

**Scopes of solid waste management in urban informal settlements:**  
**A case of Khulna.**

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**Abstract**

Kitchen solid waste is very high in proportion among the gigantic amount of waste that the world produces every single day. The total quantity of waste generated in low-income countries like Bangladesh is expected to increase by more than three times by 2050 according to World Bank data. Bangladesh has a fast growing economy and a very high density of city population that all together produces a huge amount of kitchen solid waste each day. Most of the major cities including Khulna has no significant waste management system. In the context of a very fast growing population, municipal waste collection services are still incompatible. A majority of the urban informal settlements are either excluded from municipal services or unwilling to pay the service bill. Several slums have no awareness and no proper access roads for waste collection. These bulk amount of population throw their kitchen wastes here and there and thus make a very unhygienic and disease prone living environment. As the waste trend proceeds, it is evident that decentralized waste treatment is the most effective solution for a fast approaching waste management crisis. Treating the household organic waste at source can help reduce the problem of waste drastically. This paper attempts to explore the kitchen solid waste management scopes in an informal settlement of Khulna city engaging community people and contextual resources which will analyze the Community based solid waste management approaches (CBSWM) and income prospects from solid waste. Two major analysis tools – JMP (Joint Monitoring Program) and Fishbone analysis were used to find out the problems and mapping it with indicators. The study is based on data from observations, interviews, focused group discussions and literature available on the subject. The expected outcome can provide a framework for in situ kitchen solid waste management which can hit multiple benefits at the same time like turning waste-to-income opportunities, reducing pressure on municipal services, resolving waterlogging issues; and a healthy and hygienic living environment.

**Keywords**

*Kitchen solid waste management; health and environment; income generation, informal settlements.*

## 1. Introduction

The world is producing an inconceivable amount of waste each day. Every year we dump a massive 2.12 billion tons of waste (The worldcounts.com). With rapid population growth and urbanization, annual world waste generation is expected to increase by 70% from 2016 levels to 3.40 billion tonnes in 2050 (World Bank, 2019). Also the solid waste amount in the third world countries are expected to increase three times by 2050 as per World Bank 2019 data. Some of it is recycled but a lot is simply dumped, causing problems for people and the environment. Most of the third world countries are facing enormous health and environmental issues due to lack of sincere and scientific handling and planning of these wastes.

Bangladesh has a fast growing economy and a rapid urbanization that all together is generating about 8000 tons of solid waste each day from the six major cities (Dhaka, Chittagong, Khulna, Rajshahi, Barisal and Sylhet) (Abedin and Jahiruddin, 2015). Khulna City Corporation (KCC) is a city with a population of 7.7 million and still there is no significant waste management system. The waste generation rate of KCC is now 0.50 kg/cap/day that producing around 950 tons of wastes, where about 36.84% being uncollected (Abedin and Jahiruddin, 2015). Municipal waste collection and disposal system is found inadequate and inefficient in terms of technology use and also in budget. KCC is operating a Municipal Solid Waste Management (MSWM) service which is incompatible to address the entire population.

Most of the informal settlements or slums have no solid waste disposal system, road access for waste collection and sometimes are excluded from the municipal services. These bulk size poor population are found unaware and also unwilling to pay the city corporation service bills. They throw their household solid wastes here and there and thus enormous health and environmental problems are found acute in these settlements. As a case of the city, Kashipur slum is suffering due to lack of this solid waste management consequences. The slum is located beside the rail line and few part is on KCC khash land and the rest of it is on railway khash land. This land tenure critically created municipal basic service dilemmas. Also there is no access road to most of the households. The municipal waste collection bins are not at suitable places for the slum dwellers and also the provided container capacity is inadequate according to slum population. They throw their everyday kitchen solid wastes here and there and the entire slum environment turned unhygienic and unhealthy. Also by throwing kitchen solid wastes in to the drainage, the water logging situation is found acute in last few years and the water logging is found in many settlements (Prashad Bosu and A MD Ullah, 2019). The slum became a breeding ground of diseases. Poverty, unawareness and unemployment all together is prevailing there. And this is almost a common scenario in most of our slums across the country.

The future of waste management crisis will depend on treating it in the source place (Sailesh and Shinde, 2016). Among the total solid wastes of Kashipur slum, a very high proportion is kitchen solid wastes. This paper attempts to find the contextual kitchen solid waste management opportunities and also the scopes to turn it into a prospectus part of informal settlements and

discusses in the context of Kashipur slum, Khulna. In the context of Kashipur slum, this attempt will settle down simultaneous problems at a time like water logging, poor residential health and hygiene, waste disposal solution and a scope for income generation.

## 2. Objectives

The research paper will develop based on the following objectives -

- 1) To find out solid waste management situation and constraints in existing settlement.
- 2) To explore the opportunities in context based solid waste management.
- 3) To develop a framework to turn waste-to-income prospects in informal settlements.

This attempt will settle down simultaneous problems at a time like water logging, poor residential health and hygiene, waste disposal solution and a scope for income generation.

## 3. World waste management trend, technologies and Bangladesh

### 3.1. The future of waste

Waste is not wasted in today's world anymore. Researches and technology has taken it to a far more prospectus platform. The world generates 2.01 billion tons of municipal solid waste annually, with at least 33 percent of that, extremely conservatively, not managed in an environmentally safe manner. Worldwide, waste generated per person per day averages 0.74 kilogram but ranges widely, from 0.11 to 4.54 kilograms (World Bank, 2019). If we just look into the innovation waves, it will be like-

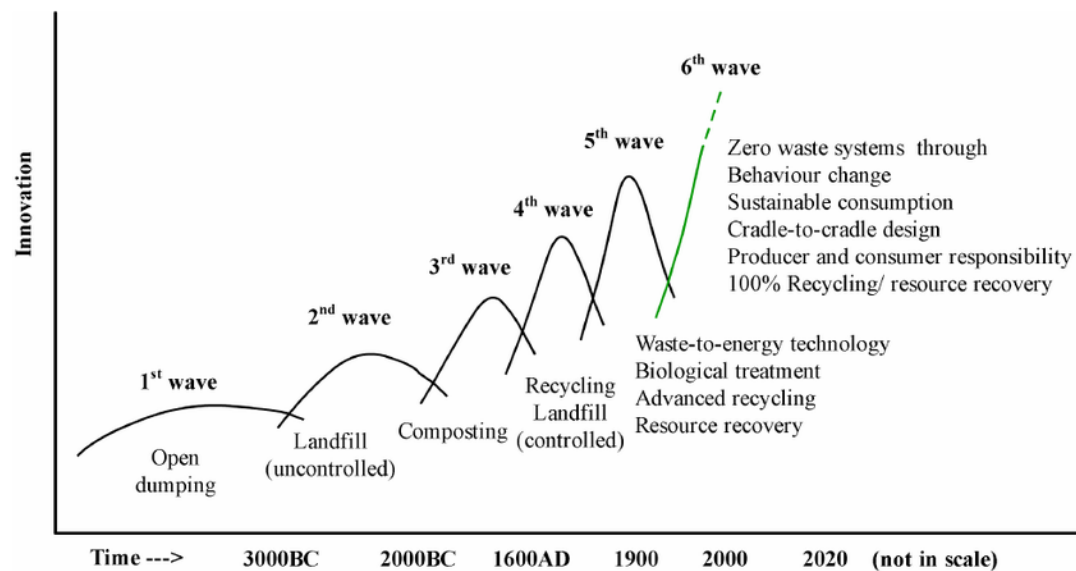


Figure 1: Waves of innovation in waste management systems adopted from the UNEP and the Natural Edge Project 2004

According to this time-waste innovation wave stages, being in the time zone of 2020, Bangladesh is still falling back to the systems of 3000-2000 BC. A very minor part of the total waste is taken under composting, recycling or energy conversion technology. Zero Waste is a set of principles focused on waste prevention that encourages the redesign of resource life cycles so that all products are reused. The goal is for no trash to be sent to landfills, incinerators, or the ocean. Currently, only 9% of plastic is actually recycled. Zero waste system, material will be reused until the optimum level of consumption.

The definition adopted by the Zero Waste International Alliance (ZWIA) is:

“Zero Waste: The conservation of all resources by means of responsible production, consumption, reuse, and recovery of all products, packaging, and materials, without burning them, and without discharges to land, water, or air that threaten the environment or human health.”

Zero waste systems through behavior change and 100% recycling is still like reaching to the moon in the context of Bangladesh. We need a solution that is least expensive and attainable. In the field of waste management, using global standard technology would be costly if not widely planned and managed. It is a frequent misconception that technology is the solution to the problem of unmanaged and increasing waste. Technology is not a panacea and is usually only one factor to consider when managing solid waste. Countries that advance from open dumping and other rudimentary waste management methods are more likely to succeed when they select locally appropriate solutions.

In the global waste management trend, decentralization is the most effective solution for a fast approaching waste management crisis (Sailesh and Shinde, 2016). Many of our neighboring countries like India, Sri Lanka, Thailand, etc. are adopting the decentralized waste treatment approaches as a central mega plant set up is costly to operate (Joshi and Ahmed, 2016). Also the Asian countries started to refuse Canada, USA and other western ships of wastes for recycling since 2019 because 30% of the wastes are totally unusable and carries organic contamination. So the future of waste management crisis will depend on treating it in the source place.

### 3.2. Treating process and technologies of Kitchen solid waste

The five commonly used treatment methods are namely anaerobic digestion, landfill, incineration, composting and heat-moisture reaction (Gao *et al.*, 2017). The fig: shows a diagram regarding the treatment methods. The Kitchen solid waste is basically the food waste and biodegradable. The solid waste in most of the urban centers in Bangladesh contains a very high proportion of biodegradable organic fraction (Al-muyeed, 2014). And this organic fraction is easily composted to reduce the amount of waste and can be used as fertilizer. Other than that,

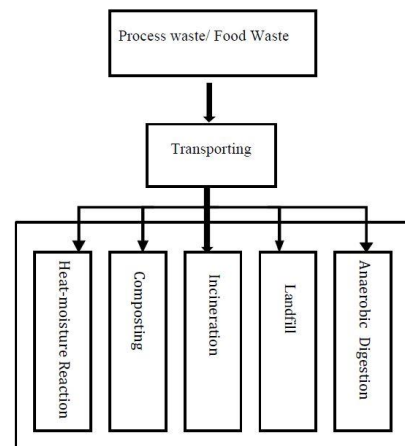


Figure 2: Kitchen waste treating process

a detail of different kind of use of solid waste, the technologies and processes and end-use sectors and products are shown in the below diagram (Lohri *et al.*, 2017) (Fig: 3). Among all these options we need to pick the feasible option that will be site and context specific.

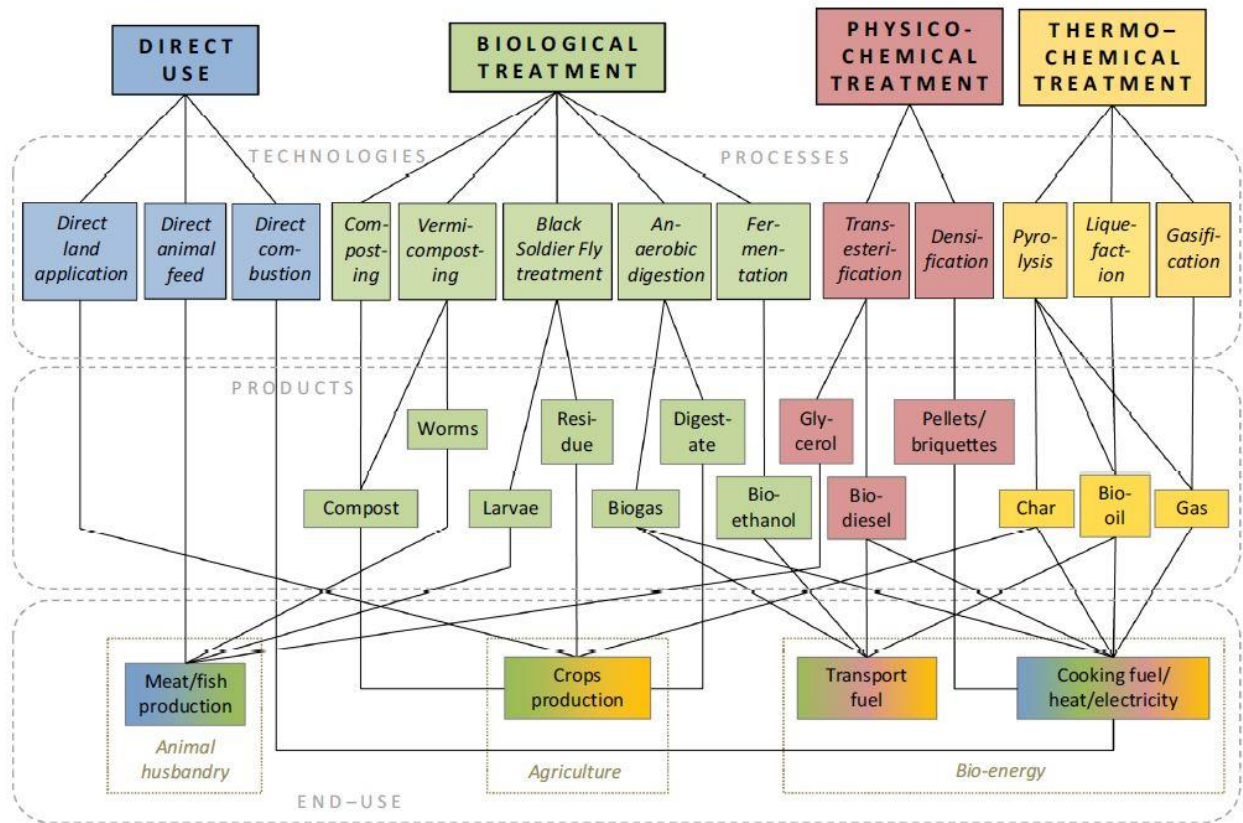


Figure 3: Bio-waste treatment technologies with their products and end-use (Lohri *et al.*, 2017)

Critical review of challenges and trends in low- and middle-income settings - Open burning is not considered an acceptable solid waste management although it is still widely practiced in urban low- and middle income settings. It poses a substantial threat to human and environmental health from emissions of mixed waste burning and/or incomplete combustion. Open burning has the main objective of waste reduction and does not recover energy nor nutrients.

### 3.3. Present scenario of waste management in Bangladesh

There are three noticeable systems of waste management in Bangladesh (Department of Environment, 2004). One is the 'Formal System', where municipalities/city corporations are responsible for Solid Waste Management (SWM). "Formal system" is based on the conventional

system of collection-transportation-disposal of waste carried out by the local authorities. In this system the concept of recycling is absent. Next is the 'Community Initiative' that is based on primary solid waste collection by CBOs and NGOs, Finally, 'Informal System' represented by the large informal labor force involved in the solid waste recycling trade chain. Partnership between these three systems is needed to promote effective solid waste management system in the country.

Since Bangladesh is still struggling in waste management as well as financial resources, we would look forward to local technologies to adapt composting, recycling and waste-to-energy opportunities in the context of Kashipur slum. Community based solid waste management approaches (CBSWM) are already examined effectively in many countries including Bangladesh (Prashad Bosu and A MD Ullah, 2019). One more adventure would be possible since the community is poor and suffering from unemployment problem. If a waste-to-income opportunity framework can be established, the community will hit multiple health-environmental-economic targets at the same time.

#### 4. Context:

Kashipur slum is located in the urban envelope where all civic facilities are available all around except this little community land mass. The distinct feature is that it has established alongside the rail line and geographically hidden from all sides to the passersby. It is likely a junction point of Khalishpur, Notun Rasta and Mujgunni. Around 1970s to 1980s the place was a low ditch land. The owner of the khash land is Bangladesh railway and partially Khulna City Corporation (KCC).

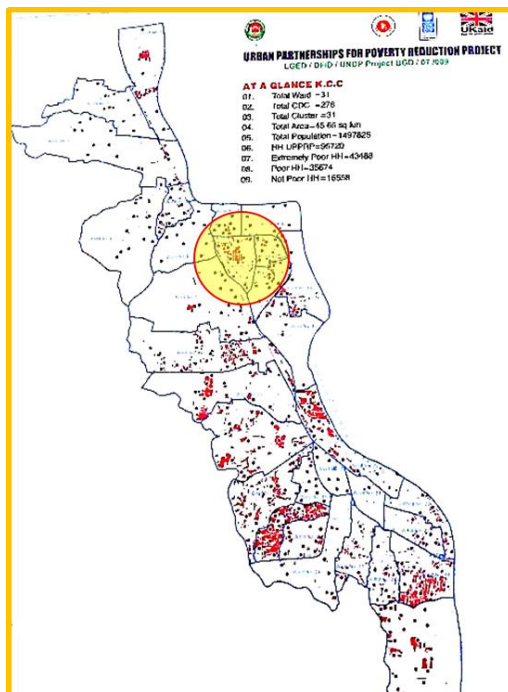


Figure 4: Informal settlements in Khulna City Corporation adopted from UNDP



Figure 5: Kashipur slum in Google map

There by the land has no tenure security but a de facto is existing since the local ward commissioners are well aware of this. Also there are electric connections to every household who also pay bills. Other than this, there are much scarcity in other civic facilities like – road connections, drainage, KWASA water supply line, waste disposal facilities, etc.

This particular paper focuses on the waste management system and while digging deep, several causes and effects came to light. The GIS and BBS land elevation maps show that the site is in a junction point of low and high land and always suffered water logging problem during rainy season. In this regard, local NGOs like UNDP, BRACK and few others had been working as per their organizational agendas since 2004. UNDP provided a huge WSAH (Water, Sanitation and Hygiene) support to improve the health and environmental condition. A major drainage connecting all toilets and used water outlets had cut down the severe water logging of the area. This was done by UNDP back in 2009 and that time the waterlogging problem was almost solved. Later on as a consequence of disposal of solid waste into sewage lines, the waterlogging has turned into an acute problem now. Also there is no waste bin or designated place for waste disposal, more over no system is provided by KCC to collect the municipal wastes from that area. People use to throw it here and there and sometimes dispose it in the provided drain or just openly beside the rail line. As a result the entire slum environment is unhygienic and people are suffering from health issues. So the solid waste management is now the first vital step to mitigate waterlogging and also health-hygiene problems.

Waste is already getting out of our control and the world researchers and scientists, environmental activists, governments of all nations, NGOs are struggling to find a better solution. The amount of waste we have already produced is kind of multiple times more than we can imagine. Not only the Kashipur slum, but the entire Khulna city is lacking behind in managing waste. Simple dumping and land filling are not a sustainable solution, also incineration is subjected to cause air pollution. So this study is an attempt to find a sustainable solution about the solid waste management in a marginalized settlement with a target to generate a framework which can be repeated in other areas as well.

## **5. Methodology**

**JMP** (Joint Monitoring Programme) was the first tool applied to evaluate the water, sanitation and hygiene situation of the settlement. The JMP estimates for a total 26 indicators related to water, sanitation and hygiene (WHO, 2018). The JMP has developed a normative interpretation for each of the terms used in the targets, and the approach to global monitoring aims to reflect these as closely as possible. The JMP uses service ladders to benchmark and compare progress across countries, and these have been updated and expanded to facilitate enhanced monitoring (World Health Organization and UNICEF, 2017).

As a finding of vulnerable health and hygiene condition and also water logging, a **fishbone analysis** was done to find all cause and effect issues. Fish bone diagram has proved to be simple, applicable, controllable, as well as adaptable. Primary data for the study is collected through FGD with two groups and committee members of sanitation and related projects, and concerned GO-NGO staffs. Books, project reports and implementation guidelines, journals, web pages, newspapers etc. are reviewed as secondary data sources.

## 6. Findings and analysis

### 6.1. Site Analysis of solid waste management situation and constraints

The study is conducted in the informal settlement of Khulna City, named Kashipur slum which is partially on Government khas land (20 households) and mostly on Bangladesh Railway land (400 households). This land criticality has created enormous authorithical service dilemmas.



Figure 6: Area map showing Kashipur slum and surrounding



The entire settlement is almost invisible both from Dhaka-Jashore-Khulna highway and from B.L.College- Nayabati connection road due to commercial shops in the front line.

The total population of the slum is 1680. The number of total household is 420 and among them 100 households claim to be landlords (captured a land area after 1971 war or bought illegally from another occupant). Another 320 households are tenants. On an average, every four to five households share a common toilet and a kitchen area.

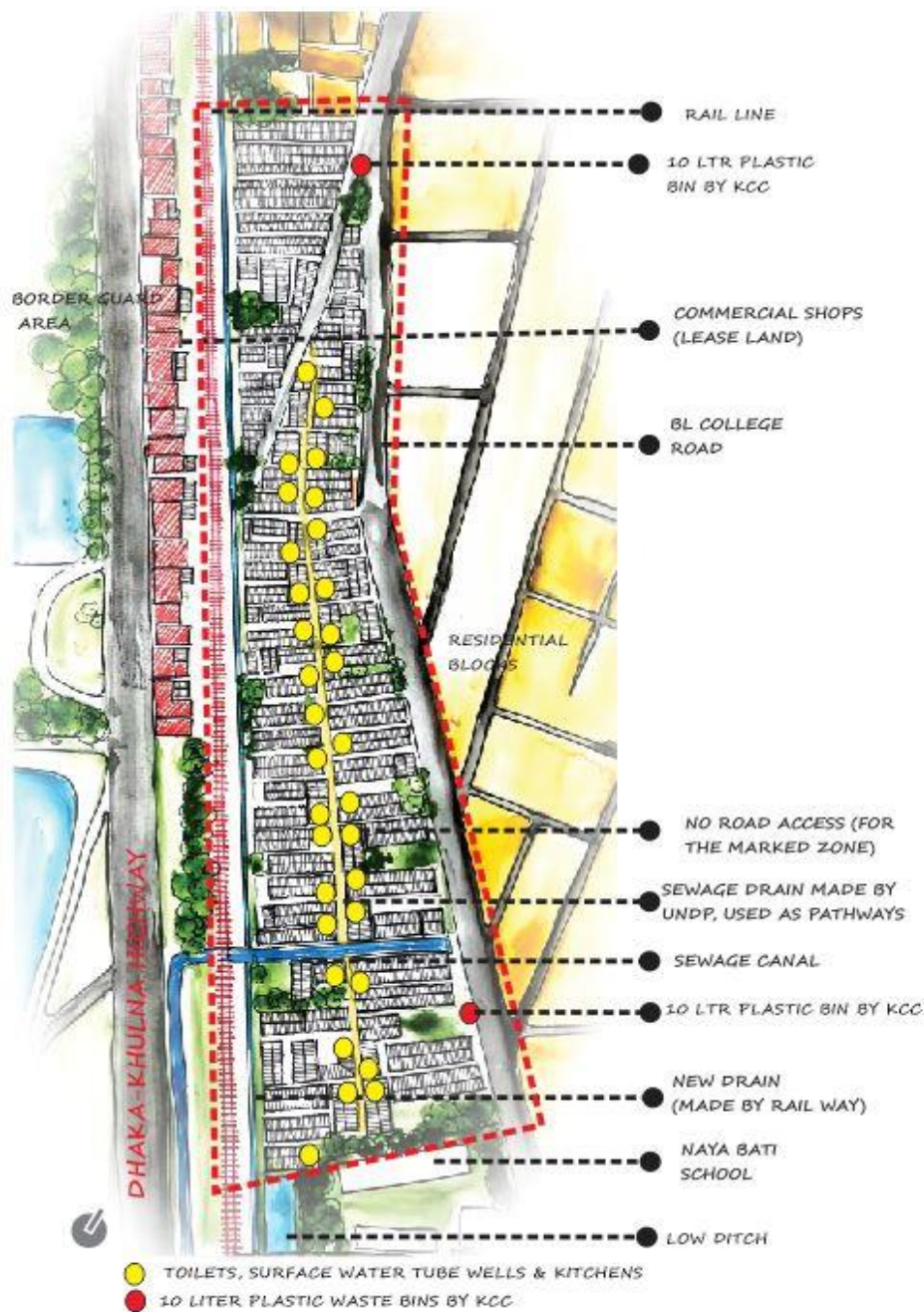


Figure 7: Existing lay out of the settlement (Problem Map)

The above problem map will illustrate the existing solid waste condition and disposal systems with surroundings. There is no system provided by KCC for waste collection. Also there is no adequate access road to all households. KCC along with BRAC very recently provided 2 road side plastic bins for waste collection but not suitable to carry domestic solid wastes up to that point. Also the bins/ containers are too small to serve the community. The entire water, sanitation and hygiene status is done following the **JMP** format.

WATER			SANITATION		
INDICATOR		KASHIPUR STATUS	INDICATOR		KASHIPUR STATUS
1	Improved Drinking water source	1 tube well	1	Improved sanitation facilities	12
2	Piped improved drinking water sources	Not available	2	Improved sanitation facilities connected to sewers	Not all
3	Non piped improved drinking water sources	Not available	3	Improved sanitation facilities connected to septic tanks	19
4	Unimproved drinking water sources	Not available	4	Improved pit latrines or other on-site improved facilities	17
5	No. drinking water facility ( surface water)	32 surface water tube well	5	Unimproved sanitation facilities	26
6	Improved water sources exceeding 30 minutes collection time	No, less than 10 minutes.	6	No sanitation facility ( open defecation)	0
7	Improved water sources exceeding 30 minutes collection time ( basic drinking water services)	1 tube well	7	Improved sanitation facilities which are shared ( limited sanitation services)	32
8	Improved water sources which are accessible on premises	Yes, 01 source	8	Improved sanitation facilities which are not shared ( basic sanitation services)	6
9	Improved water sources which are available when needed	Yes, 01 source	9	Sewer connections where wastes research treatment plants available and are treated	Not available
10	Improved water sources which are free from contamination	Yes, 01 source	10	On site sanitation facilities where wastes research treatment plants and are treated	Not available
11	Safely managed drinking water services	Available	11	On –site sanitation facilities where wastes are disposed of in situ	Not available
			12	Safely managed sanitation services	Not all

Figure 8: JMP (Water and Sanitation) status of Kashipur Slum

According to 2016 BBS report and GIS maps, the land elevation of Kashipur slum has formed a basin like character. This accumulate a lot amount of surrounding water especially in rainy season. The settlement remain under waterlogging problem for about four to six months each year. The health and hygiene condition of the total settlement was threatened. It became a breeding ground of diseases. UNDP constructed a central sewage drain (covered and used as pathway) in 2009 to solve this waterlogging problem. But most of the old toilets are directly connected to the drain. Unaware and uneducated people started to throw kitchen wastes into the drain and the

waterlogging is again seen acute in last few years. Recently UNDP provided 12 pit toilets in 2019 where vacutugs may not reach. So all together the settlement is lacking in solid waste management.

HYGEINE		
INDICATOR		KASHIPUR STATUS
1	A hand washing facility on premises	Not all
2	A hand washing facility on premises with soap and water available ( Basic hand washing facility )	Not all
3	A hand washing facility on premises lacking soap and /or water ( limited hand washing facility)	Not all
4	If sanitation facility leak or overflow wastes at any time of year	During rainy season, waterlogging is acute and wastes overflow
5	Probe for problems during the rainy season or floods	Not measured

Figure 9: JMP (Hygiene) Status of Kashipur slum

A fishbone analysis was done to find all the necessary indicators to find out the cause-effect factors of the problem.

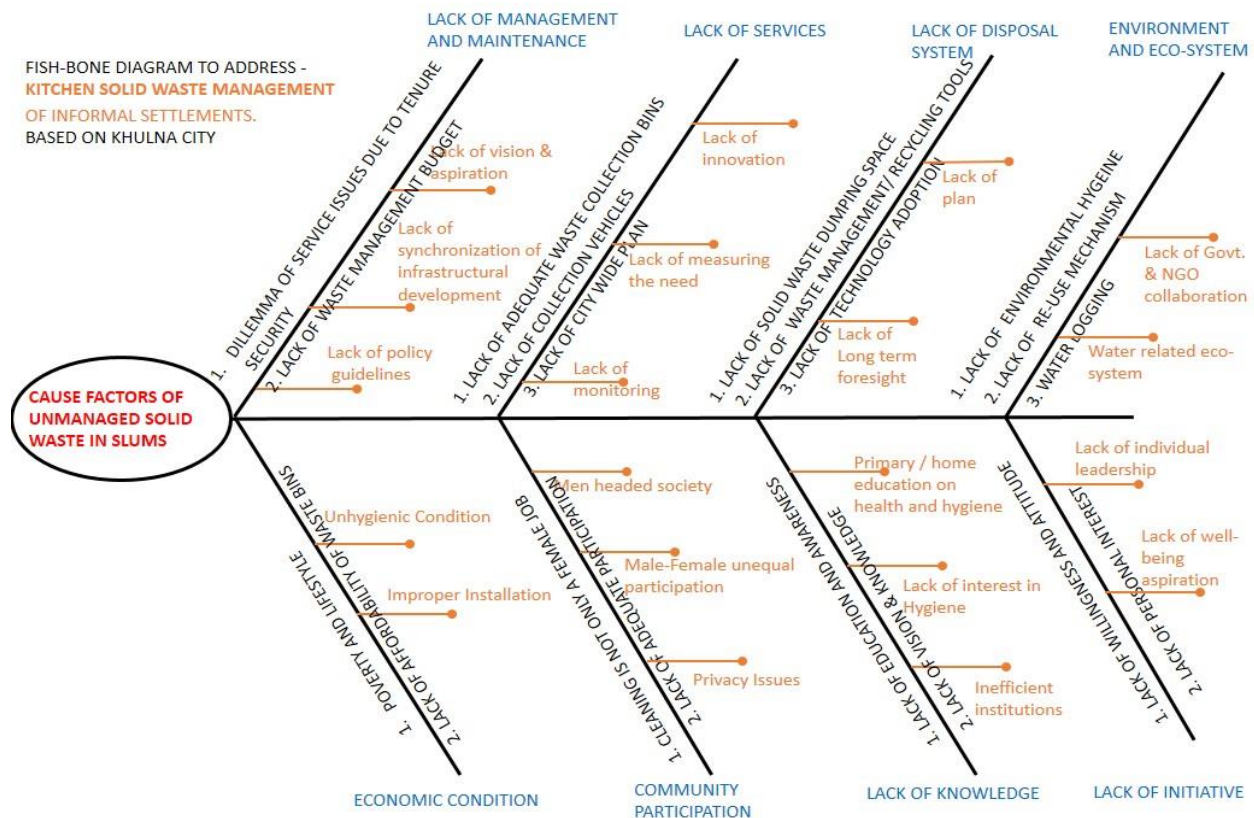


Figure 10: Fishbone Analysis for cause indicators of unmanaged solid waste in urban informal settlements

- **Lack of management and maintenance:**  
The national and local governments are still lacking in policy and action towards waste disposal and management system of the entire country. Because of land tenure criticality the Kashipur slum is excluded from municipal solid waste collection services. Also the yearly budget is inadequate to serve all city people.
- **Lack of services:**  
There are few waste collection points and also provided bins by KCC and other NGOs at different point. All are at a distant place and new bin capacity is inadequate for Kashipur slum population. Lack of measuring the target group need is important.
- **Lack of disposal system:**  
As most of the households are linear and densed in arrangement alongside the rail line and there is no proper access road, Kashipur slum and the community people could not develop a disposal system. Also lack of technological knowledge and adoption is there.
- **Environment and eco-system:**  
Lack of environmental hygiene is a vital reason of diseases and other poor health condition of the entire settlement. Throwing kitchen solid wastes here and there has caused severe waterlogging condition.
- **Economic Condition:**  
The overall poverty is a reason behind their less clean lifestyles. They do not buy a particular pot to dump their kitchen or everyday waste. Sometimes females just grab all in their hand and go close to the rail line and throw it to a little far away.
- **Community Participation:**  
Few of the community people are aware and first initiated the idea of waste collection and to do something prospectus with waste. But most of the slum population are not at all bothered. Male population are found not interested in keeping a clean environment. They claimed it as a female job.
- **Lack of Knowledge:**  
Lack of education and awareness is a vital reason behind the unmanaged wastes, unhygienic living condition and poor health.
- **Lack of Initiative:**  
A lack of initiative is rooted from the top to bottom level of this waste management problem. But people who are suffering the direct consequences are also ignorant and lacking in taking initiatives. There is a lack of individual leadership in most of the people. Their personal interest and wellbeing aspiration is also found very low.

## 6.2. Opportunities in context based solid waste management

The World Bank data shows that middle and low-income countries generate 53 percent and 57 percent food and green waste, respectively, with the fraction of organic waste increasing as

economic development levels decrease. The composition of waste in low-income with respect to middle and high income group is shown below –

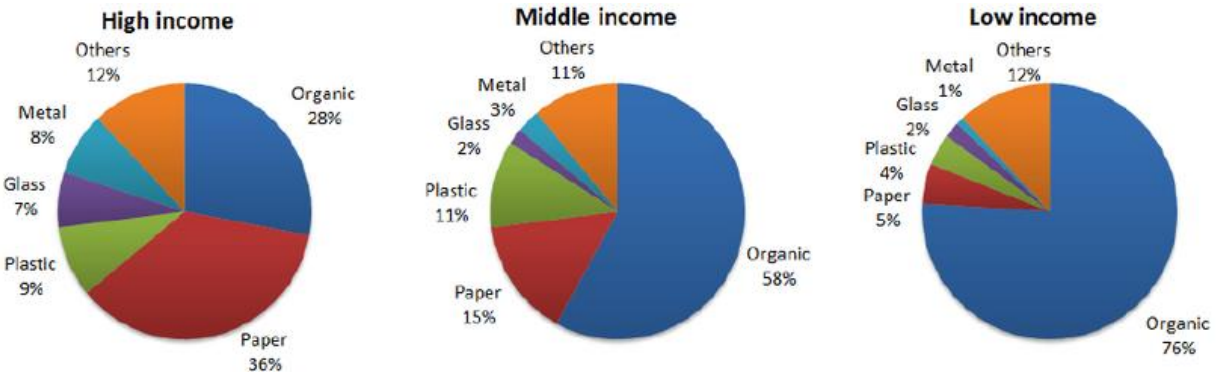


Figure 11: Composition of solid waste in different income groups adopted from World Bank database 2018

Per capita generation of wastes in six major cities of Bangladesh (Alamgir and Ahsan, 2007).

Income level	Per capita waste generation (kg/day)						Average
	DCC	CCC	KCC	RCC	BCC	SCC	
A	0.504	0.378	0.368	0.343	0.327	0.429	0.392
B	0.389	0.343	0.333	0.320	0.278	0.395	0.343
C	0.371	0.350	0.319	0.242	0.247	0.340	0.312
D	0.305	0.253	0.264	0.309	0.269	0.248	0.275
E	0.270	0.189	0.203	0.239	0.172	0.260	0.222
Average	0.368	0.030	0.297	0.291	0.259	0.334	0.309
SD	0.090	0.079	0.065	0.047	0.057	0.080	0.070

High socio-economic (A), Middle upper socio- economic (B), Middle socio- economic (C), Middle lower socio- economic (D), Low socio- economic (E)

Figure 12: Per capita waste generation

Another 2007 study shows that the per capita waste generation in lower socio-economic strata in KCC was found 0.203 kg/day (Alamgir and Ahsan, 2007). It is obvious that the amount will be more now. Again, low income groups has a 76% of organic waste.

Theoretically, Kashipur slum produces total solid waste  $(1680 \times .203 \times 30) = 10,231$  kg/ month.

From a FGD it was found that people are interested to make income out of waste. Waste picking, collecting, separating, selling, and making compost and selling it to local nurseries and farmers were their field of interest. A part of the population can thus earn money from waste management and lessen their unemployment problem.

### 6.3. A framework to turn waste-to-income prospects in informal settlements

There can be few selected collection points, or even can be a door-to door attempt to collect household solid wastes. A set of interested waste workers will be needed who will be paid by community fund from CBOs. In Kashipur slum, there are interested females who is looking for income opportunities. They showed interest to become waste workers. In fact, they are the people who first thought of this opportunity and came up with an idea in a different research survey. Dumping site selection in Kashipur slum is critical due to density and land scarcity. Still there is a point beside the big sewage canal where a cow shed is established in one side, which can be used. Cow dung can also be used in compost making. A proper link up with the recycling market who buys used plastics, glasses or metals need to be introduced to enhance selling opportunity. Also a network with local farmers to sell compost is necessary. Alongside the Dhaka-Khulna highway, there are nursery areas where compost has high demand. The turn over from selling wastes and composts need to be calculated to run the whole program.



Figure 13: A waste-to-income framework for informal settlements

## **7. Recommendations**

An overview of the study indicates the following recommendations –

- An overall awareness on domestic waste handling and disposal is needed in this settlements. So that they stop throwing wastes here and there.
- Prospects of managing and reusing waste need to be brought in day light.
- Selecting collection places need to be judged by calculating waste amount and container capacity.
- CBO funds can be used if people are enough motivated.
- Selection of dumping places will be crucial since density is very high and land tenure is in most cases unavailable.
- An estimated turn over need to be calculated beforehand.
- A proper training in waste handling and on technical aspects are also important for workers.
- Private sector involvement is essential for taking a lead.
- Revising national and local policy frameworks to address waste sector and income opportunities also waste management budget.

## **8. Conclusion**

East and South Asian countries started to refuse taking the waste cargo ships of western countries in last few years. Now governments across Asia are saying no to the imports, which for decades fed mills that recycled waste plastic. As more and more waste came, the importing countries faced a mounting problem of how to deal with tainted garbage that couldn't be easily recycled. The long-term message for nations is clear: Deal with your own garbage. Treating wastes in its source place is now the new challenge. Following this the role of Integrated Communal Solid Waste Management is already being examined in various context. Central city wide plan may not be effective in a fast growing population and urban sprawl. Also the profit making prospects from wastes are not negligible now a days. Since informal settlements are most vulnerable in case of environmental hygiene and health, to make an in-situ solid waste management plan for informal settlements can contribute to the people environmentally as well as financially. This research can help as a module solution to discuss in other informal settlements and cost effective technologies can be adopted to make the idea into reality.

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