

From Alley to Landfill: Challenges of and Design Opportunities for Cleaning Dhaka's Communal Trash

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ABSTRACT

Garbage is an endemic problem in developing cities due to the continual influx of migrants from rural areas coupled with deficient municipal capacity planning. In cities like Dhaka, open waste dumps contribute to the prevalence of disease, environmental contamination, catastrophic flooding, and deadly fires. Recent interest in the garbage problem has prompted cursory proposals to introduce technology solutions for mapping and fundraising. Yet, the role of technology and its potential benefits are unexplored in this large-scale problem. In this paper, we contribute to the understanding of the waste ecology in Dhaka and how the various actors acquire, perform, negotiate, and coordinate their roles. Within this context, we explore design opportunities for using computing technologies to support collaboration between waste pickers and residents of these communities. We find opportunities in the presence of technology and the absence of mechanisms to facilitate coordination of community funding and crowd work.

CCS Concepts

•Human-centered computing → Collaborative interaction;

Keywords

information communication technology for development; ICTD; waste management; garbage; collective action; crowdsourcing; crowdfunding

1. INTRODUCTION

In many developing cities, open waste dumps are hallmarks of rapid and unplanned urbanization. They contribute to the spread of diseases, environmental contamination,

and catastrophic flooding [16, 37]. Garbage collection requires little skill and yet of all the trash generated, only 30% is collected in Karachi, 40% in Yangon, 50% in Cairo and many Indian cities [24], and 37% in Dhaka [38]. *Why is there garbage everywhere?* is a question that confounds foreigners, locals, and governments alike.

There is no shortage of human labor for this low-skill job: most developing cities have well-established waste picker communities. Nearly 15 million people are engaged in the informal waste sector in developing regions, more than those engaged formally. In 2012, the global solid waste management service sector was worth 390 billion USD and accounted for 5% of urban jobs in low-income cities [5]. There is no shortage of money for waste disposal: residents, officials and external NGOs are willing to pay to clean up these urban centers. In Jan 2014, the World Bank committed 410 million USD to help improve basic municipal services in Bangladesh, 1% of the fund is specifically committed to solid waste management [6]. This is just one of many waste management initiatives in developing regions.

The garbage problem is deceptively simple; after all, how hard is it to just pick up the garbage and dump it? We explore the complexities of the garbage problem through an in-depth study of the trash collection ecology in Dhaka, Bangladesh. In Dhaka, residents pay waste pickers for door-to-door trash collection. Waste pickers collect trash from households and sort the trash for profitable by-products and dispose of unprofitable trash at small dumpsters on alleys and side-streets. Ideally, municipal workers would then collect trash from the small dumpsters and transport them to landfills. We find, however, that municipal services tend to be infrequent and unreliable and, over time, overflowing dumpsters become open waste dumps. We refer to these open waste dumps as *communal trash*. Residents suffer from ubiquitous communal trash, but unlike household trash they are not directly responsible for its removal. Our goal is to study the trash collection process with the purpose of solving the communal trash problem without interfering with the household trash collection process.

Our primary contribution is an ethnographic study of the informal trash economy in Dhaka. In particular, we study the well-functioning, technology-free, household trash collection process at four neighborhoods in Dhaka. Our study reveals at least two opportunities for collaboration and collective action among residents and waste pickers that can not only solve the communal trash problem, but also elevate the socio-economic status of the vulnerable waste-picker com-

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munity. These opportunities are:

Organizing collective action for communal trash cleanup. Communal trash collection is an activity where individual action does not have much impact, hence warranting collective action: residents cannot independently and completely clean up open dumps in their neighborhoods nor can they fund the costs of doing so. Second, a ‘tragedy of the commons’ situation leads to limited incentives for individual action; even if a few residents can support the clean-up costs, a perceived free riding problem hinders these residents from participating in communal trash collection efforts. *Can we design a system to bring willing residents together to collectively contribute to cleaning communal trash?*

Organizing waste pickers for crowd work. A key barrier to waste pickers providing communal trash cleanup services is their inability to negotiate fair prices. Although residents and waste pickers interact on a daily basis in Dhaka, there are few opportunities for price negotiation of household trash pickup or other services. In the absence of a waste pickers’ union in Dhaka, the waste pickers have no collective bargaining power, earn less than a minimally sustainable wage, and are exploited by middlemen. By re-orienting themselves as independent crowd workers who provide services at a sustainable price, waste pickers might be more inclined to engage in communal trash cleanup. *Can we design a system that gives waste pickers the ability to directly negotiate prices and organize to clean up communal trash?*

In Dhaka we observe an efficient economy surrounding household waste collection and consider whether this economy could somehow be extended to communal trash cleanup. From our findings we carefully assess whether an interventionist approach or a technological one can support a natural growth of the trash ecosystem to include communal trash.

2. RELATED WORK

2.1 Waste Management in Developing Countries

Rapid population growth and urbanization has overwhelmed traditional waste management systems in many cities of the developing world, leading to open dumping of waste and posing a serious threat to human health and the environment. Municipalities spend between 20-50% of their operational budget on waste management systems [27, 8], and yet fail to keep cities clean due to poor planning. Waste management technologies and systems that are adopted are especially prone to fail when they are not appropriate to the social, economic, and technical context of the city, e.g. poor maintenance of trucks and equipment, high cost of building and maintaining waste treatment plants, lack of capacity in trained labor and funds, and inadequate policies and law enforcement [33, 37]. In circumstances where only 50% of refuse is collected [39], residents are left with little choice other than to dump their garbage in nearby vacant lots, public spaces, and rivers.

In most developing countries, informal communities of waste pickers handle 15 - 20% of the waste generated [9]. The International Labor Organization (ILO) defines informal waste pickers as individuals or small and micro-enterprises that provide waste management without being formally assigned. They offer door-to-door trash pickup ser-

vice for households and collect, sort, and trade recyclables, thereby providing logistical, financial, and environmental benefits to municipalities, industries, and residents. Despite the valuable service they provide, the informal waste pickers have low social status as they spend long hours working in hazardous environments of open dumps and landfills. They are economically exploited by a hierarchy of actors such as traders, residents, municipality workers, and the “waste mafia” owing to their poverty, illiteracy, and their lack of employable skills, market knowledge, and bargaining power [24]. Their laborious service amounts to extremely low incomes, forcing families and children into the waste picking business.

The garbage problem has been explored from a variety of perspectives to better understand the problem and potential solutions. In the waste management literature, proposals have been put forth to address the problem from several directions including waste picking, dumping, disposal, and recycling [34]. In Bangladesh, the garbage problem is recognized by the government, and widely discussed within academic circles [19, 18, 11]. Beyond waste collection and disposal, researchers have also explored re-use and recycling behaviors and best-practices [20, 35]. By nature, the waste management problem is a collaborative task that requires the engagement of community members and different public/private stakeholders [9]. In India, researchers explored community-based approaches and argue for collective action and collaboration [14].

Policy, planning, and financial arrangements to reduce waste have also been studied in different contexts [25, 29]. Some works argue that increases in social capital encourages voluntary participation in waste management and could pave the way for sustainable solutions [29, 30, 21]. From a technology standpoint, many solutions have been developed to fortify infrastructure gaps [21, 28]. These numerous discussions and approaches offer a variety of perspectives, but none of these works explore the potential of using computer-supported collaborative platforms to help solve the garbage problem.

2.2 Computer-supported Coordination and Intervention

We briefly describe complementary research works on online mobilization, coordination and collaboration to illustrate that online collaborative platforms can be used to bridge large distances and unite people online together toward a common purpose:

Works relevant to enabling collective action by residents. Introducing technology in existing social and organizational contexts is not without challenges and is well studied. Nattalja discusses the use of information technologies in cooperative settings and the importance of developing shared technological frames when introducing technology [26]. Schuler et al. examine the role of social computing technologies in group-activities, and report on the importance of moving away from designs that impose structure and focus on providing means to share meaning and consensus [32]. To address the problems of coordinating collective action, namely free-riding and social loafing, Cheng and Bernstein developed a platform to catalyze collective action conditional on a minimum activation threshold of participation or hours [13]. Beltran et al. developed novel a crowd funding platform, Codo, that allows donors to specify their own conditional

donations: A donation is only collected if the donor’s conditions are met [10]. These funding platforms can form the basis for the design of a community-based platform that allows residents to contribute only if other residents also contribute, hence eliminating free-riding concerns.

Works relevant to organizing waste pickers as crowd workers. Several technological platforms successfully organize crowd workers: Amazon mechanical turk crowd sources computational work to workers around the globe [1]. On-demand mobile workforce applications such as Task Rabbit [3], Uber [4], etc., coordinate the distribution of physical tasks to willing workers located nearby. The design of a platform that organizes waste pickers as crowd workers should be guided by these systems. Teodoro et. al describe the importance of providing crowd workers, in our case waste pickers, autonomy over work schedules, task selection, and compensation [36].

Adoption of technological solutions in the developing world. The trend of mobile technology adoption in developing communities makes it a promising platform for developing technological solutions. Works by Sambasivan et al. use exploratory studies to describe living realities, adoption, and use of mobile phones in urban slums [31]. Medhi et al. and other researchers from the CHI and ICT for development (ICTD) communities examine the challenges to mobile use in low-literate communities and offer viable solutions including text-free and voice-based interfaces [23, 22]. Other works introduce novel technology and interface design through direct interventions in developing regions [17, 22, 15]. The most closely related work to our problem of coordination in developing regions, Gupta et al. studied the introduction of a mobile crowdsourcing platform for digitizing documents in India [17]. This wealth of literature supports the possibility of using technology interventions to address large-scale societal problems in developing contexts.

3. METHODOLOGY

Our study contributes a detailed understanding of the trash ecosystem in Dhaka, Bangladesh through an ethnographic study of the practices of the actors in the informal garbage collection ecosystem and their relationships with each other.

Our study was carried out in two phases. In the first phase carried out in December 2014, our in-situ Bangladeshi researcher visited 10 neighborhoods in Dhaka. Each site was visited multiple times over consecutive days. After a survey of the initial 10 neighborhoods (Figure 1), we narrowed down on four rather diverse neighborhoods in terms of affluence, education levels, and infrastructure. Azimpur and Shantinagar are older residential areas of Dhaka, typically occupied by well ranking officials such as government employees or university professors. These communities are better educated, have broader social networks, and care about civic issues. Itkhola Bazaar and Mirpur are fast growing, middle to upper class, residential areas. We avoided communities of a lower economic status as we were seeking residents with the financial capacity to contribute toward communal trash cleanup. We spent 80 hours worth of community observation and relationship building in this phase.

In the second phase, we started our three-month study from January to March 2015. We visited each neighborhood multiple times to conduct semi-structured interviews. Our researcher interviewed residents who were introduced

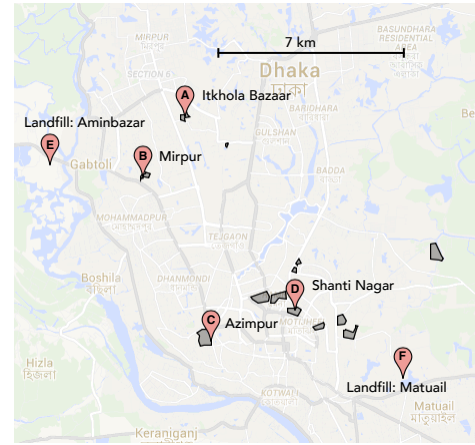


Figure 1: Visited communities in Dhaka. Shaded areas are where we visited to make informal observations. A - D mark the four areas where we conducted the bulk of our study. E and F mark the two landfills Dhaka.

to him through personal connections. He interviewed waste pickers while they were unloading their rickshaws or sorting through recyclables. Through initial interviews with residents and waste pickers, he identified and subsequently interviewed additional actors, namely building committee members and picker agents — rickshaw owners who manage one or more waste-pickers. We spent more than 50 hours conducting interviews.

Of the 26 participants we interviewed, 14 were waste pickers, 10 were residents, one was a building committee member, and one was a picker agent. The interviewees included 16 men and 10 women (6 residents and 4 waste pickers). The education level of the waste pickers ranged from no formal education to grade 9, whereas that of residents ranged from high school (grade 12) to masters degrees¹. We inquired about the waste picking process, the finances associated with it, the existing collaboration between the various stakeholders, and tried to grasp the varying attitudes towards civic cleanliness and willingness to contribute towards it.

The field work was conducted in Bengali, the local language. The interviews lasted up to 35 minutes. They were recorded and later translated and transcribed into English.

Analysis. Through open coding and later a focused coding exercise, two of the co-authors independently coded the interviews and then reconciled the codes through discussion with the other authors. Our findings revealed the generally positive relationships between waste pickers and residents, residents’ attitudes towards civic cleanliness, and expectations of fairness in community-organized activities. We also examined the codes in relation to our initial goal of solving the communal trash problem and we found major themes surrounding the complex relationship dynamics between stakeholders, and the subtle intimidation and exploitation suffered by waste pickers at different levels. These observations helped shape our eventual discussion and design recommendations.

¹The respondents reported studying in the local Bangla education system, which is similar to a K-12 approach with 12 grade levels.

We organize the presentation of our findings as follows. We begin with an overview of the garbage collection ecology. We then describe in detail the roles of the different stakeholders, their perceptions of trash, and the socio-technological context. Finally, we summarize our findings across two themes: (i) the challenges of collective and collaborative action, and (ii) power dynamics and exploitation.

4. GARBAGE COLLECTION ECOLOGY

Dhaka is the 11th largest city in the world. Currently, 12 million people live in this mega city with a shockingly high population density of 36 people per square meter [7]. Dhaka produces 3,500 tons of waste per day. Yet, of these 3,500 tons of waste, only 1,800 tons make it to the landfill and 400 tons are recycled. The remainder finds its way to inner-city open waste dumps, rivers or lakes [39]. Many residents resort to burning trash to contain its sprawl, contaminating the air and soil in the process (Figure 2a). Until 2009, Dhaka had a single landfill, with the second landfill coming into operation just recently (Figure 1). City Corporation — Dhaka’s municipality — manages solid waste. City Corporation does not directly pick up waste from residential areas. Instead, City Corporation employs street sweepers who clean streets and collect communal trash from designated City Corporation dumpsters and transport it to landfills.

Dhaka’s residents rely primarily on a large informal sector of waste pickers for household trash collection. Many Bangladeshi neighborhoods have cohesive communities that are well-organized with appointed committees and leaders. Committees maintain neighborhood safety and cleanliness by hiring security guards and waste pickers. Contracted waste pickers collect trash from subscribed households. Trash is typically collected in waste baskets and transported using rickshaws (Figure 2b). The waste pickers extract valuable recyclables from the trash (Figure 2c) and dump the rest in City Corporation dumpsters placed around the city (Figure 2d). Ideally, City Corporation sweepers equipped with garbage trucks collect trash from the dumpsters and dispose them at landfills every night between midnight and 3 am.

4.1 Waste Pickers

Most waste pickers migrated to Dhaka from remote villages throughout Bangladesh to make a livelihood. The typical waste picker is illiterate and very few have completed elementary education. For those without an education or other employable skills, waste picking is an easy sector to find employment. Many migrants enter the waste picking business from childhood, or come to this job when they have no other stable or sufficient employment options.

In Dhaka, a waste picker collects trash from roughly 300-500 households a day. They conduct their collection rounds between 10:00 am and 3:00 pm. They announce their presence at a neighborhood or building by whistling. Residents usually place their trash in front of their doors and waste pickers use a basket or bucket to pick up waste. They transport trash along their collection routes using a rickshaw. On filling the rickshaw, a waste picker typically empties his/her rickshaw at a sorting area nearby and quickly returns to collect more trash from the remaining households on his daily route.

Collecting garbage is hard work. Pickers are not allowed to use elevators in high-rise buildings and need to use the

staircases to get to the higher floors. Trash collection from these floors is thus highly laborious, especially for women. Consequently, waste pickers earn more from apartments on higher floors. After collection, waste pickers spend hours sorting the trash to extract valuable recyclables, which they later sell to traders. They dispose the remaining trash in City Corporation dumpsters. Waste pickers earn 4,000 to 6,000 Bangladeshi taka² (51 to 77 USD) per month from door-to-door trash collection.

Waste pickers did not report competition amongst themselves, saying instead that neighborhoods are pre-specified by the building committees. Waste pickers respect each other’s territory: “*Why will he pick from my neighborhood? He will pick from his and I will pick from mine. We also don’t sell to the same shops*” (WP02). Though waste pickers know each other, they do not have official unions or formal cooperatives.

Recyclables and other income sources. Selling recyclables or *vangaris* is a major income stream for many pickers. Most waste pickers sort the trash themselves (Figure 2d). However, in some neighborhoods, groups of 10-12 waste pickers hire sorters to sort trash for a fixed monthly service fee. Sorting usually occurs at multiple stages: waste pickers perform a preliminary sort and a smaller number of dedicated sorters further sort this trash at dumpsters or landfills. Table 1 lists the different recycled materials along with their sale prices.

Table 1: Recyclables (vangaris) extracted from trash and their sale prices

Recyclable	Price (per kg)
Bottles	20 taka
Glass	3 taka
Paper	3 taka
Plastics	25 taka
Tin	13 taka
Iron	22 taka
Copper	250 taka
Brass	320 taka
Hair	400 taka
Coconut coir	30 taka

On average, waste pickers collect around 100 kg of recyclables a month and they report a monthly income of 2,000 to 6,000 taka (25 to 77 USD) from selling recyclables to traders. Traders usually sell these materials to industries at higher prices.

Space constraints often dictate the frequency with which waste pickers sell vangaris. A lack of storage space and a concern for personal hygiene are some of the reasons that force waste pickers to sell vangaris daily: “*I live in a very small space. Even if I keep these [vangaris] in my home, people living nearby can see it and won’t like it. I try to keep the place clean. I sell these everyday so I can keep my room clean. I leave home empty handed and I go back home empty handed*” (WP07). Others sell recyclables weekly, monthly, or as needed. Some waste pickers rent storage space in a shop or in a garage for storing recyclables.

Many waste pickers have multiple jobs to make ends meet and to support their families, such as: cleaning sewer pipes,

²1 taka equals approximately 0.013 USD.



Figure 2: Images from Dhaka's Trash Collection Ecosystem

plumbing, sweeping garages, selling recyclables, vegetables, etc. Waste pickers typically work for long hours and are eager to learn employable skills from others such as plumbing.

Career aspirations. Many waste pickers aspire to get government jobs (i.e. work for City Corporation) because they believe that a government job will provide them with social prestige and a higher salary. City Corporation employees often benefit from the work of the waste pickers, and encourage them to help out and to pick up trash from households. Waste pickers feel encouraged by the City Corporation employees and continue to hope that they will eventually be employed as official street sweepers: “In the last 20 or 22 years, they have come here several times. They told us that we would become government employees” (WP02).

Some waste pickers are hired informally by City Corporation employees and believe that they work for and receive salaries from the “main office”. However, this is not the case and these waste pickers continue to make low incomes.

Trash collection tools. Rickshaws allow waste pickers to scale up their income generating activities. Unfortunately, rickshaws are relatively expensive and cost 35,000 taka to build and approximately 2,000 to 10,000 taka per year to maintain and some are so poorly built that they require monthly maintenance. As a result, most waste pickers do not own rickshaws and must work under rickshaw owners or *picker agents*. Some neighborhoods provide waste pickers with rickshaws, which is a path toward self-employment. Self-employed waste pickers collect payments directly from residents, and earn on average more than pickers who work under picker agents.

4.2 Picker Agents

Picker agents own rickshaws and manage several waste pickers. They usually own between 5-10 rickshaws and control trash collection in several neighborhoods, assigning around two waste pickers to each. They are influential members of the community and typically run small businesses. They organize, distribute, and rotate tasks such as loading/unloading the rickshaw, door-to-door collection, and sorting among pickers. They negotiate trash collection rates with building committees and collect payments from residents. Waste pickers employed by agents tend to be worse off financially than their self-employed peers. Self-employed waste pickers earn on average 5,000 to 8,000 taka per month whereas agents pay pickers around 2,900 taka per month and keep the revenue from recyclables.

In our field interview, we came across one agent who owns a rickshaw and employs two other pickers. He reported earn-

ing 20,000 taka per month and paying his employees a salary of 6,000 taka per month. He also provides his employees with snacks and allows them to keep the revenue from selling recyclables. This is not the norm: waste pickers who work under agents are generally exploited and receive extremely low salaries. Waste pickers are often intimidated by their agents, and some cannot even imagine pursuing entrepreneurial career paths. “We work under a manager, so we cannot do anything else. We do what they say” (WP04). When asked what they would like to do if they had a rickshaw of their own, one waste picker gave the following depressing response: “You can’t make assumptions when you work in a dumpster” (WP05).

At a level above picker agents, local political figures and City Corporation employees unilaterally decide the allocation of trash collection territories to agents and pickers. They also take a cut from any collection or recycling revenue. These figures are feared by the pickers and despite numerous attempts to interview them (a politician in Azimpur and a politician in Itkhola Bazaar who also owns a sports club), we were not able to do so even after introductions through our personal connections.

Collecting payments. In the case of self-employed waste pickers, payment is collected during their door-to-door trash collection rounds. Residents are regular with payments and sometimes provide three months payment in advance, which is appreciated by the waste pickers. However, payment delays occur when residents are not home when payment is due. It takes about ten days to collect payments from all households assigned to a picker. Waste pickers understand that residents have busy schedules and are not intentionally delaying or withholding payment.

In the case of waste pickers managed by agents, the agent collects payments from households and pays waste pickers their salaries. Reportedly, waste pickers receive their salaries regularly by the 10th of every month.

4.3 Residents

Most residents we interviewed were not originally from Dhaka; they migrated to Dhaka for education or work and their relationship with the city is still nascent. They still do not know or trust everyone in their neighborhoods, but have close ties with some members of the community based on shared interests or activities such as attending religious services at mosques, taking recreational walks, etc. Within these close-knit groups, residents help each other out during emergencies. In general, the men in the neighborhoods are more connected because of their daily interactions at

the mosque. Women generally do not go to the mosque in Dhaka. Men also formally represent the family unit at the building committee meetings. The building committee, sometimes referred to as the social welfare organization, is an avenue for the neighbors to get together for ceremonies and functions, especially during Eid-ul-Fitr.

During Eid-ul-Fitr, Chaand Raat or other religious celebrations, customs dictate distributing food (sacrificial goat, or *qurbaani* meat), monetary (*zakat*) and material gifts (clothes) to the poor and needy in the neighborhood, who are often domestic help or hired labor including waste pickers and security guards.

Who is responsible for household & communal trash? A building committee usually sets up a smooth system for trash pick up from households. The committee hires the necessary labor (waste pickers, sweepers, security guards, etc.) to keep these spaces clean and secure. Waste pickers typically arrive around midday and residents place their trash outside their apartments for collection. Residents see waste pickers as dedicated workers who hardly miss a work day and even if they do, they usually send a replacement. In the worst case, residents carry their trash to the nearest City Corporation dumpster or they store their trash for later pickup.

As managers of the household, women usually set aside the trash for pickup and deal with waste pickers. They believe door-to-door trash collection is an essential service and despite steadily increasing monthly fees, they are willing to pay *“whatever they [waste pickers] ask because this is an essential service”* (R05). Some residents spoke to us about increasing waste picker salaries to help them adjust to inflation in the Bangladeshi economy.

Most residents find their buildings or compounds to be “reasonably clean.” In buildings or compounds where the committee does not maintain cleanliness beyond household trash pickup, residents take initiatives to keep these spaces clean. These spaces include staircases, garages, corridors, and areas immediately surrounding their building or compound. Some residents are driven to do so out of their religious beliefs: *“Cleanliness is a part of my faith”* (R03, R10), *“It is our moral responsibility to keep ourselves and our surroundings clean”* (R04). Other residents are motivated by social reasons such as preserving a good social status and reputation: *“when someone visits my house, it does not look good when the staircases are dirty”* (R01). Residents often (every few weeks or when needed) ask their domestic help or hire laborers to clean the area for a fee, usually between 100-500 taka. Residents acknowledge the presence of free riders that are apathetic towards building cleanliness.

Most residents blame the presence of open waste dumps in alleys and on side-streets on City Corporation. Residents complain that City Corporation employees are irregular at picking up communal trash, unresponsive to complaints, and disorganized with sewage repairs leading to bad odors and health risks. Some residents also attributed open waste dumps to poor behavior from their fellow community members who do not value cleanliness and disrespect others. *“There is a lack of awareness and apathy leading people to dump waste on the streets without any regard for their neighbors or fellow citizens”* (R01). A lack of a collective effort prevents many residents from contributing to public cleanliness; *“individual action does not amount to much without collective support or engagement”* (R03).

4.4 Community Leaders

Building and neighborhood committee members are appointed by residents to represent them and take collective action on their behalf. Committee members are respected as leaders and attend to community duties such as hiring waste pickers for door-to-door trash collection, security guards, sweepers for cleaning common spaces, and plumbers for sewage repairs. They also organize social and community networking events. Most residents do not feel comfortable taking individual action for community efforts without the approval of their committees if they exist.

4.5 Social-technological context

Social Stigma. Waste picking is not a respected profession. Many waste pickers are aware of the prevalent social stigma and keep their vocation hidden from their families back home. They believe that their choice of livelihood will hurt or sadden their parents, and therefore, they lie. Some tell relatives that they work in garment factories. A waste picker was asked to divorce her husband because he works in and employs her in waste picking.

Many waste pickers themselves, however, are proud of having a legal income stream from waste picking. Some waste pickers feel good about their profession as it offers better pay and has more flexible timings when compared to working in the garments factory or pulling a passenger rickshaw. *“Why would I do this job if I think it is bad? Everyone comes to Dhaka for work, not for play”* (WP10). Many waste pickers value educating their children so that they can have a better future.

Gender roles. Bangladeshi society has well-defined gender roles: women usually manage the household and men handle the finances. Our interviewees, residents and waste pickers, employed women and homemakers all subscribe to these gender roles. Women defer financial decisions to their husbands. When we asked the women how much they would be willing to contribute to a community cleanup project, they replied with *“Talk to my husband”* (R06) or *“I don’t know. My husband usually deals with committee matters”* (R03). Women waste pickers also go door-to-door to collect trash and sort it. They, however, do not handle payment collection and leave this task to their husbands. When asked about her monthly income, a waste picker responded *“I don’t know, my husband collects the payments and sells the recyclables. I only collect trash”* (WP08).

Even in cases where husbands exercise poor financial judgement, the women still feel that they have no right to discuss or manage finances. For example, a woman waste picker complained that her husband spends all her money recklessly and that she has no financial autonomy.

Women waste pickers usually have a more positive relationship with the residents. Women express a stronger sense of belonging and loyalty to the communities they collect trash from, whereas most men waste pickers would switch to another neighborhood or job for better pay.

Technology. Residents in affluent neighborhoods are tech savvy, and use mobile phones and internet for work and entertainment. Other residents regularly use mobile phones but are hesitant to use it for paying bills or transferring money; they fear being “hacked”. Many residents only use laptops for work. All the waste pickers we interviewed had mobile phones that they used strictly for communicating with family back in the village. One young waste picker

uses his phone to listen to music and often tinkers with its features. Even though most waste pickers have feature phones, they only use it for phone calls; they are unable to read SMS messages and they fear sending messages accidentally. Our findings on technology prevalence and use generally corroborate with the existing literature from developing regions [17, 31, 12].

Some residents actively supported the idea of using technology to deliver information and a free market service for waste picking, mostly because it would resemble services in the “developed world” and because it would offer quick and instant service. Other residents resist any introduction of potentially complicated or disruptive systems in what they believe is a simple and economically efficient trash collection model that works well. From the waste picker perspective, there was a concern that a technological solution would be challenging to use, but if the system were able to improve their income then they would be willing to cope with the challenges.

5. MAJOR THEMES

5.1 Collective action and collaboration

We find that residents are primarily concerned with keeping their households and common areas within buildings clean. They feel a lack of control in contributing to the cleanliness of public spaces such as parks, abandoned lots, alleys and side-streets. Most importantly, residents believe that their contributions would amount to nothing without a majority support from their community.

Without majority participation, residents find it unfair to expect them to contribute as they are paying to keep their households clean and occasionally paying out-of-pocket to clean up the common areas within their buildings: “*Personally, I might not agree to give anything at all. I am contributing to cleaning my household and the staircases. Why should I contribute to clean up the streets? I will not pay personally for that. If the committee members collectively decide something, then I will have to participate*” (R01).

Even among residents who advocate citizen participation in public cleanliness, majority participation is the deciding factor for their own contributions. Many residents explained that everyone in the neighborhood should pay a mandatory fixed amount towards any collective initiative for public cleanliness. “*When people pay different amounts towards the same goal, it destroys the sense of harmony in the community*” (R04). Residents believe that “*the fixed fee should be decided by the building committee, who holds authority as a decision-maker and takes into account the individual financial abilities of residents, thereby charging a fair amount for a majority of the residents. If you want to live in the neighborhood, you will have to make some sacrifices*” (R02).

When asked if they think their neighbors would contribute towards the collective initiative (if and when it exists), the dominant belief is that their neighbors would contribute if the initiative is good and there is enough awareness. Residents are realistic and realize that not everybody would contribute in the beginning and it is important to create awareness. One resident gave an example of how difficult it was to initially use the digital electricity meter, but once everyone got used to it, it became convenient.

We also asked if residents would be willing to initially invest more towards a collective effort to get it off the ground.

Responses ranged from “*No. I wouldn’t*” (R05, R07) to “*Depends on my income, my income is not that good*” (R01, R02, R08). Only one resident was enthusiastic about contributing funds to raise awareness on public cleanliness campaigns. This resident believes in leading community beautification projects in his own and other neighborhoods.

All residents believe that the government (City Corporation) has the primary responsibility for keeping public spaces clean because the government owns these spaces and collects taxes from citizens for such services. Three of the ten residents we interviewed were indignant about citizen contributions towards cleaning up public spaces and that their only responsibility is only to notify City Corporation about communal trash piling up in public spaces: “*Why should we contribute? It is the City Corporation’s responsibility. We can only keep our households clean, the rest is not our responsibility*” (R08).

Other residents believe that citizens should contribute towards public cleanliness; however, it must be a collective initiative. One neighborhood reported an instance of fundraising towards community clean up, where participating households contributed 100 taka each to hire laborers. A few residents have shown leadership through community clean up and beautification projects, which has inspired similar actions in other neighborhoods. These residents are setting an example in terms of raising awareness, and they believe that others will contribute when they begin to see the benefits.

In addition to collective fundraising to support communal trash pick up, residents and waste pickers can benefit from structured collaborations. For instance, communities that provide rickshaws empower waste pickers as they no longer rely on exploitative agents. To support proper disposal of communal trash at landfills, residents should appropriately incentivize waste pickers to do so. There is an opportunity cost for disposing trash at landfills in terms of lost opportunities for door-to-door trash collection. In the absence of traffic jams, it takes at least an hour to reach a landfill from many residential centers and rickshaws cannot sustain the long trip to landfills through bad roads. Many waste pickers, however, are willing to dispose of trash at landfills for a higher compensation (300 taka per household per month) if provided with motorized vehicles. These vehicles, like rickshaws, can be provisioned by residents of a community.

5.2 Power dynamics and exploitation

Waste pickers have very low social status, minimal education, and few employment options. Consequently, they are easily exploited by picker agents, traders, residents, and City Corporation employees. As we described, picker agents usually pay waste pickers extremely low wages forcing pickers to take on multiple jobs to make ends meet. Pickers fear their agents and do not negotiate better pay for fear of losing their jobs. Waste pickers sell a variety of recyclables to traders who own vangari shops in the city, but most waste pickers do not know the true market value of the recyclables they collect and hence cannot demand fair prices from traders. City Corporation employees as well as local political figures also unfairly treat pickers by allocating trash collection routes to favored agents.

Residents and waste pickers have a more complex relationship. Waste pickers respect the residents and appreciate their tips and gifts during Eid, which can range anywhere from 2,000-10,000 taka depending on the neighborhood. As

a token of appreciation, pickers proudly wear the gifts they receive from residents. They are also quite tolerant of payment delays and understanding of the financial situations of their clients: a waste picker who also works in a slum said: *“How can I ask them for money, they live in the slums, they are also poor. They make their livelihood just like me. I should not take more [money] from them”* (WP08).

The residents appreciated the services provided by the waste pickers, and reported admiration for their dependability and work ethic. A waste picker described a conflict between a waste picker and a resident, where the committee defended the waste picker and evicted the resident. Anecdotally, the committee was reported to have said, *“Tenants come and go, but these guys [waste pickers] have been working with us for a long time and they will continue to be here tomorrow. We value their service”* (WP02). Some residents argue for increasing the minimum wage for waste pickers to allow them to raise and better educate their children and condemned society’s stigmatization of waste pickers who provide an essential service: *“At a time when salaries have increased in every sector, starting from a peon to a guard to a driver, what about the one who picks waste — their role is no less than others. Rather, it’s the most important and essential one. If it is not done, it’ll create a serious problem. The environment will be unlivable, but we don’t value this task enough”* (R04).

Despite this apparently good relationship between the residents and waste pickers, there are deeply rooted tensions related to class and power, which inevitably result in exploitation. Waste pickers are not allowed to use elevators to access higher floors in high-rise buildings. When waste pickers negotiate or demand a higher service fee for trash collection or other service like plumbing, residents pretend to be insulted and pay a significantly smaller amount. For example, a waste picker who repairs sewers and takes on plumbing jobs explained that when he demands the market rate of 500 taka per job, the residents only pay between 200-350 taka. If he declines the job, they will call external plumbers and pay them the market rate without objection. Residents are reported to have said, *“How can you ask for that [market price] amount? You have been working with us for so long, you have to take what we give you”* (WP04).

Residents are aware of the vulnerability of the waste pickers and they know that pickers are careful not to anger them for fear of losing their jobs. Thus, residents can underpay for services without any accountability. *“Sometimes they [residents] haggle and give us a smaller amount and say, ‘just take this’. We have to happily take what they give us”* (WP04). Thus, many waste pickers feel exploited despite other positive feelings about residents. One waste picker said that he would move to a different neighborhood if they paid him more.

Poor education means that waste pickers tend to have poor business or entrepreneurial skills. It was challenging to explain the concept of a free market to waste pickers. Often they would respond: *“If everyone is doing that, we will also do it. I can’t make this decision alone”* (WP01). However, after further explanation of how a free market works and the opportunities for fair competition and pricing, some waste pickers feared that their *“neighborhoods will prefer others over me”* (WP07) especially since the waste picking profession has a low barrier to entry.

6. DESIGN OPPORTUNITIES

Through our study of the household trash collection process in Dhaka, we find several opportunities that can motivate communities to solve the communal trash problem. While there are challenges and risks surrounding the specific implementation of a new system, technological or otherwise, opportunities do exist and we discuss them here. As we describe these opportunities we relate them to potentially applicable technology research from the literature.

6.1 Collective Action

The communal trash sector is an unexplored market, currently managed by City Corporation workers who are inefficient and unreliable. There is no incentive to clean up the streets, and the trash remains ignored even by agents who profit from household trash collection. Yet, throughout our study, we find that residents care about the cleanliness of their environment. Some residents even organized themselves to initiate neighborhood beautification projects. Moreover, residents are willing to pay to keep certain public spaces clean. Some residents have individually sponsored the clean up of smaller communal spaces (e.g. stairwells) and hired cleaners for this purpose. Thus, there exists both an unmet demand for communal waste-picking services and a willingness to pay for such services.

Support for conditional and continuous funding. The civic spirit shown by the residents is dampened by an unwillingness to contribute unless a majority of the neighbors do so as well. Contributions from neighbors is necessary because individuals cannot shoulder the costs of communal trash removal alone. This provides an opportunity to enable community-level fundraising through novel collective action mechanisms such as conditional or continuous funding. Conditional funding could allow residents to enforce statements like *“I will only fund a clean up if at least 20 other members of my community contribute as well”* [10]. Continuous funding could allow a predictable stream of income to be allocated without manual re-negotiation during each funding cycle. These design opportunities require novel fundraising support and could potentially leverage some of the recent work on crowdfunding.

Financing infrastructure. Our findings show that neighborhoods that provide rickshaws enable waste pickers to be self-employed and earn a viable monthly income. Residents share concern for the well being of waste pickers and through a crowdfunding platform, neighborhoods could also invest in supplying pickers with the appropriate waste picking tools and infrastructure (e.g. rickshaws or motorized vehicles), and potentially improve their livelihoods.

6.2 Crowd Work

Waste pickers are constantly looking to make an extra income and increase their social status. To these ends, waste pickers are willing to perform additional work and take on multiple side jobs. Although waste pickers are a willing workforce, they currently have no incentive to remove and properly dispose communal trash. Furthermore, in the current ecosystem, waste pickers have little or no bargaining power and are at the mercy of picker agents and residents.

We believe that this is an opportunity to design a system for cleaning communal trash that could provide the following benefits: (i) eliminate middlemen, (ii) allow waste pickers to set their service price, and (iii) allow waste pickers to

position themselves as service providers in a free and competitive market, which in turn elevates their social status. Cleaning up communal trash falls outside the jurisdiction of picker agents, and this presents waste pickers with a situation without middlemen and with the possibility of negotiating a fair price for their services. Existing crowdwork platforms like Taskrabit allow workers to perform small neighborhood jobs or tasks [3], but adapting this kind of platform for the waste pickers of Dhaka presents localized cultural, organizational, infrastructural, and financial challenges as described in this paper.

6.3 Towards a Community-based Solution

We believe that a system of incentives and mechanisms could be designed to clean up communal trash in Dhaka. Here we sketch a potential a community-based crowdfunding platform that could achieve this goal.

The community crowdfunding platform should place more responsibility on the residents to initiate the clean up process and financing, and in the process, have the potential to organize and support waste pickers by giving them more infrastructure, more bargaining power, and entrepreneurial training. We initially target the residents because they are tech savvy and open to a technology solution if it is better than the current system. In contrast, waste pickers are a vulnerable population so we should exercise caution before introducing technology where none existed previously. Given the hesitation of waste pickers to adopt a new system, we recommend deployment in phases. In the first phase, waste pickers can receive tasks as they currently do, via personal networks or phone calls. As the market for communal trash becomes established, we recommend introducing concepts such as mobile money transfer (e.g. BKash [2]) to receive payments. A system like this can help introduce waste pickers to technology literacy and financial management. In the future, through careful design of contextually appropriate interfaces [23] and appropriate training, waste pickers could place their bids for different tasks (i.e. cleaning particular neighborhood lots) as is typical of crowd workers today.

6.4 Implications and Risks

Creating a new market for communal trash pick up introduces a technology and market where none existed previously. We briefly discuss the important implications that this could have on the existing relationships between the various actors in the waste ecosystem in Dhaka.

Household trash pickup service. If the benefits of the technology solution for communal trash pickup are realized, there is a possibility of the system being used for door-to-door pickup services as well.

We found that door-to-door money collection takes a long time. Waste pickers who learn to use mobile money transfer systems could use the same system for household trash pickup and make the money collection process simpler and faster. With residents making individual financial decisions online, the role of community leaders could be diminished and could impact other areas of neighborhood management.

Threats to waste pickers from exploitative middlemen. Waste picking is a profitable industry for all except the waste pickers who are severely disadvantaged and exploited. If the communal trash pickup sector becomes profitable and elevates the waste pickers, picker-agents and other political agents could lose control over the ecosystem. Our

design cannot prevent threats to or the bullying of disadvantaged waste pickers. An offline support system (in the form of a cooperative) should be developed in conjunction with the technology solution to work towards empowering pickers and providing them with business training to alleviate fears of competition, to realize market demand and to quote profitable and competitive clean up prices.

Role of City Corporation. Despite the benefits of a decentralized solution such as the one we are proposing, municipal services are the government's responsibility and essential to the operation of cities. If the daily trash pickup service offered by the City Corporation is replaced by the waste pickers, there is a possibility that the City Corporation could become more unreliable and ignore other work that is beyond the capacity of waste pickers.

Women's role in household finances. Women, both among residents and waste pickers, could be further sidelined by the introduction of technology in the trash ecosystem. Currently, women manage the household, but our respondents have not been very proficient with technology and are uncomfortable making financial decisions. Introducing an online system that moves the financial process online could further remove women from having control over household finances. Women also generally seem to better understand importance of the daily trash pick up service provided by the waste pickers and are accommodating of the consistent increase in trash pick up fees; sidelining women in this process could translate to less money for the waste pickers.

7. CONCLUSION

In this paper, we explored in detail through ethnographic methods the informal waste management ecology of Dhaka and actors therein. From our in-depth study we described interesting findings surrounding collective action, the current exploitative practices caused by imbalanced power dynamics, and contextually relevant gender and stigmatization issues. We observed that despite the ultimately complementary goals between residents and waste pickers, the multifarious thematic challenges prevented cooperation for mutual benefit. We posited that this market failure could potentially be solved by the introduction of properly designed collective action and crowd work mechanisms. We believe that this context is laden with opportunities for the ICTD community and that our findings can help motivate the agenda for solving the communal garbage problem.

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