are breeding grounds for mosquitoes- thereby causing threats to the children especially.
7. Despite several complaints to the Municipal authority, nobody paid the attention to this severely threatened scanrio.

Causes	FGD1	FGD2	FGD3	FGD4	FGD5	FGD6	FGD1(W)	FGD2(W)
Less/Least Awareness								
Wrong Attitude towards citizen								
Do not how to segregate								
More Plastic usage								
Using vacantland as dump sites								
cross ward dumping								
regularity of cleaning								
insufficient workers								
Road side dumps								
Drain side dumps								

	>25%
	25-50%
	<50%

Fig. 10 The perception of the citizens and the waste workers (last two columns) behind such generation of huge wastes Source: Primary Survey, April, 2023

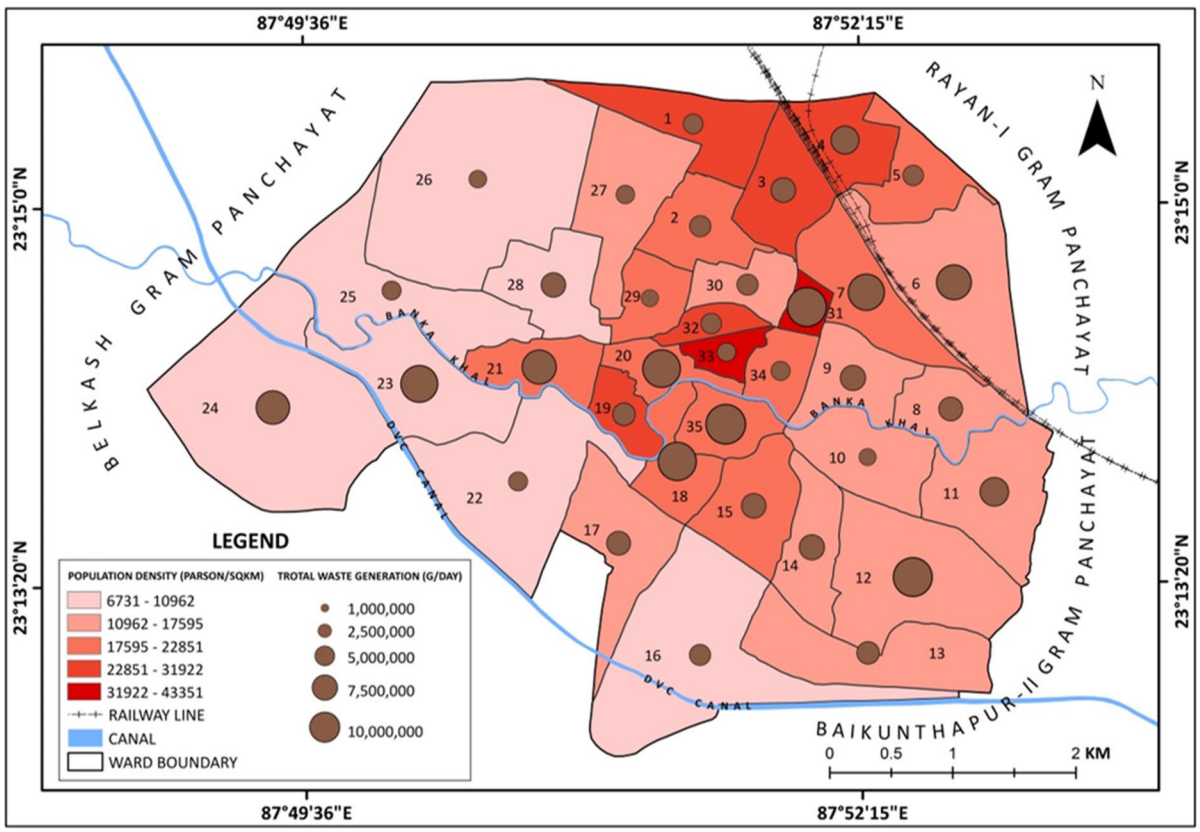

Fig. 11 The distribution of population and waste generation in Burdwan Municipality Source: Burdwan Municipality, 2023

Image. 5 and 5A. The improper waste dumps in open areas Source: Field Survey, April, 2023

Image.6 The drain is filled with trashes Source: Field Survey, April, 2023 (Fig. 11)

The situation of Khosbagan (Ward No 10) and Rath Tala (Ward No.23) is a little bit better –possibly there might be two reasons: firstly, Khosbagan being the medical center of the Municipality area (all well-equipped nursing homes, clinics, pathological labs) it has got its separate system of handling medical wastes as it is sorted by an agency from Asansol (as per the conversation with the officials) and secondly, both the areas are being locationally famous and geographically centralized. There is a sharp contrast distribution of conservancy facilities in the centrally positioned wards and the peripheral ones, which can be easily interpreted with the variation of the existing open and haphazard garbage dumps. Even in some mostly populated areas, the drainage lines are completely covered by the trail of plastics and glass bottles. The diagram below shows the responses from both the citizens, including the waste workers, to the perception of the causes behind the waste accumulation (Fig. 10).

The Municipal waste workers of both the focused discussion groups have come up with an appeal to make the citizens more aware of the waste segregation at the source policy- they should be trained enough to eliminate the bio-waste, non-biodegradable ones and watery waste. This would make them help to work faster and better. Not only this, but they have also suggested making a waste management system on an individual basis for every household so that at the time of collection there would be no mistake of mixing waste. They have urged the Municipal authority to put a strict ban on plastic usage, maybe with an imposition of monetary fine to the users. Both group members have complained about their problems associated with the over exposure to waste. They do not have proper shoes or raincoats to work in the rainy seasons when the drain clogging reaches its peak. They also suffer from skin diseases due to scarcity of gloves and exposure to many chemical insecticides. But clearly, a blame game is prominent among the Municipal officials, waste workers and the citizens to avoid their part of duties towards the city environment.

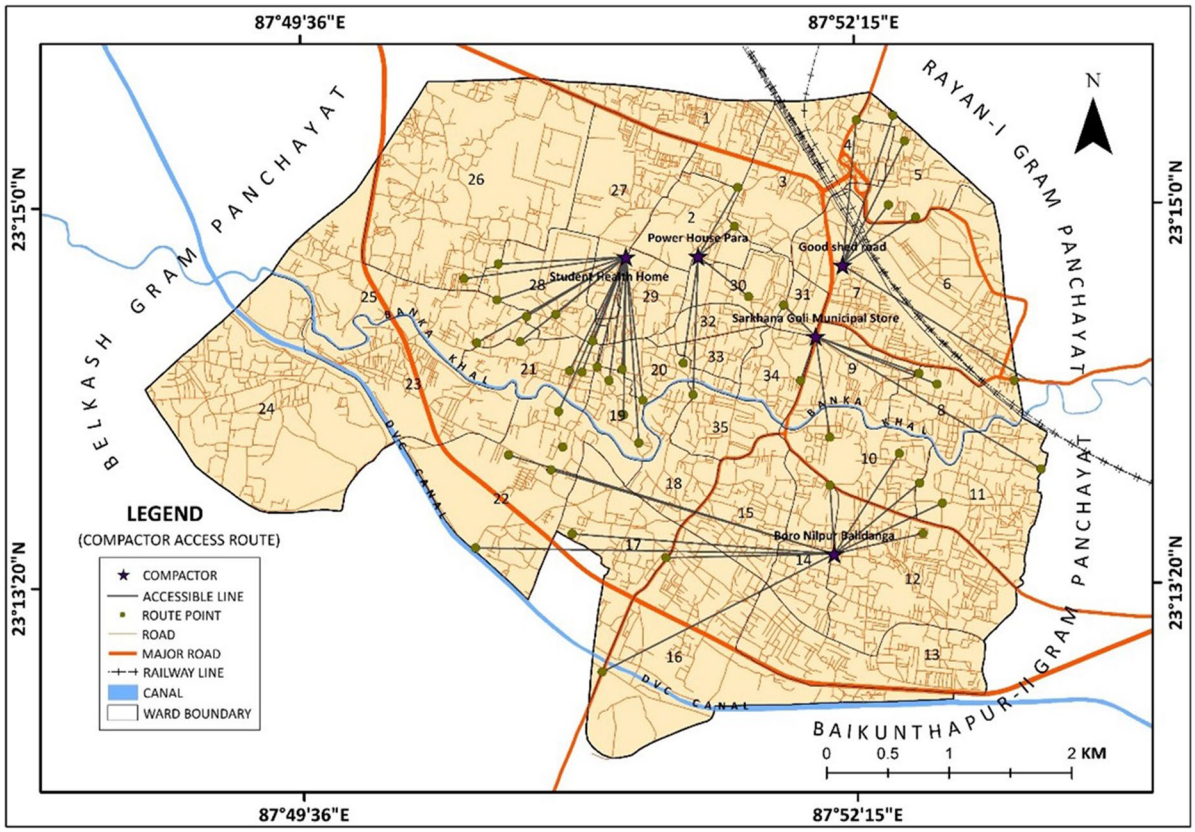

Fig. 12 The routes of access towards the existing compactors Source (Base Map) Burdwan Municipality, 2023

Recommendations

The recommendations have been categorized into two parts- a) Structural, the one which is related to the equipment and infrastructure and b) Non-structural which deals with mostly the awareness and duties of the citizens (including officials, waste workers and commoners). Burdwan Municipality has got five compactor stations, which are used to reduce the size of waste material before dumping them into the landfill sites, thus helping in better processing of trash. The Stations are at Good Shade Road, Powerhouse Para, Boro Nilpur Balidanga, Sarkhana Goli Municipal Store, Shyamlal near Student Health Home. The compactors are placed in such a way (Fig. 12) that the peripheral wards of the Northwest and Western parts are getting deprived of this facility, rather some added pressures of performance are being given to the station of Boronilpur Balidanga. (Fig. 12) In this situation, a network analysis is performed through ArcGIS with the option Location-allocation – which assists in determining the optimal locations for facilities to service a set of demand areas. The locations may be attempting to meet the greatest amount of demand, minimize pressure to the greatest amount of already pressurized compactor, or maximize the working efficiency of the compactors by suggesting a new location of the compactor. Firstly, to justify the location of the new compactor, some buffers were created around all the stations which are of 1500,2000,2500,3000 m., which depicted with the existing compactors, which do not cater the farthest parts of the municipality. Therefore, to cover the whole municipal area with the compactors' influence, another one was introduced at

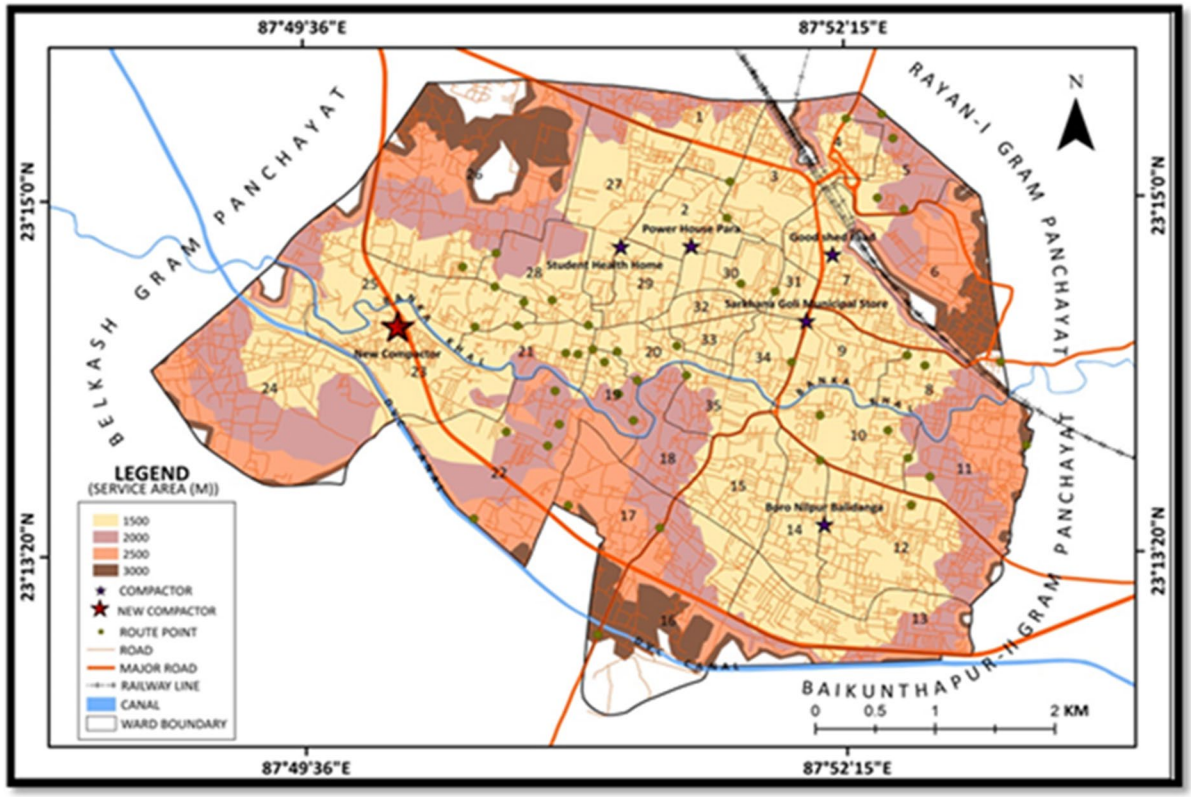

Fig. 13 The service/influence area of the compactors Source (Base Map): Burdwan Municipality, 2023

Image.7 and 7A: The Municipal Waste Workers at work Source: Field Survey, April, 2023.

the western part of the municipality (Fig. 13) which would reduce the existing load and through the service area it is seen that the whole area got covered in terms of compactors' service influence. (Fig. 14).

Figures 14 and 15 As far as the non-structural recommendation from the respondents and the interviewers are concerned, they pointed out some gestures with which change of this waste stagnation can

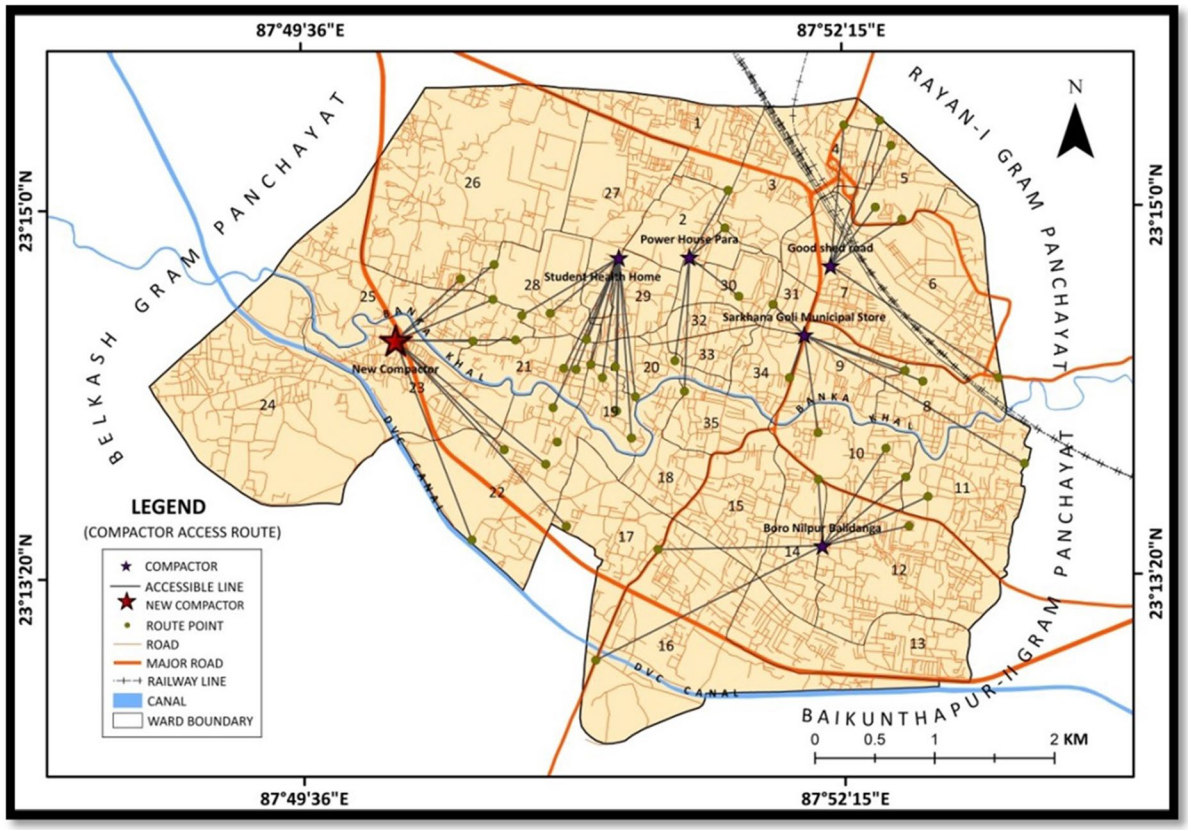

Fig. 14 The Accessibility routes of all the compactors including the new proposed one Source (Base Map): Burdwan Municipality, 2023

be possible. They are represented in a diagram below: (Fig. 16)

In this regard, following Alipour et al., 2015 it can be said that citizens' participation is the key-citizenship collaboration involves altering their views through culture building and citizenship education, which is considered by urban managers in a variety of ways and is the most essential answer for changing people's attitudes and improving civic culture. Given that any society educates special citizens with special characteristics, ensuring the survival and continuity of social life and development in any country, deliberate citizenship education on the issue of waste materials should be considered for all segments of society.

Conclusion

Unscientific solid waste management not only poses problems to cities' infrastructure and amenities, but causes air pollution, water, and soil contamination. Open and unsanitary landfills contribute to contamination of drinking water and can cause infection and transmit diseases. Our study area has always been an old and heritage city that is why competing with the new planned cities in the modern era is quite impossible. The city suffers from air borne and water borne diseases because of mistreated wastes, undesirable behaviors of the dwellers and negligence of urban local body. The Central government has approved the

Fig. 15 Google earth image reference the original location is **Point-A** Rath tala Manohar Das Vidyaniketan but due to presence of a school it can be shifted towards **Point-B** Lakurdi Annapurna club in the western part of the municipality. (retrieved on May, 2023)

12th and 13th Finance Commission Grants and Funds for Municipal Solid Waste Management to encourage it in cities. The initiatives such as UIDSSMT(Urban Infrastructure Development Scheme for Small and Medium Towns)and JNNURM(Jawaharlal Nehru National Urban Renewal Mission)from 2005 later on, as well as the most recent Swachh Bharat Mission as SBM. (Mani & Singh, 2016) Apart from these, there are other two scientific missions too- Waste-to-Energy and Waste-to-Wealth. In Burdwan Municipality, other than Plastic-Ban policies, (though that is not properly monitored regularly), we have found that there is no other initiatives have been taken up. A huge difference between the regulations on paper and the ground scenario and a complete absence of monitoring system from the authority is clear. Instead of a top-down approach towards sustainable solid waste management, community-centric, individual-based approach might prove much more efficient as it can be regularly assessed with the help of some local urban leaders. Reducing waste at the source, segregation and recycle- these three should be the pivotal steps to fight against unnecessary dumps of waste. The municipality would probably gain more comfort in distributing the responsibilities among local citizens to some extent while focusing on amplifying the infrastructural network of solid waste management.

Fig. 16 The conscience of a citizen toward keeping the city sustainably clean

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