Source Separation of Solid Waste at Households level through Community Mobilization in Selected Hotspot of Island City of India, Port Blair, India

Aviral Saxena[1], Carla Rossitto Nadal[2], Vaishali Nandan[3]

[1]Waste Management Advisor, CCPME & MOWI Project, GIZ-India, Port Blair, Andaman & Nicobar Islands (ANI), 744101, India
[2]Technical Advisor, CCPME & MOWI Project, GIZ-India, New Delhi, 110001, India
[3]Project Head, CCPME & MOWI Project, GIZ-India, Port Blair, New Delhi, 110001, India
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Presenting author email: aviral.saxena@giz.de

Abstract: - Port Blair Municipal (an Island city) is facing the challenge of source segregation despite lots of awareness activities done by the municipality. Even, Ministry of Housing & Urban Affairs, Government of India initiated special drive for waste segregation at source like Hara-Geela, Sukha-Neela in across the county. In spite of massive awareness activities about waste segregation, waste segregation at source still is a challenge for municipality. This study was conducted in three identified Hotspot of Port Blair city in India. This paper presents waste characterization study, interviews, households surveys, door to door monitoring & mobilization with household women during and after waste collection activity. This survey attempts to identify the limiting and motivating factors on the part of households to waste collection, waste segregation & waste given to waste collectors by Households. The results shows that women of households are the key player to ensure the waste segregation at households' level which makes the changes during the mobilization like; improvement in not given waste to waste collector 39% to 18%, reduce the percentage of household who were providing unsegregated waste to waste collector 30.44% to 16.46 % and improvement in waste segregation 31 % to 65 % which shows women are key stakeholder for door-to-door mobilization in waste management activities.The result also shows a significant difference between waste segregators and non-waste separators on their level of perception towards implementation of laws for source segregation. Perception may change in attitude through mobilization and proper monitoring of waste management activities and also that methods and frequency of collection are the major limiting factors preventing households for waste segregation in Port Blair City.

Keywords: - *Source Segregation, Fisherman, Collection routes, Awareness, Islands*, enforcements.

I. INTRODUCTION

Proper Solid Waste Management (SWM) is a challenge for municipality to protect the environment and the well-being of human beings. If waste is not properly managed by municipalities or Urban Local Bodies, it may contaminate to soils, water and air thereby affecting the quality of life, human health and also creating threat to marine life as became a marine litter which may be a cause to create nuisance and marine life feel uncomfortable. The major components of SWM are waste generation, source separation, collection, transportation, processing, and disposal. At the first stage of waste generation, whereby source reduction strategies can be implemented which may be the initial step to manage the waste. For effective waste management waste minimization through reuse and recycling which necessitates incorporation of waste segregation in the waste management stream [1]**.** In addition, waste segregation at source may ease handling and processing, enhance the potential for resource recovery and reduce operational costs. [2] According to The Solid Waste Management Rules 2016, in supersession to the Municipal Solid Waste (Management and Handling) Rules 2000 by Government of India. Primary collection of waste defined as collecting, lifting and removal of segregated solid waste from source of its generation including households, shops, offices and any other non-residential premises or from any collection points or any other location specified by the local body (3, (34), Solid Waste Rule 2016). and also defined the duties for waste generators *"Every waste generator shall segregate and store the waste generated by them in three separate streams namely bio-degradable, non-biodegradable and domestic hazardous wastes in suitable bins and handover segregated wastes to authorised waste pickers or waste collectors as per the direction or notification by the local authorities from time to time"* (4, (1a), Solid Waste Rule 2016). [3] Segregation of waste can save valuable resources in the form of saved hours required to deal with the un-segregated waste. With the segregation of waste at the source point, the amount of waste going to the landfill is greatly reduced and without waste segregation, composting or recycling is not possible [4]. Accordingly, Port Blair Municipal Council provided the two types of dustbins (Blue for Dry and Green for Wet waste) to household for segregation of household waste

and parallelly, Port Blair Municipal Council create the awareness among the citizens for segregation of waste through their municipality staff. In view of this, waste segregation needs to be adequately communicated to the public, so that residents‟ habits, behavior and traditions can be changed for the better, thus enabling local authorities to achieve government goals towards solid waste management [5]. Periodic research has been performed where new methods like people participation initiatives suggested under Swacch Bharat Mission (SBM) of Ministry of Housing & Urban Affairs (MoUHA), Government of India across the India and technologies have been developed to find a friendly solution to the issue in waste segregation particularly involving the waste generators to separate their recyclables. Attitudes and perceptions toward waste segregation at source and rating of waste disposal issues in people‟s minds and in the scheme of official development plans have not been adequately considered which has thus led to the recent upsurge in waste disposal problems in developing countries. Communities don't have the attitude as long as to store the waste at home and handover to waste collector, even they did not wait for the morning waste collection system and throwing in nearby drain or dumped at open places which is the most suitable option for households to get rid of from their wastes. Generally, people perception, this is the responsibility of municipality [6]. The perception of the community specially women of households in waste segregation cannot be denied and is important to examine for the purpose of improving the municipal solid waste management strategies to manage, prevent and mitigate excessive waste disposed to drains or in landfill thus extending the lifespan of the landfill. Women play an important role in the recycling of household waste separation at home in Turkey [7]. According to study conducted in Machala, Ecuador to examined attitudes, knowledge and practices of urban households relating to solid waste disposal, in the most households (88%), women were responsible for separating waste. [8]. Port Blair Municipal Council, still facing the challenges in the attitude towards waste segregation & that' why this study was necessitated. As in a wide spectrum, source segregation at household level is not given adequate attention to, as the waste generators are not considered in its planning and design stage because their "felt needs" are not highlighted and determined. This paper presents a study carried out to determine collection of waste and its monitoring, how involvement of women of households through mobilization effect the segregation of waste at households and their perceptions; limiting and motivating factors toward waste segregation and also to determine whether there are existing infrastructure and legislative setup to support household participation in waste segregation in Port Blair City.

II. METHODOLOGY

2.1 Study area

The current extent of the area under investigation (Port Blair Municipal Council) is bounded by the geographical coordinates 11°35'30" and 11°41'30" N and 92°41'30" and 92° 45' 30" E (figure 1.1) This study is related to Andaman and Nicobar Islands (ANI's), a Union territory belonging to India is situated in the Bay of Bengal. Port Blair Municipal Council (PBMC) is the only municipal body in ANI's and Port Blair is the capital of it with a population of 1,39,828 residents and a total of 36488 households. [9]. GIZ- India is implementing the Cities Combatting Plastic Entering Marine Environment (CCP-ME) project in Port Blair City in collaboration with Port Blair Municipal Council. The present extent of the Port Blair Municipal Council (PBMC) is 41.22 Sqkm with a perimeter of 55.31km with twenty-four wards. GIZ-India in consultation with PBMC selected 03 Hotspot area namely, Junglighat Fish Landing Area (Fisherman community) (Ward No-14), R.K. Mission area (House Holds, educational institution and officials, Ward no-10) and Carbyn's Cove-Austinabad (Urban Households and shopkeepers Ward no-22) (figure 1.2)

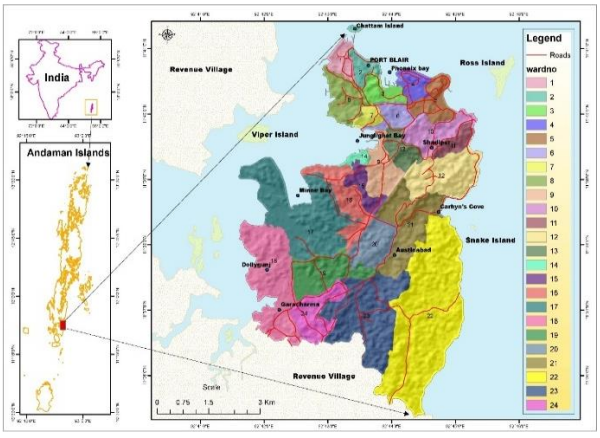

Figure 2.1: Map of Port Blair Municipal Council

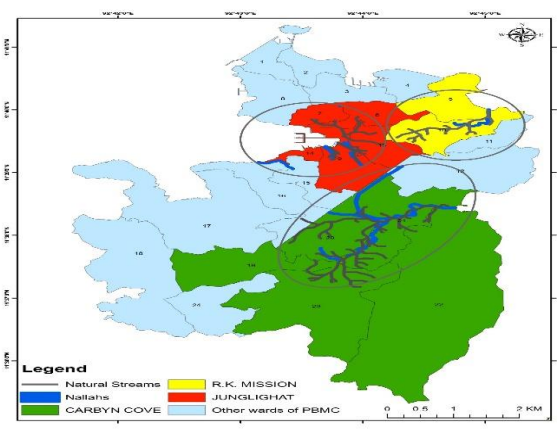

Figure 2.2: Map showing the Hotspot Study area

This study is being conducted in all 03-hotspot area and to understand the current practices of waste segregation at source through door-to-door monitoring & mobilization of waste collection system in the respective area. A structured survey questionnaire which included information on the sociodemographic status of the respondents, segregation practices, route maps of waste collection and satisfaction status of households for waste collection service used to elicit information. High population density and topographical considerations were among the factors for choice of this case study area, while topography has implication on the operational activities related to waste management. It was learnt that Port Blair city has an undulating terrain such that movement of pollutants from high to low elevation is possible. In Jungligaht area (Fisherman community area) fishing activity and business is practiced. The main source of income is engagement in fishing industry and employment in both formal and informal sectors. It is a major Fish Landing Center in the city and Andaman & Nicobar Islands as well. The adjoining of FLC, fisherman community is residing which is densely populated area. 2nd R.K. Mission, It is a posh locality in Port Blair City, has the major recreational centers and institutions like RK Mission, JNRM and Gandhi Park etc and 3rd Austinabad (Carbyn's cove area) which is a major tourist attraction because it is the only beach in the city & the households and commercials are mostly situated on the west side of the drainage.

2.2 *Sampling Procedure and Data Collection*

Sample was selected using stratified sampling technique where each ward was taken as a stratum. Sample size was selected based on simplified formula for proportions by Yamane [10].
According to Yamane, at 95% confidence level,

$$n = N/1 + N\ (e)2 \quad (1)$$

Where *n* is the sample size, *N* is the population size, and *e* is the level of precision.
At 95% confidence level and 5% precision level, the required sample is 383 households. Sample were selected in 03 wards and focusing on their living standard of hotspot area. Final sample households selected for this study is 1505 households that gives a 2.57% precision level at 95% confidence level and a response rate of about 95%.

2.3 Data collection and analysis

The study employed 06 data collection methods which are waste characterization study, review of route map for waste collection, interviews with community, door to door monitoring of waste collection & segregation, Mobilization of community for waste collection & segregation and measurements of waste and conducted in 03 three identified hotspot area of PBMC. Initially, a detailed waste characterization study was conducted to understand the waste composition and per capita waste generation and waste composition in the respective area. To achieve this, houses were provided with plastic bags for waste collection and thereafter, the volumes and weights were measured. To obtain the weights and volumes of individual constituents (organic food waste, glass, plastics, paper, pampers, electronic wastes, textiles, metal/tins, aluminium, sweepings and ashes) of waste were sorted [11]**.** Secondly, to understand the waste collection & segregation system, the collection route of identified Hotspot area has been reviewed. Thirdly, Interviews were meant to track the existing knowledge for waste segregation and collection timings from the women of the households that included the community leaders. Semi-structured interviews were conducted to obtain information pertaining to the practice, challenges and factors affecting waste separation which was undertaken using a structured questionnaire to collect information on household-level practices, challenges and attitudes on waste management. The sample size for survey was considered adequate to depict the real situation as the household characteristics are almost homogenous. Table -1 shows the data of tentative households and population in the hotspot are given below :

Table 1. Identified Hotspot and their households and population

Hotspots	Households	Total Population
Junglighat	1165	5119
RK Mission (Small Pockets)	174	598
Carbyn's Cove (Austinabad (Small Pockets)	166	699
Total	**1505**	**6416**

Fourthly, all the households come under the route were monitored and mobilize for at-least 10 days. The reported information was substantiated with site observations during the waste collection by waste workers in the morning

where waste collection, segregation, storage, accumulation, and handling at site were tracked & monitored. Fifthly, Mobilization of Households women was done after the collection service specially who were not providing the waste and not providing segregated waste to the municipal workers on same day. Community mobilization refers; it is a process that brings together different societal factions to deal with something such as a health crisis, a social problem, or an environmental issue. Everyone gets involved, including local, national, and federal government groups, NGOs, religious groups, businesses, and individuals. Benefits of community mobilization include the sharing of resources and funding; more effective problem-solving; better representation of voices within the community; and accountability. Sixthly, measurements of waste collected by the municipal workers on route wise were done, to understand the waste generation.

3 Results and discussion

3.1 Waste generation and composition

The average solid waste generation rate for households of Port Blair was established to be 0.23 Kg/capita/day (n = 240) for High Income Group, 0.20 Kg/capita/day (n = 240) for Middle Income Group & 0.19 Kg/capita/day (n = 240) for Low Income Group respectively. A study from Gorkha Municipality, Nepal reported that the per capita household waste generation in Gorkha municipality is 0.24 kg/capita/day, and an estimated total household waste generation is 9.4 tons/day [12] data of this study supports the result of waste characterization study of Port Blair city. This is differed from Central Pollution Control Board (CPCB) report which shows the rates for Port City (0.76 Kg/capita/day) reported in the previous literature [13]**.** This difference may reflect because CPCB calculate the per capita waste generation on a simple equation (total waste generated in the city/total population) (total waste refer as the waste generated from all the institutions like; Hotels, Commercials, Educational Institutions, Hospitals and Markets etc.) The present studies show the data on individual house to house sampling [9]**.** In terms of the waste composition, food waste constitutes the highest composition value by weight, volume, and density.

Table 2. Household solid waste average composition values for Port Bair City, Andaman & Nicobar Islands

Type of waste	High Income Group (HIG)	Middle Income Group (MIG)	Low Income Group (LIG)
Plastic	7.44%	6.82%	8.05%
Paper & Cardboard	7.568%	6.085%	6.270%
Metal	2.381%	1.121%	0.913%
Glass	0.991%	1.827%	2.880%
Rubber & Tyre	0.318%	0.314%	0.864%
E-Waste	0.368%	0.868%	0.285%
Textile	1.022%	1.500%	3.426%
Other Non-Biodegradable waste	4.853%	4.212%	3.135%
Other organics	68.994%	66.990%	70.002%
Other- Domestic hazardous waste	5.148%	8.615%	2.900%
Fines (combined with organics, dirt and miscellaneous materials less than 5 cm)	0.920%	1.646%	1.275%

In terms of the waste composition, food waste constitutes the highest composition value by weight, volume, and density. The 68 % of organic waste was found in the household study. Scholars from Tanzania reported that approx. 57% of organic waste found in the waste stream which is nearby the present study**.** [14] Another study also agrees with the composition values of waste from previous studies especially for organic waste [15] However, there is a slight deviation for composition values of other types of waste such as papers and plastics. The difference may be attributed by in the type of economic activities, changes in lifestyle as well as the Island greenery geography that increase the amount of organic waste (which includes fish processing waste and horticulture waste) and due to tourist and other activities other waste may increase the number of recyclables from the waste stream. Now, e-commerce plays an important role in generation of pure dry waste in form of packaging which generates Carboard, Tetra Pack and plastic waste.

3.2 Solid waste Collection and Route coverage through questionnaire

The municipal authority is responsible for performing street seeping & door to door waste collection (DTDC) from the households across all 24 wards which is carried out by the staff appointed by PBMC. However, considering the difficult terrain, the DTDC is mostly conducted using smaller hand carts (drums /plastic carts attached with wheels). The waste is later taken to the nearest secondary collection /transfer points (as a bin free city, these are uncontained open sites) and then through 24 auto tippers transferred to concerned Solid & Liquid Resource Management Centre (SLRMC) or dumping site for further disposal. To understand the collection practices of municipal authority, the route of sanitary workers reviewed and found that in all route waste from households is being collected by walk, there is no collection vehicle deployed in route for collection of waste from the households. The route wise households of hotspot area are given in below table, which is the sample for the study.

Table 3. No of routes in each hotspot and targeted households on each route

Items	**Junglighat (HS-1)**							**RK Mission (Small Pockets) (HS-2)**				**Carbyn's Cove (Austinabad (Small Pockets) (HS-3)**	
Route Nos.	RN-1	RN-2	RN-3	RN-4	RN-5	RN-6	RN-7	RN-1	RN-2	RN-3	RN-4	RN-1	RN-2
No. of Households during survey	87	159	146	154	201	231	190	-	82	29	45	40	87
No. of Households for Mobilization	87	159	146	154	201	231	187	18	82	29	45	40	126

Route Map

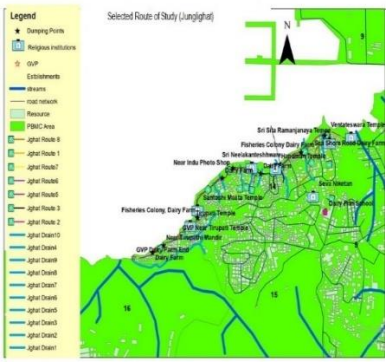

Figure 3.1: HS-1

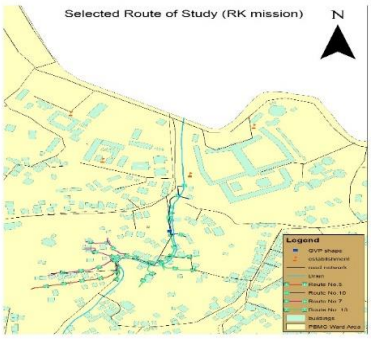

Figure 3.2: HS-2

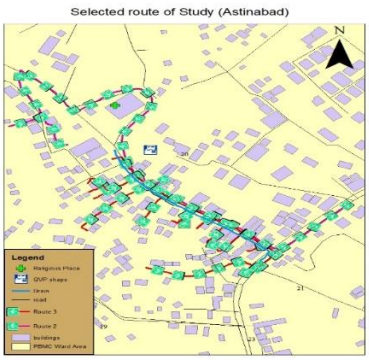

Figure 3.3: HS-3

The survey was conducted in 1451 households indicating a good response rate. During the interviews with the households of identified hotspot area route wise through questionnaire to understand the knowledge and perception about the waste management, Table 4 shows that in Junglighat area only 51.54 % (HS-1) of respondents using the dustbins provided by PBMC and 20.21 % (HS-1) did not give any response about waste storage system in their households. In the households, generally more than half used small dust bins and rest not used proper bins. [16]

Table 4. Storage of Households waste at home

Waste storage at home	**HS-1**	**HS-2**	**HS-3**
Stored at Bin provided by municipality	51.54 %	68.18 %	67.72 %

No storage-Direct disposal to Dump/Drain	1.71 %	1.30 %	2.36 %
Stored at Rubbish Bin/ Drum	17.72 %	21.43 %	23.62 %
Stored at Plastic Bag	0.94 %	2.46 %	3.94 %
Stored at Cardboard Box	0.43 %	0.00	2.36 %
No response	20.21 %	0.00	0.00
Other	7.45 %	6.49 %	0.00

Table 5 shows that all most more than 93 % of the household respondents' perception, they were storing the waste and handed over to waste collector in all 03-hotspot area, this shows that majority of the people are more conscious to waste disposal [6] and approx. 06 % of the respondents having the practice to throw the waste in outside and they were not caring about negative impacts of waste throwing outside.

Table 5. Management of Waste/disposal of waste by Households

Management/disposal of generated solid waste at House	**HS-1**	**HS-2**	**HS-3**
Managing wet waste at home and handover Dry/recyclable to waste collector	10.79 %	13.46 %	11.02 %
Throwing it outside and don't care about it	6.59 %	10.26 %	0.79 %
Store the valuable and the rest dumped in a roadside garbage bin/dump	0.34 %	0.64 %	0.00 %
Store in a single bin and handover to waste collector	39.13 %	21.79 %	25.20 %
Store in Wet, Dry & Hazardous stream & handover to the waste collector	1.2 %	0.64 %	0.79 %
Storing wet and dry waste and handover to waste collector	41.95 %	53.21 %	62.20 %

Table 6 shows the household waste segregation practices among respondents in hotspot area. In terms of the household SWM practices, about 776 of the respondents (66.44 %) segregate their waste at home while the remaining 392 respondents (33.56%) did not practice waste segregation at home in HS-1 area, in comparison of Middle- and High-Income area HS-2 (84.32%) and HS-3 (81.89%) where separation of waste at source more than 80% as per the respondents. HS-1 is low-income area of the city. Generally, people with lower incomes are less likely to segregate their waste than those with middle and higher incomes. [17]**.** Out of the total **1451** respondents interviewed, only 3.34 % (HS-1) and 3.94 % (HS-3) of the respondent themselves normally reuse of any waste in the households and in 9.62 % (HS-2) of the respondents are doing some activities to reuse the waste home. Studies have revealed that 7 %-15% of the waste is recycled or reuse. [18].

Table 6. Households option about waste segregation

Segregation of waste	**HS-1**	**HS-2**	**HS-3**
Separation of Waste at source	66.44 %	84.32 %	81.89 %
Reuse of any waste	3.34 %	9.62 %	3.94 %

Table 7 shows the more than 80 % of the respondents all the HS waiting for the waste collector for next day to provide the waste if waste collector did not visit their home on collection day. Eventually, 6.59 % (HS-1) respondents dumping their waste in drain and 8.33 % of respondents (HS-2) dumping their waste nearby in the street. Scholars from Cameroon reported that most of the household's precise night dumping as the main way of getting rid of the waste in open spaces and nearby bushes, and holes dug around the households. [19] As table 07 shows that in HS-2 and HS-3 area, 6-10 % respondents managing kitchen waste in their garden. Residents in the highest socioeconomic strata, have a better understanding of waste disposal as well as organized methods of disposing of it in comparison to other low-income areas that practice indiscriminately dumping. [20] Table 08 shows that 59.08 % (HS-1), 45.51 % (HS-2) and 40.16 % (HS-3) respondents of hotspot having almost same perception about the dumping of waste at roadside, because public did not want to store the waste at home for a long time. The is mismanagement is significantly split between developed and developing countries. For example, about 80% of solid waste in African countries is dumped indiscriminately in open spaces, streets, stormwater drains, rivers, and streams [21]

Table 7. How dispose of generated waste if collection not happened

Question	HS-1	HS-2	HS-3
Handover to waste collector next day	82.71 %	78.85 %	88.98 %
Dump nearby in the street	5.14 %	8.33 %	2.36 %
Dump in open or drains	6.59 %	2.56 %	2.36 %
Use the kitchen waste in garden	5.57 %	10.27 %	6.30 %

Table 8. Households' perception about people who dump their waste alongside roads

Question	HS-1	HS-2	HS-3
No waste bins around the street	16.52 %	25.64 %	13.39 %
Don't want to store for a long time	59.08 %	45.51 %	40.16 %
Non-availability of waste collector	2.23 %	0	0.79 %
Lack of waste collection	3.17 %	0	1.57 %
No knowledge about segregation	10.79 %	16.67 %	27.56 %
Irresponsible behavior	2.40 %	0	0
Stores stinking obnoxious odor	0.60 %	0.64 %	0.79 %
Lack of awareness	0.17 %	0	0
Other reasons	5.05 %	11.54 %	15.75 %

Table 09 shows that Respondents from HS-2 & HS-3 are aware about the negative impact of waste in drains which goes to ocean and create problem for marine life, 47.63 % (HS-1) respondents are having no idea about the harmful impact of marine little. This shows that urban poor knowledge and perception about marine little is low in comparison of HS-2 and HS-3. A well-managed city with medium or low income may be significantly different from a similar city with poor urban MSW management [22]

Table 9. Households' understanding how waste in drains affect local area/marine life.

Question	HS-1	HS-2	HS-3
Sewage and drain blockage	9.75 %	18.59 %	23.62 %
Consuming animal ingest waste can be harmful for humans if eaten	6.68 %	21.15 %	18.90 %
Negative public health impact	6.94 %	15.38 %	10.24 %
Entangle or drown ocean wildlife	17.14 %	21.79 %	17.32 %
Animals ingest waste,get choked or starved	11.86 %	15.38 %	8.66 %
No Idea/No response	47.63 %	7.69 %	21.26 %

Table 10 shows that respondents from all the area HS-1, HS-2 & HS-3 are satisfied with collection service, with current practices of waste management and feels their locality is clean but the awareness and knowledge about the solid waste management rules and bylaws of PBMC is very low as it shows that whatever the service providing to them, they are accepting this comfortably as per their perception because they did not aware about the implementation activities of solid waste management system like; collection, segregation, transportation, processing and disposal as per SWM policy, Stricter enforcement of byelaws should be ensured by the sanitation unit where administrative penalties for minor violations should be taken with urgency. [23] Another reason may be that as PBMC is not collecting the user charges from the households for collection of waste and enforcement of bylaws is yet to be implemented efficiently. Scholars from Ghana reported that there should be an introduction of user charges so that residents will pay for the waste management services they enjoy. As residents are willing to pay for improved services, the user charges should take the form of pay-as-you-dump. This would control the rate at which residents generate waste in the municipality. [24] Scholar from Ethopia reported that most common options for community to dispose their waste are drains & burning in the absence and presence of municipal service [25].

Table 10. Collection of Waste from the households and their opinion about services

Question	HS-1	HS-2	HS-3
Regular collection of waste	90.58 %	85.9 %	93.70 %
Satisfaction with current services	87.16%	81.41 %	92.91 %

Awareness about SWM rules	5.22 %	8.97 %	7.87 %
Awareness about how waste collector disposes their waste	11.39 %	16.67 %	5.51 %
Feels their locality is clean	68.49 %	78.49 %	85.04 %

Table 11 shows that 56.70 % of the participants responded in HS-1, thought need to impose the fine on open area dumpers, in comparison of HS-2 (39.10%) and HS-3 (37.01%), it is relatively high. The scholars from China reported that somehow, penalty is having had a direct impact and indirect impact on waste separation behavior. [26] Respondents of all the HS area are agreed with all most same percentage awareness on proper waste management need to organize. Awareness is the main factor which motivates them to dispose the waste properly. [27]. HS-2 (22.4%) and HS-3 (25.20% respondents need 02 times frequency for collection of waste in their area, HS-1 (9.06%) which is relatively shows that most of the people are happy with service and they don't need 02 times waste collection frequency. In earlier study it was reported that the adequate collection frequency to during the collection of waste by considering the amount of waste generated per fraction and the average density. [28]

Table 11. Households' suggestions for improvement in Household waste management

Question	HS-1	HS-2	HS-3
Need to impose heavy fines on dumpers	56.70 %	39.10 %	37.01 %
Need to organize awareness programs	34.24 %	38.46 %	37.80 %
Need 2 times waste collection services	9.06 %	22.44 %	25.20 %

3.3 Monitoring of collection and segregation services (Actual status) during door-to-door collection and Community mobilization of Households Women

In Port Blair city, the collection of waste from the households is being done by Municipality through their municipal workers, there is no private operator involvement for collection of waste. The collected waste is being transported to concerned Solid & Liquid Waste Management Centre (SLRMC) for dry waste management and Compost Unit for Wet waste center in decentralized manner. There are no informal workers structure available in the city and no kabadiwala or pickers come to home to purchase the recyclable items from the households like; Mainland (Main part of India). After completion of above exercise which was conducted to understand the attitudes and perception of respondents of 03 Hotspot area. To understand the actuality of the waste management system, we monitored the collection and segregation of waste at households' level, researchers visited the locality with workers as per identified routes of the area. During the mobilization 1505 households were mobilized (Table-3). As, Port Blair city has one time waste collection system in the morning only, during observation we recorded the data of each and every household of the route and record the household's information whose provide the segregated waste, whose provided unsegregated waste, whose did not provide the waste-to-waste collectors and also identified the location where waste collectors are not going to collect the waste. Women are the first environmental educator who are responsible for waste management at Household level human waste for disposal of children cleanliness of latrines, waste pickers and scavengers, street sweepers, managers of biomass which flows in agricultural system, hygiene within home and public places and composting. [29]. After gathering the information during collection system about households' practices for waste management, we target the households' women for community participation. Women may have different definitions of what is waste or garbage. They may also manage waste differently and put different priorities on its disposal. It was evident that it is very important to increase the level of awareness amongst women regarding performing SWM in the household and the community [30]. Interpersonal Communication was conducted with women of the Households through door-to-door community mobilization, each and all households were visited to discuss the issue of segregation, trained them to do the segregation at home and how to do deal with the waste. Interpersonal communication has an essential role in enhancing the quality of relationships and strengthening the bond between people [31], as it can help you understand others, not simply what they say, but also how they see the world.

3.3.1 Status of Waste Collection

As shown in table no.10 that 86-94% and 81-93% of respondents were satisfied with regular collection of waste and satisfaction with current practices but during monitoring, it was observed that average 39 % of households of all 03 area (**HS-1 :35.97%, HS-2 :42.64% & HS-3 :37.84%)** were not providing their daily generated waste to waste collector. Regarding the availability and utilization of collection service, out of 1505 respondents, 61% of respondents who are utilizing the waste collection service and 39% of households did not utilize it. In initial days of monitoring activity, it was observed that due to lack of adequate frequency of collection of waste, lack of

equipment's with workers, non availability of household's member (due to fisherwomen goes out for sale of fish in across the city), not early wake up may be the major issue for this and also all some households of area were not being covered by sanitary workers. In Junglighat area, due to terrain area some of the households are not covered or approached by workers. The study indicates that most of the people do not have access to proper waste disposal facilities. Majority of studied households dispose their solid waste in uncontrolled methods like nearby dumping points, roadside and into drainage ditches. Port Blair city is having one time frequency for collection of waste which is in morning only, sometimes households' people did not wake up in the morning and do not provide their waste. Although scholars in Africa, suggested that frequency of waste collection and route must be determined for optimum utilization of waste collection. [28]

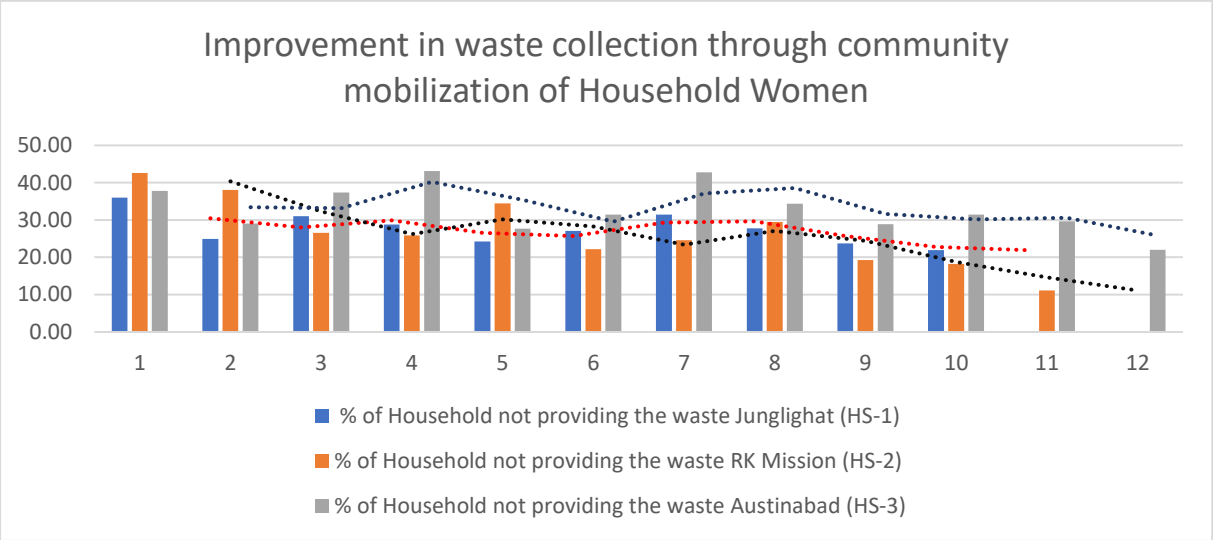

Figure 3.3.1 improvement in Waste Collection Service

After monitoring of households during collection services, the team visited the households for community participation specially targeting to women of the households in the afternoon. A woman is the key decision maker of the household responsible for the waste disposal practices of the family. Her contribution to the family is remarkable. In, solid waste management required harnessing traditional knowledge and skills, particularly that of women [32]**.** Women and men defined solid waste differently. Inclusion of women in solid waste management was found to ensure proper sanitation behavior would be observed by the community and contributions in cash, kind or labour would be availed. During their house-to-house visit, they were communicating the women about collection, segregation, negative impacts of waste dumping and promoting them to do the household composting if space is available in their houses. One to one communication with household women was very effective and it improved the result of collection of waste (Fig 3.3.1). It was observed that after communicating with households, the average percentage of households who were not providing the waste comes in declining rate of 18 % in all 03 area (21.92 % HS-1, 11.11% HS-2 and 22 % HS-3) respectively.

3.3.2 Coverage of unsegregated waste handover to waste collectors

Fig 3.3.2 shows that **average 30.44 %** of household in all 03 area **HS-1 (54.59%), HS-2 (12.40%) & HS-3 (24.32%)** were handing over the unsegregated waste to waste collector in initial days of mobilization. This unsegregated waste can also affect the lives of people of a whole city. [33] Manual scavenging but these unsegregated wastes choke not only drains of cites but also the path of rehabilitation for these group of people. Their job is a dirty one as it involves going down in sewer without any protection, gloves or masks and cleaning the choked drains with basic tools. After communicating with households' women, the average percentage of households who were not providing the segregated waste comes in declining trend 30.44 % to 16.46% in all 03 area (36.84 % HS-1, 5.56% HS-2 and 7% HS-3) respectively. In addition to this, the environmental damage and filth associated with un-segregated waste poses a health threat to the people, which can be avoided by proper segregation method [4].

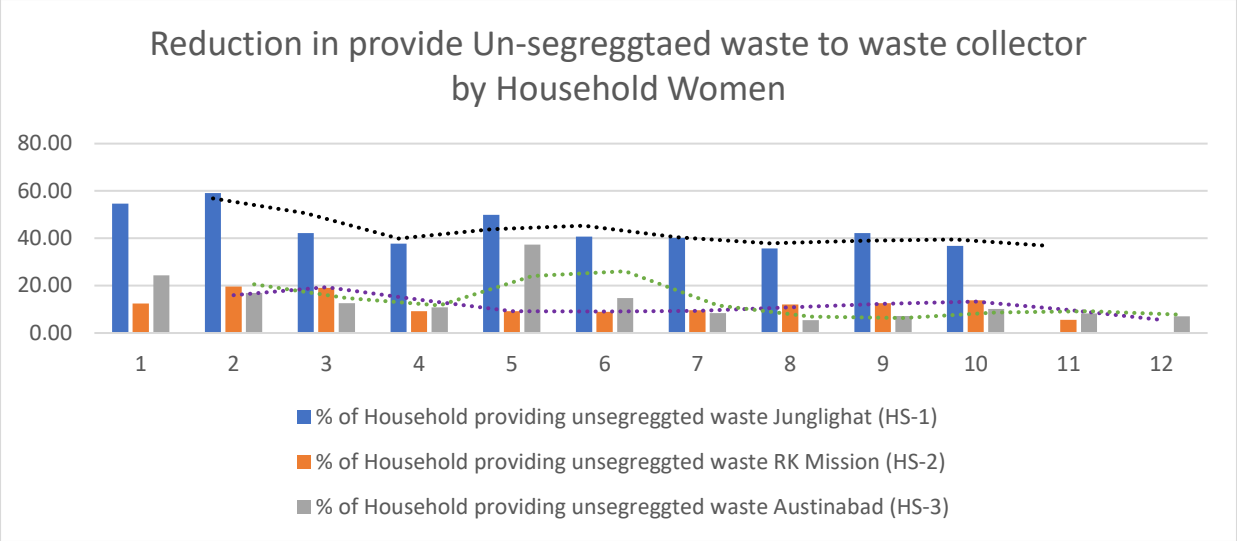

Figure 3.3.2 Reduction in provide unsegregated waste to waste collector

3.3.3 Status of Source Segregation

Regarding the source separation of waste at Household level, there is big difference observed in perception and actual practices of households during monitoring of households, as shown in table 6 where respondents of HS-1 (66%), HS-2 (84 %) & HS-3 (81%) respectively responded that they were segregating the waste and but during the monitoring & mobilization activity it was observed that actually **average 31 %** of household in all 03 area **HS-1 (9.44%), HS-2 (42%) & HS-3 (51%)** were segregating the waste at source in initial days of mobilization. Therefore, a program of continuing education & mobilization is essential in bring about a change in public attitude. The satisfaction level of the respondent household about the waste collection service as provided by the municipality is found satisfied but there are some failures for proper waste management. Greater level of public participation and awareness in segregating waste and proper management of wet waste in scientific manner through campaigning is required to improve the practice of waste management. [34] [35] During the campaign, volunteers went to every house and explained the motivation for segregation to the household heads through one-to-one interpersonal communication (IPC) and the most prominent women in the house, distributed campaign materials, conducting community meetings and also showed a small video on diseases caused by mosquitoes due to waterlogging, clogged drainage systems and sticker were distributed to every house for them to stick on their doors to motivate other members in the house to participate in segregation.

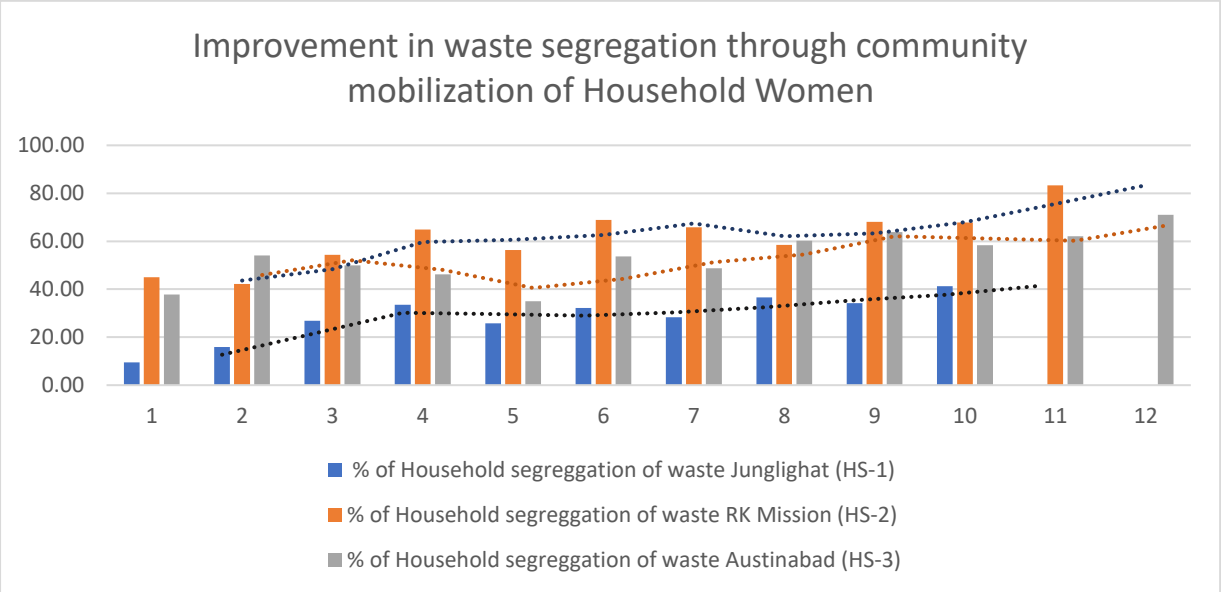

Figure 3.3.3 Improvement in waste segregation through community mobilization of Household Women

Our objectives were to understand whether our campaign was effective; whether households became socially responsible and separated their wastes. Based on the four mechanisms of the campaign to motivate the women in the households, we find the following results (shown in fig 3.3.3). First, there has been a 121% increase among participating households in separating the wastes in 10-12 days daily monitoring of garbage collection data. It was observed that actually **average 65 %** of household in all 03 area **HS-1 (41.25 %), HS-2 (83.33%) & HS-3 (71%)** were segregating the waste at source after mobilization campaign. The results shows that segregation practice is very low in HS-1 in compared to HS-2 and HS-3 receptively as the community of HS-1 having low income and education level. Although household income negatively influences the waste segregation behaviour, environmental awareness and waste segregation practice can positively influence the waste segregation behaviour of the household. [12] Researchers from Bangladesh revealed that providing awareness by targeting women in the house to manage wastes and to at-home segregation is the best strategy for cities in developing countries to manage city wastes which would help build resilience against the threat of waterlogging. [36] Researchers from Dehradun found that the cleanliness story of Indore is a true transformation through community participation, and this is prime activities for success for Indore city in cleanliness. [37] It was observed that Port Blair Municipal Council is providing the waste collection services in all 24 wards of the city and conducting mobilization through their Swacchta Awareness Team, due to lack of monitoring and household's women involvement, the attitude of citizens generally not changed. As a pilot phase, the local government can enforce or improve the waste segregation through involvement of household's women and daily monitoring of waste collection services to the areas where it provides the waste collection service. In long term, after the municipality has enough technical, financial and manpower resources to provide proper waste collection service to all the areas and ensure the waste segregation at source through community mobilization and monitoring.

3.3.4 Coverage of Composting of waste at Household level

The present study was conducted to assess the knowledge of the homemakers regarding use of household kitchen waste to make compost for kitchen garden and nutritional benefits of the fruits and vegetables grown. During the mobilization of households, we found that some of the households' women were interested in composting at household level and the residents where they have the space of garden for composting of kitchen waste to make the compost at their home and are interested to do by herself also. Composting is means of recycling organic matter back into the soil to improve soil composition and fertility and worked as wonderful conditioner for soil. Composting is one of the most promising technologies to treat waste in a more economical way. Composting is a low-cost, natural process that transforms kitchen and garden waste into a valuable and nutrient rich food for garden.[38] Crate Composting is an aerobic method of composting. i.e., the organic waste is broken down by microbes in the presence of oxygen. The inbuilt spaces/ holes in the crates allow for sufficient aeration and reduce the need for manually turning the compost to increase oxygen. Compost has a lot of benefits like: reduce landfill space, reduce surface and groundwater contamination, reduce methane emissions, reduce transportation costs , reduce air pollution from burning waste, provide more flexible overall waste management, enhance recycling of materials and can be carried out with little capital and operating costs. [39]**.** During the mobilization activities, it was found that some households women were interested to do the composting of wet waste at household level. The researchers also conducted a capacity building program on Crate Composting to enhance knowledge of homemakers on ways to prepare compost from kitchen waste, growing kitchen garden with rich nutritive value and also provide the crate for composting. 16 households' women started the crate composting in their house which is being monitored regularly. It shows that because of our campaign in the house, it was women who became more motivated than men, and so, there has been a 1% rise in the role of women to manage their waste properly.

3.3.5 Measurement of waste generation at Household level

During the monitoring and mobilization activity, route wise collected waste was measured by the survey team in all hotspot area, it was observed that households were generating 100gm/day to 500gm/day waste on daily basis which was simply calculated on total waste generation in the route divided by no. of households. As HS-2 is the mostly middle-income group area (500gm/day), so the waste generation in the HS-2 locality is higher than HS-1 area which is low-income group area. The crisis of solid waste is mounting and threatens to become a grave source of environmental pollution because waste generation is on an increase in relation to population growth. It was also due to the lack of proper coverage of residential areas by municipal workers that the waste generated in all the groups studied was found being disposed on roadsides. The study revealed, the MIG to be the highest producer of solid waste than HIG followed by LIG. The differences found in the quantity of waste generated by almost all the three groups. [40]

Conclusion

Various reports, research papers and news articles show that the un-segregated waste has affected the environment at its extreme and it is continuously causing many problems in the field of Municipal Solid Waste Management in India. Hence, there is an urgent need for proper segregation of waste that would lead to scientific disposal of waste. It can lead to various benefits such as enabling technology up-gradation, better quality products, saving of valuable raw material resources of the country, reducing the need for landfill space. In study, we found major difference in perception (77.55%) and their attitude (31%) for segregation of waste, this study tried to highlight the importance of waste segregation at source for effective management and identify the determinants for willingness of households to segregate waste in future if the municipality enforces the law. One of the major findings of the study, proper monitoring of waste collection service and enforcement of municipal bylaws play an important role for success of waste segregation at source and review of waste collection services, deployed manpower, availability of equipment's and routes to cover all households of the area to be reviewed at regular intervals. According to study, it is suggested that frequency of waste collection is to be improved or may be a definite point for collection of waste in the evening to be exercised. The municipality should educate and target the women of the households about the importance of waste segregation and also provide relevant training to encourage households to segregate waste. The study reveals that encouraging women to manage solid waste using community-based composting not only helps the cities to reduce their risks it also reduces the burden on cities to dispose of a huge volume of municipal solid wastes to garbage disposal sites. It makes the cities climate resilient and promotes the concept of sustainable and resilient cities which is one of the sustainable development goals. Women were highly experienced in managing natural resources, bringing valuable knowledge that should be harnessed through bottom-up processes. Through involvement of women in waste segregation practice, we achieved the average 65 % of waste segregation at source. Policy implementation is a huge challenge for the municipality and so the findings from this study could be taken into consideration to enforce the law of waste segregation at source in the study area as well as other area of municipality in Port Blair. There is significant association between the knowledge of the housewives regarding household waste and its management and their selected demographic variable that is educational status and no association between knowledge of the housewives regarding household waste and its management and their selected demographic variable that is age, religion, and size of the family, source of information and income of the family. Through measurement of daily collected route wise waste, the study revealed, the Middle-Income Group (MIG) to be the highest producer of solid waste than High Income Group (HIG) followed by Low income Group (LIG).

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