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TOWARDS AN ALTERNATIVE PLANNING PERSPECTIVE FOR HOUSEHOLD SOLID WASTE MANAGEMENT IN URBAN INFORMAL SETTLEMENTS: THE CASE OF KHULNA, BANGLADESH

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Abstract

The scope of spatial planning within a community scale for household solid waste management (HHSWM) in space-constraint situations like urban informal settlements is almost absent in waste management studies, and this study fills the gap. In Bangladesh, most of the fast-growing cities with a high population density have no significant solid waste management (SWM) system, and the municipal services are incompatible. Along with several socio-economic and awareness issues, one of the major difficulties for urban informal settlements is connecting the SWM system with the municipal waste collection service because of the highly congested spatial arrangements and lack of accessibility. It is evident through several studies that decentralized waste treatment is one of the most effective solutions to a fast-growing waste management crisis. This study aims to investigate an alternative in situ approach from spatial planning dimensions for the HHSWM in informal settlements in Khulna, the southern metropolitan city of Bangladesh. The methods comprise investigation data from observations, built environment mapping, spatial analysis, key personal interviews, and focused group discussions with stakeholders. The finding contributes to a spatial planning framework for HHSWM in informal settlements that incorporate multiple benefits, like waste-to-income opportunities, reducing pressure on municipal services and maintaining a healthy and hygienic living environment.

Keywords: household solid waste management, spatial planning, income generation, informal settlements

Introduction

The unprecedented economic growth and demographic changes in the major cities of Bangladesh pose a severe challenge to urban local authorities. An estimated 8000 tons of solid waste are produced daily from the six major cities (Dhaka, Chittagong, Khulna, Rajshahi, Barisal and Sylhet), the most of which is still not being collected (Abedin & Jahiruddin, 2015; Alamgir & Ahsan, 2007). The population surge from neighboring rural communities, the enormous informal settlements in the center and periphery districts, and the dependence on basic services will reach an unimaginable level by 2050. It would be unaffordable, physically demanding, and ecologically damaging for a municipality to provide facilities for the collection of household (HH) waste in

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such a circumstance (Gowda et al., 2013; Jerin et al., 2022). Decentralized waste management systems through community empowerment must be essential to urban sustainability as a consequence (Campos & Zapata, 2014; Henry et al., 2006; Sailesh & Shinde, 2015).

The conventional solid waste management, which consists solely of collecting, carrying, and dumping, has been found to be extremely harmful to the environment. Even if it is recycled there, the transport costs, service costs, and land prices are already high. On-site waste recycling or management is being advocated globally to reduce the waste problem. However, there is a shortage of research on spatial planning alternatives for waste management within the informal settlements. A community based solid waste management (CBSWM) approach is being practiced in Global South countries, which in practical considers a community as a ward under one municipality and aims to connect with municipal waste collection stream (Kasala, 2014; Sibanda et al., 2017; Zapata Campos & Zapata, 2013). A citywide inclusive plan for achieving the 'just city' (UN-Habitat, 2016) is now the new global perspective that has spatial dimensions. Aligning with the global slogan of integrated SWM (UNEP, 2009), the national perspective of SWM of Bangladesh (DOE, 2010)(DOE, 2004) has restrengthened integrated MSWM (Municipal Solid Waste Management) where HHSWM is a vital part. Citywide inclusive and integrated planning perspective is not effective in all kind of situations and an alternative has to be planned for informal settlements.

During the last three decades massive demographic shift in form of rural-urban continuum caused by large number of job seekers in urban areas, privatization of the economic sectors and climate-induced migration is taking place in the south-western coastal cities in Khulna, Bangladesh (Parvin et al., 2016). A prominent migration surge starting right after the liberation war in 1971, and then frequent cyclone, storm surge, flooding, heat waves, salinity intrusion etc. all together caused an inconceivable urban growth that has gone beyond the capability of municipal civic services.

Khulna City Corporation (KCC) is a city with a population of approximately 9.5 million (UN-World Population Prospects, 2019) and still there is no significant waste management system. It has an insufficient waste collection service and the end scenario is dumping of waste in landfill sites. The waste generation rate of KCC was 0.50 kg/cap/day that producing around 950 tons of wastes, where about 36.84% being uncollected (Abedin & Jahiruddin, 2015). KCC (Khulna City Corporation) is operating a Municipal Solid Waste Management (MSWM) service, which is incompatible to address the entire population. 1134 informal settlements have been identified all over Khulna city and 538 clusters are categorized as extreme poor settlements (Alam & Mondal, 2019). Majority of the urban informal settlements are either excluded from municipal services or unwilling to pay the service bills. Informal Settlements have a very congested spatial arrangement having no proper access roads for waste collection or in situ treatment. The entire city faces enormous problems due to these mushroomed slums and their unhygienic waste disposal practices. In many places the citywide collection bins are placed in such a distance that slum people do not have an easy access up to the bins. On the other hand, the composition of solid waste in low-income people is very high in biodegradable portion 76% (WorldBank, 2018). The majority of the waste is still kitchen solid waste, along with certain other materials like papers, glass, polyethene, plastics, metals, etc. The organic or biodegradable portion can be composted (Hemidat et al., 2022; Rahman & Al-Muyeed, 2010; Razzaghi-Asl, 2022) and the other portions can be re-used or re-sold to the recycling market (Fahmi & Sutton, 2010; Gutberlet et al., 2017; Tsheleza et al., 2022). Overall, there is potential to generate income from waste by integrating spatial planning alternatives within informal settlements.

Keeping all these in consideration, this particular research will examine the existing spatial flow of household solid waste (HHSW) and will find ways to provide a spatial solution, including a framework of HHSWM, so that the waste problem can be minimized to a significant extent within the site and can also create income opportunity.

The three objectives of this research are –

1. To identify the existing spatial flow of HHSWM in urban informal settlements.
2. To investigate the obstacles to connect with the conventional municipal solid waste management.
3. To develop a spatial planning and a supporting framework for HHSWM in urban informal settlements.

Materials and Methods

Based on the objectives of this research it has adopted a case study approach. The paradigmatic standpoint is constructivist and has acted in an interpretative research mode.

Analytical framework

The major indicators for data collection and analysis according to the objectives are shown in the below diagram. Findings from objective 1 and 2 can determine whether the particular settlement can be connected with the mainstream municipal service or it needs an in-situ planning. Objective 3 is to develop a spatial planning and a supporting framework.

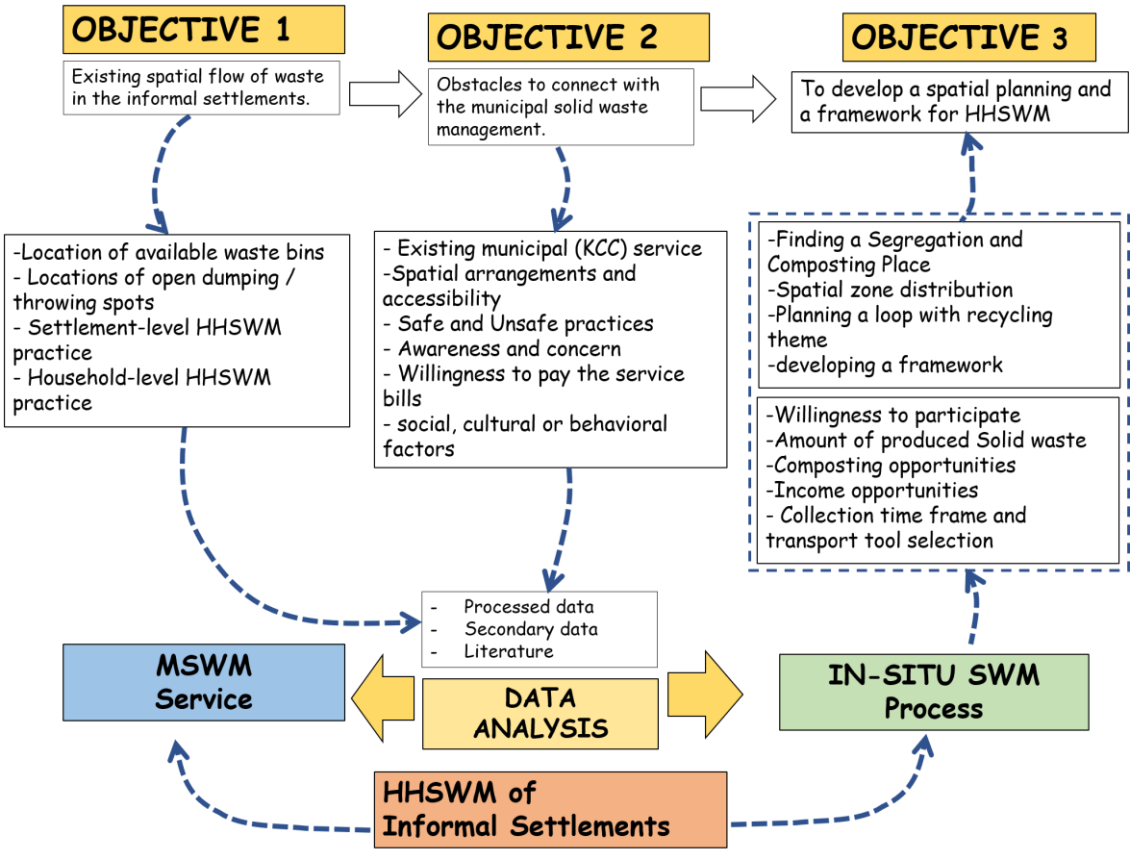

Figure 1. Analytical Framework of the research (source: author).

Selection of site

The selected settlement is from the list of most densely populated and extreme poor informal settlements with in Khulna city. The UPPR (Urban Partnerships for Poverty Reduction) project (from 2009 to 2015) map of extreme poor settlements was used. To triangulate the prediction, GIS and Google Map data was examined and also a KII (Key Informant Interview) with the project engineer of UNDP was carried out. A purposive selection was done based on the data found and comment of the KII person. The key informant revealed that Kashipur slum settlement is prominent among those settlements and very densely populated with less accessibility to all houses. A non-participant observation based on – 1) population size, 2) density of households, 3) accessibility and connectivity, 4) access to basic services, 5) tenure, and 6) open dumping situation further confirmed that these settlements are lacking in solid waste management.

Selection of indicators

A series of indicators are selected from different authors, which were either used as an attribute in action research or in any research of SWM. Socio-cultural, financial and spatial dimensions are analyzed. The indicators of spatial dimensions are the particular input of this research. Indicators under spatial dimension were derived from the site-specific attributes, such as – congested spatial arrangements, narrow accessibility, open-dumping situation, etc. The data collection method was mostly observation, photographs and interviews. A secondary data (per capita waste generation 0.203 kg) was used to calculate the estimation of solid waste in low socio-economic income people (Alamgir & Ahsan, 2007) and its monetary profit (a survey findings). The market price of composts made from biodegradable wastes was recorded, and also the price of recyclable materials was calculated to show income hope so that community participants get more interest.

Sample size and sampling methods

Kashipur slum has 210 HHs along the rail line; 40HHs (20% of 210 HHs) were taken under questionnaire survey. 5 interviews, 2 KII and 3 FGDs (Focused Group Discussion) were conducted in Kashipur slum. Numbers of respondent or bigger sample size was not a priority according to the research type. To create a single truth or to find common phenomena, a scenario was to be built out of all the individual stories and responses. Random sampling and snowball sampling has been applied for the questionnaire survey. Respondents from the narrow access areas were selected where connectivity is difficult for waste collection vehicles.

Data collection methods

The research has formulated multiple spatial mapping to understand the existing linear waste-flow, people's practice of HHSWM and the spatial distribution of their activities. The following table shows the data collection methods and tools adopted for this research –

Table 1. Data Collection method and data collection tool of the research

Data collection method	**Data collection tool**
Observation	Photographs from camera, field notes, physical survey
Interview	Open ended set of questionnaire
KII	Open ended set of questionnaire
Questionnaire survey	Semi-structured set of questionnaire
FGD (Focused Group Discussion)	Open-ended questions
	Group discussion on given topic
	Note taking
Mapping	Secondary source maps printed on graph papers, field notes, community feedback

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The primary data for the study was collected through participant and non-participant observations for mapping. A semi-structured questionnaire survey was conducted to get data as per the pre-selected indicators. Other interviews were conducted with stakeholder groups and committee members of solid waste disposal and related projects, and concerned GO-NGO staff.

Spatial mapping

To analyze the spatial constraints of slums, built and non-built environment analysis by drawings, plans, and informative sections are produced. Also, the present practice of household solid waste disposal and standard practices are brought into two-dimensional plans. Plans are produced to visualize waste-flow. Schematic sections are produced to understand safe and unsafe practices with respect to access roads, waste collection services and surrounding environmental features. A mapping technique was used following the "Community Mapping Handbook" by ACHR. Taking secondary source maps and printing on a graph paper is a simple technique to assume real positions of structures, drains or pathways (ACHR, 2011). This interpretation brought clarity in visual understanding and scopes of further loop planning, zoning, or space distribution could be sorted out.

Case context

Kashipur slum is a junction point of Khalishpur, Notun Rasta and Mujgunni area. The slum developed alongside the rail line around 1970s. The owner of the khash land is Bangladesh railway and partially Khulna City Corporation (KCC). There by the land has no tenure security but de-facto is existing since the local ward commissioners are well aware of this. Also, there are electricity connections to every household who also pay bills. Other than this, there are much scarcity in other civic facilities like – road connections, drainage, KWASA (Khulna Water Supply and Sewerage Authority) water supply line, waste disposal facilities, etc.

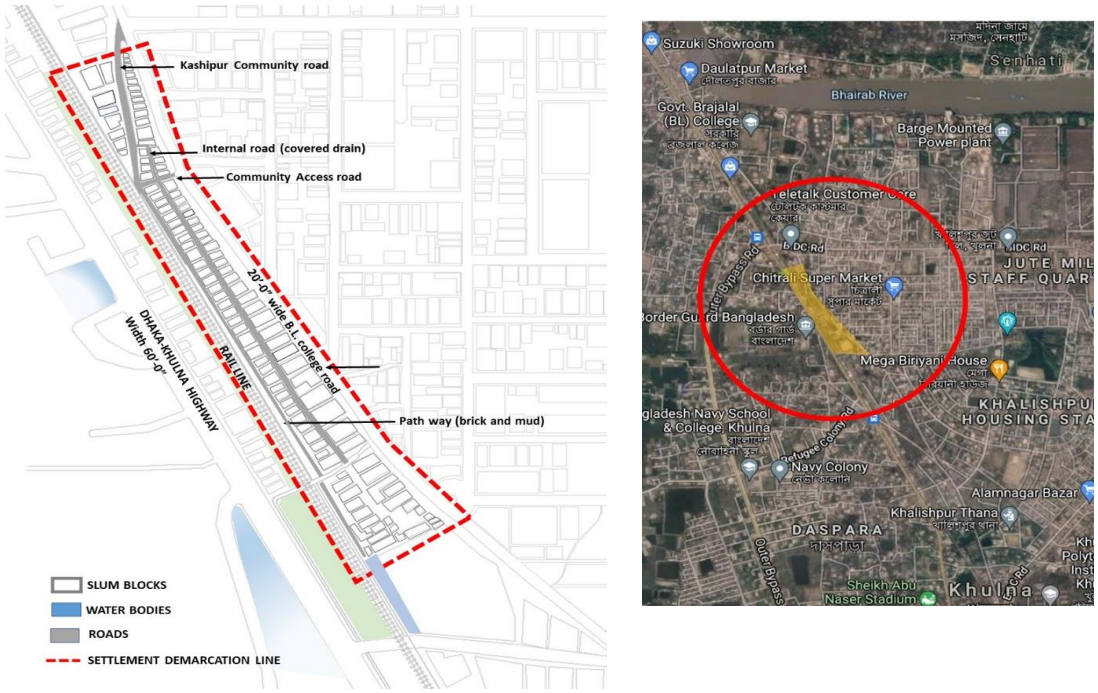

Figure 2. Left: Study area of Kashipur slum (source: author); Right: study area marked on Google map.

The pilot survey, GIS, and BBS land elevation maps show that the site is at an intersection point of low and high land and has always suffered from waterlogging problems during the rainy season. In this regard, local NGOs like UNDP, BRAC, and a few others have been working since 2004. UNDP provided a major drainage connecting all toilets and black water outlets that reduced the severe waterlogging of the area. This was done in 2009, and at that time, the waterlogging problem was almost solved. Later on, as a consequence of the disposal of solid waste into sewage lines, waterlogging has turned into an acute problem.

Triangulation and validation

To develop reliable evidence of mapping, selected site visits are repeated through the whole process. All the spatial information through observation and photographs was put on maps of secondary data and was further cross examined with Google maps. Almost every single piece of data was derived and analyzed from multiple data collection methods, which brought strong data triangulation. Several individual questionnaire answers were cross-examined in FGD sessions as well.

Results

Settlement-level findings

In Kashipur slum, more than half of the houses are alongside the rail line, and dwellers often throw their HH solid waste on the other side of the rail line. Sometimes they throw it in the open and newly made drain of the railway, and sometimes in the ditches beside the Nayabati school boundary wall (southern end). Besides the school wall, there was a massive dumping of waste full of raw kitchen materials, papers, and plastics. The roadside settlement has easy access to most of the civic services provided by KCC. Previously there were no masonry or plastic bins for that area. Three plastic bins are provided in the year 2020. There is a big central drain, which has run through the middle of the HH clusters. Each of the cluster toilets and tube wells has a connection with it. This drain is connected to a wider city drainage network. The end point was full of kitchen waste and creates waterlogging.

Household-level findings

When asked about their daily life practices, a female respondent informed that most of them use "malsha," a wide clay pot or a bucket for keeping their kitchen wastes (Bin locations, Figure 4). They throw it beside the rail line or here and there when the HH chores are done.

Existing municipal service

Only 3 bins (half cut plastic drums) of 100 liters are provided by the ward commissioner which cannot contain even one day waste of half of the settlements, placed alongside the rail line or in small set back areas of railway land. Two neighbor female respondents informed that it is collected once a week, or sometimes even once in 14 days.

So, it spills over and people again throw their garbage on the other side of the rail line. The CDC (Community Development Committee) leader says that 3 bins (Figure 5) are not adequate for a community of 420 households.

Spatial arrangement and accessibility

Kashipur slum has several house clusters those have an entry of only 1.5 feet to 2 feet. Some of the dwellers came earlier and captured bigger size land plots, and now they made 5 or 6 extra rooms and gave for rent. In this way the slum is extremely congested. In the year 2019 Bangladesh Railway gave notice to keep clear set back of 25 feet from the rail line. People did not leave the place, rather managed to squeeze within the given land limit. The yellow lines are the access roads those are wide enough to enter by a waste collection van. The red lines (Figure 5) show pathways which are not wide enough or smooth enough for a collection van entry.

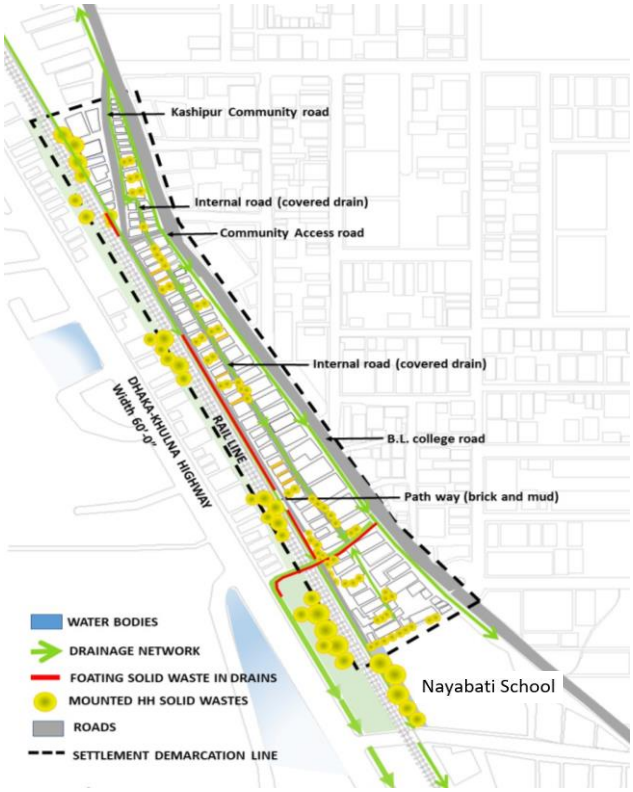

Figure 3. Solid waste duping areas spotted during field survey (source: author).

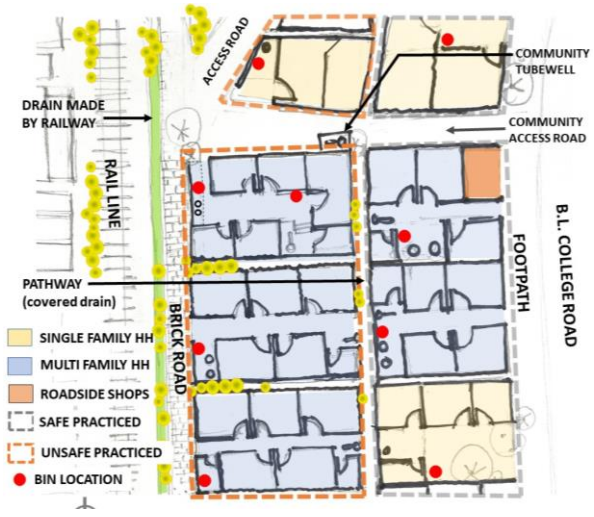

Figure 4. Cluster blow-up and HH-level solid waste practice (source: author).

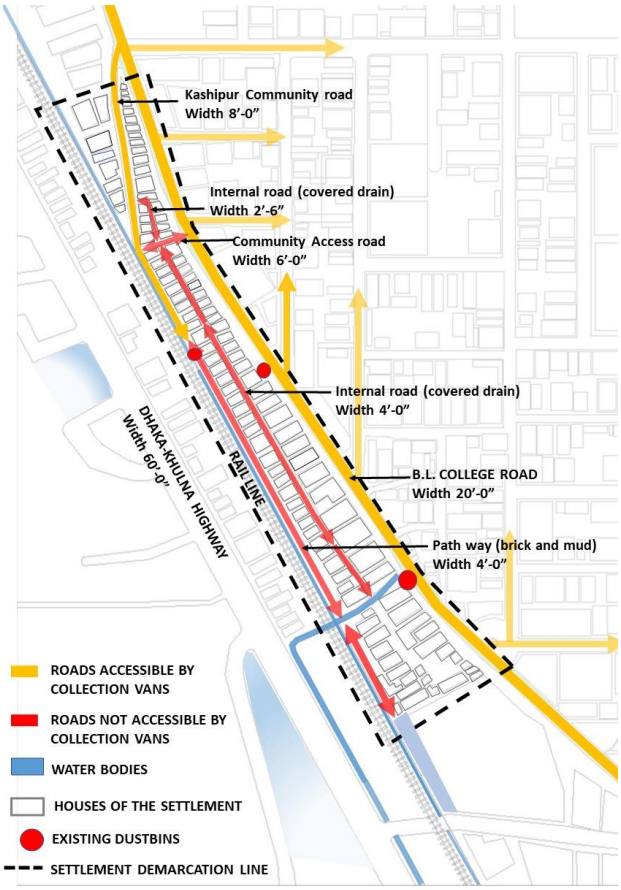

Figure 5. Existing roads of the settlement with road width (source: author).

Safe and unsafe HHSWM practices

The surroundings of study settlements are still in poor condition – water loggings, flies and mosquitoes, damp and dirty aisles in between houses are vivid examples. A survey team conducted this investigation (Figure 6) and collected data on secondary source maps. This reading was taken as per visual non-participant observations, with participant observation, and feedbacks from the neighbors and community. Where the surroundings were found more filthy and full of garbage, plastics or dumped wastes, those HHs were marked as unsafe practicing HH.

Willingness to pay the service bills

According to the vital indicators, dwellers willingness to pay for waste collection service is important. The waste collection service bill in Kashipur is 50 taka. It is found that Kashipur rail line side dwellers are least interested to pay for the service since they have plenty of options to throw it out. Still 40% of the study population are willing to pay.

City lockdowns and emergency situations

This research was conducted during the COVID-19 pandemic and there by few exceptional findings came into light. When small areas were locked down, the municipal solid waste collection service was also suspended

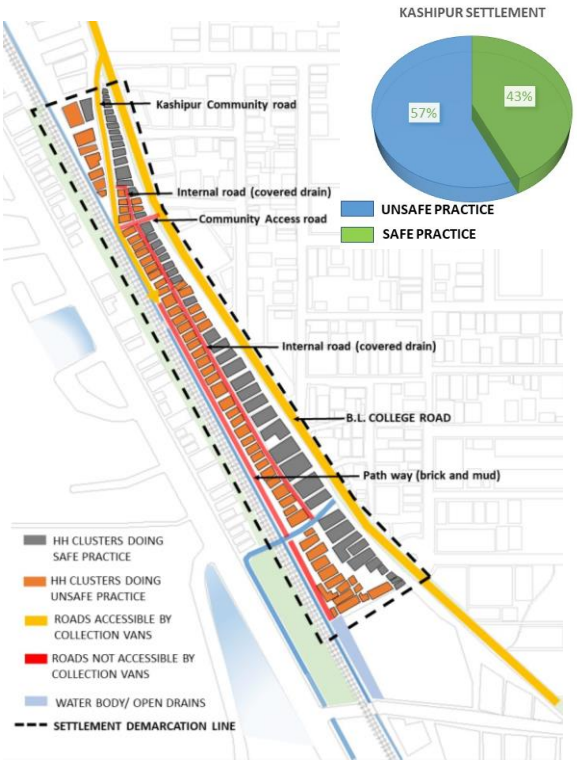

Figure 6. Safe and unsafe practiced HHs and ratio obtained from observation and neighborhood feedback (source: author).

for a very long period. The community waste containers became overloaded soon and the areas were full of dumped waste, spreading foul odour. Almost after two months of dilemma, authorities decided and considered waste collection as a major unavoidable task even in pandemic situations.

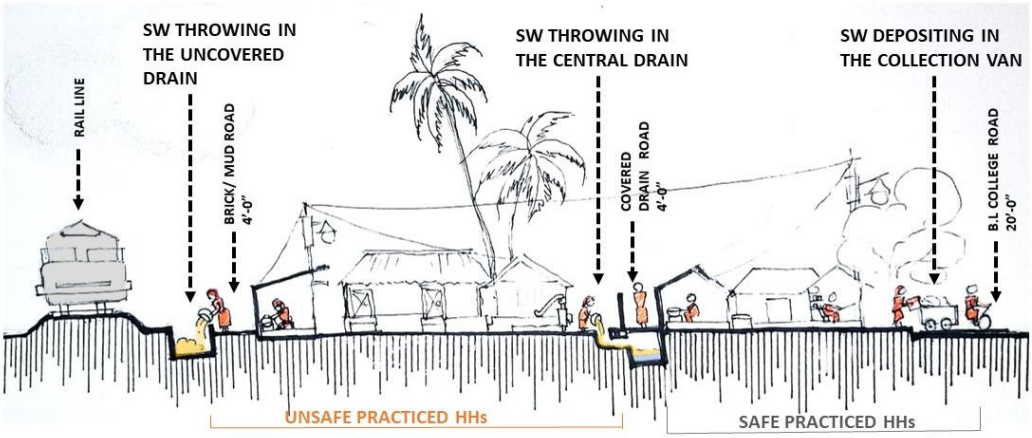

Figure 7. Schematic section of the settlement to show HHSWM and safe-unsafe practices (source: author).

Social, cultural or behavioral factors

Few Kashipur slum respondents informed that any community facility is first delivered to the influential slum dwellers, or to the people who maintain a good liaison with community leaders. Also, the residential areas have big size containers for solid waste disposal, but Kashipur slum has got small containers, which are so inadequate in terms of population.

Figure 8. Willing to pay and unwilling percentage (source: author).

Figure 9. Willingness and unwillingness to participate in waste-works (source: author).

Willingness to participate in waste related works and composting

After discussing a probability of income generation from waste, many of the settlement people showed interest to participate in waste related works (Figure 9). During the COVID-19 pandemic many of the study population were jobless and had been searching for income opportunities. Also, residents who were already involved in the work of breaking down materials were aware of the compost and recycling markets. So, there were 20% of the females who showed interest in working in waste collection and composting work.

Time-frame of waste collection

Since females were considered the most available and cooperating members of the settlements, and a good percentage showed an interest in waste-related work, a convenient time frame was asked from them for waste collection work. They were given three options, such as, 9.00 am to 12.00 pm, 12.00 pm to 3.00 pm, and 3.00 pm to 6.00 pm (Figure 10). They discussed a few of the reasons that this is their free time. They can complete their household chores and then work for some income. It was found that 3.00 pm to 6.00 pm is mostly preferred.

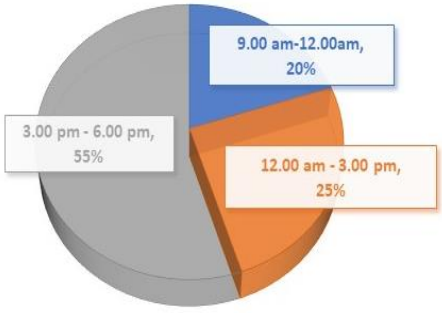

Figure 10. Preferred time of waste collection (source: author).

Figure 11. Preferred pull-push cart or trolly sample (source: internet).

Waste transport tool selection

Some transport trolleys, vans, and vehicles were discussed in FGDs showing photos from the internet, and here (Figure 11) is the sample that was picked according to the narrowest community golis/pathways. Also, it was found that, according to the physical strength of women, lighter carts or trolleys (20 kg–30 kg) were more preferred.

Discussion

Findings from the existing HHSWM practices of the slums

The primary objective was to understand the existing spatial flow of HH solid waste. The key understandings and learnings from peoples' HHSWM practices are -

- Cultural and behavioral practices are infused in people. They follow what others are doing and throw their waste here and there. Also, unavailable waste collection service leads to unsafe practices. Distance of disposal places are hindering also. And door-to-door collection is so far the "No fail" attempt as observed.
- Only females are concerned about waste disposal issues.

Findings of obstacles to get connected with the municipal solid waste management

The second objective was to investigate the obstacles to connect the slums with the local or municipal services. The spatial analysis of HHSWM shows that -

- Mostly there are inadequate municipal services - arrangements of bins, distant disposal location and irregularity in collection. Unavailability of access roads are main obstacle for door-to-door collection.
- The collection time frame is also important. The females who are maidservants or who work outside cannot deposit the waste into the collection van at a given time.
- Lack of awareness and motivation are major socio-cultural reasons of HHSWM problems.

In a nutshell, an in-situ planning of HHSWM is necessary to be planned where communities will be independent to manage their wastes. Composting idea was a profitable adventure in this situation since the organic portion of solid waste in low-income communities is very high (76%).

Figure 10. Proposed area for major collection route and dumping spot for segregation (source: author).

Spatial planning and a framework development of HHSWM

The third objective was conducted more in a participatory way. It was easier to understand and to take decisions that were well discussed with community people. In spite of the very congested and chaotic spatial arrangement of the informal settlements, with the help of community people and their feedback, a collection loop was designed, collection tools (trolley type) were selected, and probable free spaces were selected. The major learning from this part is that all settlements may not have the option of free space. In those cases, rented rooms can be taken under consideration.

Participatory planning for finding a segregation and composting place (Figure 12)

This study has taken the above-mentioned issues under consideration and stated a planning proposition that is absolutely guided by the community's people. For a better and smoother collection loop, community roads need to be identified properly. Since HHSWM will require some space to dump collected wastes, segregate the wastes, and placing the composting barrels, community people have selected places, which they felt convenient. Kashipur slum badly needs an access road for the back side (rail line side) HHs. Also, the uncovered drain made by the railway is a physical hazard and also a scope for unsafe SW practice.

The big and 15' wide-open drain, which is a part of the city drainage network, is also uncovered. A possible 80' X 25' sqft space is possible to manage if the big drain is covered. A roof is necessary to keep collected wastes safe from rainwater.

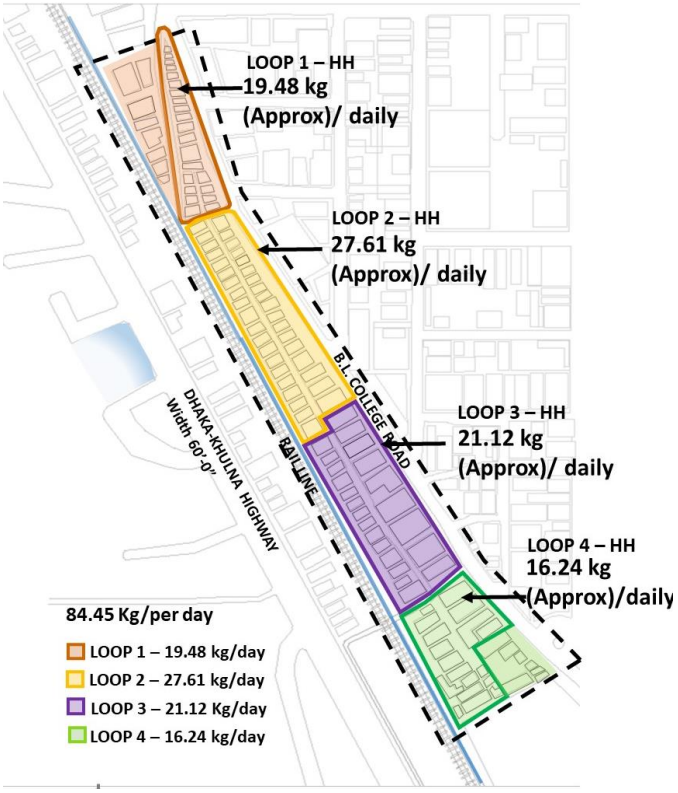

Figure 11. Solid waste collection loop planning by the settlement people (source: author).

The participatory planning for waste collection loop **(Figure 13)**

Kashipur slum can be provided with four loops and a total daily collection of 84.45kg and monthly 2500kg solid waste. Since women were interested in the collection job in the early afternoon, so a group of 04 collection trolleys will be comfortable for them as they said. The time period will range from two to three hours approximately.

An assumption of compost and recyclables

Biodegradable parts are very high in proportion in the HH solid waste of the Informal Settlements. According to secondary data, the HH wastes found in the lower income strata are mainly organic parts which is kitchen waste 76%, paper 5%, plastic 4%, glass 2%, metal 1%, others 12%. So, the major portion is potential for composting. Another 2007 study shows that the per capita waste generation in lower socio-economic strata in KCC was found 0.203 kg/day (Alamgir & Ahsan, 2007). It is obvious that the amount will be more now. Again, low-income groups have a 76% of organic waste (Figure 14).

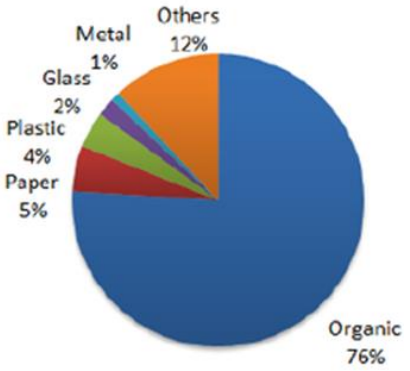

Figure 12. HH solid waste portion in low-income strata (source: World Bank, 1999).

Theoretically, Kashipur slum produces total solid waste (1680 x .203 x 30) = 10,231 kg/ month. Each kilogram of solid waste can produce one-fourth kg compost. Also, the plastics and other recyclables are sold in the recycling stores 20-30 BDT/kg, caps and rings of plastic bottle necks are sold 100 BDT/kg, a recycling store owner informed.

The framework and model for HHSWM

The first step is to plan the collection loop; the second is to develop the framework. The first step involves gathering community perspectives through FGDs, identifying interested waste workers, choosing the preferred time frame for waste collection, choosing the waste transport tools, and locating a composting location. The key points of the framework can be crosschecked in any informal settlement, which is having a HHSWM problem. An in-situ HHSWM is possible to plan if the pre-requisites are available in the setting.

The analysis of working indicators mentioned in analytical framework articulates the specific technical details of the project –

- Interest of the stakeholders is the key ingredient to initiate.
- Participants will be needed from the community. Females are found interested in waste related works.
- Awareness and cultural practices of the slum dwellers need to be strengthened. Safe practice needs to be introduced and explained.

- Spatial planning needs to be in place. Community road width needs to be measured, and then a waste-carrying trolley cart needs to be selected with people's participation.
- Zoning and Loop planning (measuring all road width and circulations, zone planning for smooth collection) is the most crucial part where design charrette is recommended with community participation.
- Selecting a composting place, or renting place will be required as well. An estimation of daily collection will be helpful to calculate the required area for composting.
- A preferrable time need to be selected by the community for a successful door-to-door collection.
- Technological and start-up financial support will depend on community fund or willingness of GO, NGOs.

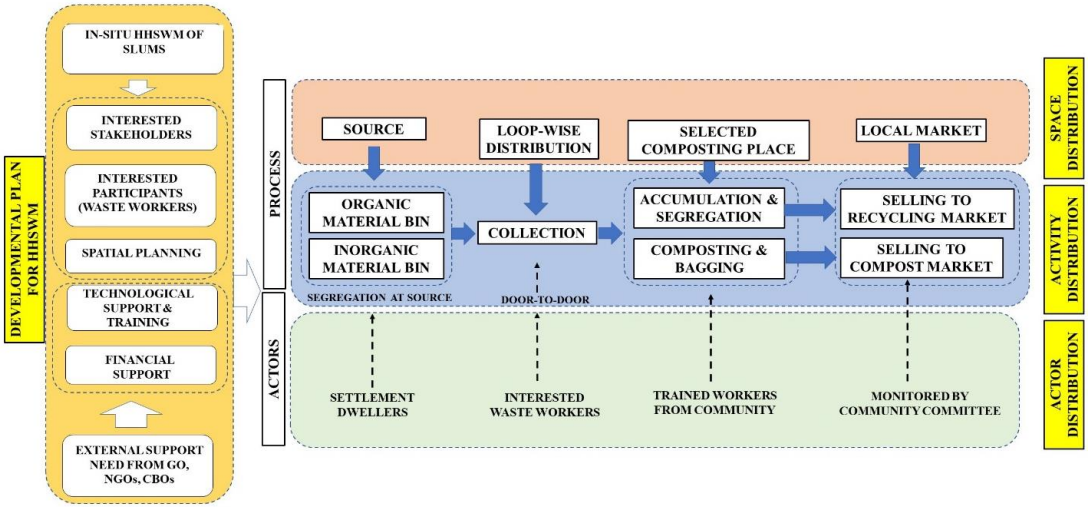

Figure 13. The Framework for an in-situ HHSWM plan in informal settlements (source: author).

Recommendations

- The following recommendations to obtain an in-situ installation procedure are taken from the knowledge and comprehension of the HHSWM of informal settlements and are supported by the framework (Figure 15) produced from this research-
- SWM policies should be revised. Local government needs to acknowledge and support the community for in-situ HHSWM.
- In spatial planning phase, multidisciplinary interventions and design charrette will bring out better and effective results. Manual collection, segregation, barrel composting, manual bagging are preferred for informal settlements. Expert opinion will be required.
- All settlements may not show willingness or may not have free adequate space for composting. In those cases, how the settlements can be connected with the city SWM service need to be analyzed.
- Addressing and engaging community females mostly in decision-making process will be effective.

- The participants will be from the concerned community. It will impose social responsibility and community pressure for proper collection. Also eliminate few unemployment issues, and will create income opportunity.
- Each informal settlement should be studied individually, either to get connected fully with municipal/ local waste collection (door-to-door) service, or to install an in-situ SWM system (when applicable).

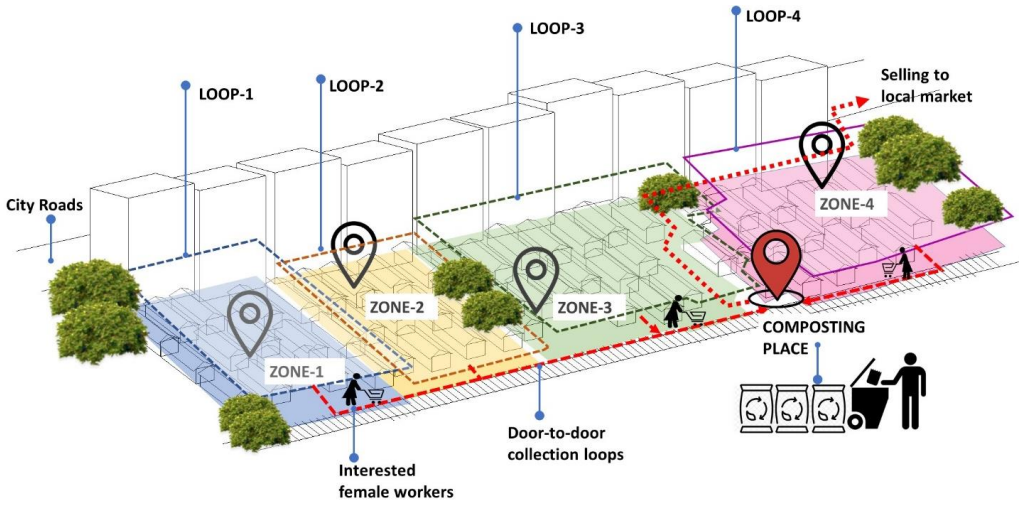

Figure 14. Schematic Spatial distribution model for slums – Loop planning, zoning and composting location (source: author)

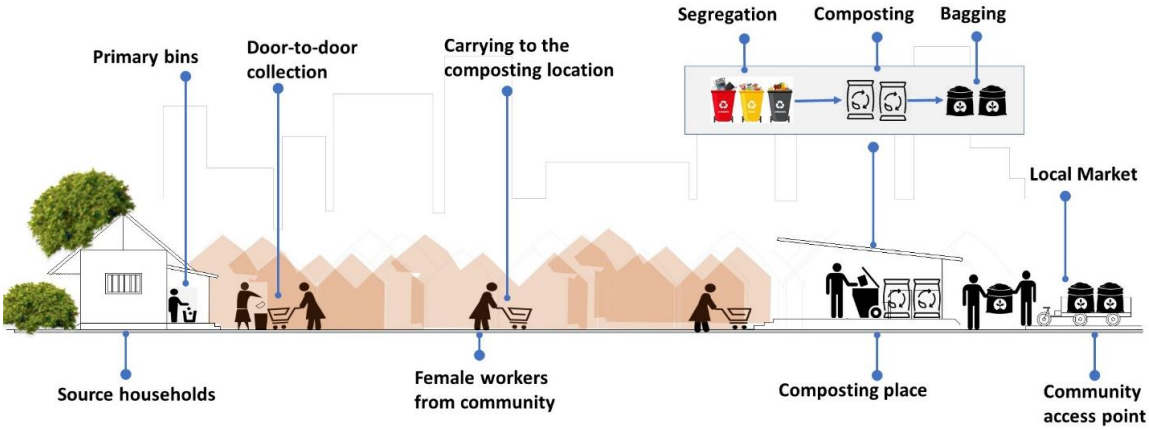

Figure 15. Activity distribution model - adopting available low-cost technologies (source: author).

Conclusion

The study investigates the income opportunity scope by engaging female waste workers from the community. It analyzes the spatial arrangements, waste-flow mapping, and proposes waste circulation loops with the help of community participation. It also proposes local, low-cost composting technologies. These magnitudes

together were not adopted in previous attempts, and this project has the potential to offer the desired low-cost and affordable HHSWM for the informal settlements.

There are a number of low-cost technologies, but those need to be integrated with other specific problems, such as where to place the waste, who will be involved, how to make it a sustainable solution, etc., in order to be used as a solution. Therefore, the spatial planning interventions are needed to solve these problems. The spatial analysis will bring two possible conclusions – either a way can be sorted out to connect the informal settlement with municipal services. Or, if the connection is not achievable, an in-situ composting opportunity can be explored. The proposed framework and models can help to guide policymakers to investigate similar informal settlements, and the idea can be examined in reality.

The study has limited its focus to the spatial dimension of HHSWM only, and it has not discussed the problems relating to other domestic wastes or black water, other social, environmental, economic, technological, or administrative dimensions. Future multi-disciplinary research can help to validate the study from socio-economic and other relevant perspectives.

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