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The Challenges of Using Citizen Reporting to Improve Public Services: A Field Experiment on Solid Waste Services in Uganda

January 14, 2020

Abstract

Governments around the world are investing in technologies that allow citizens to participate in the coproduction of public services by providing monitoring and feedback, though there is little evidence about how these initiatives impact the delivery of public services. We implemented a large-scale randomized field experiment that involved organizing 50 citizen reporters in each of 100 neighborhoods across Kampala, Uganda to provide weekly reports to the municipal government about the delivery of solid waste services via an SMS-messaging platform, resulting in 23,856 reports during the nine-month study period. Citizen reporting did not reduce informal waste accumulation as targeted, which would indicate improvements to formal services. Using our observations as participants in the development and deployment of the reporting platform and interviews with staff at the government agency receiving the citizen reports, we show how the public generated inconsistent information that did not fit existing decision-making processes. We generalize lessons from this field experiment by explaining how coproduction enabled by information and communication technologies (ICTs) is likely to improve public services based on the *alignment* of citizen-produced data with the specific information problems managers face; the *search costs* of detecting public services failures; the *quality* of citizen-produced data; and the *operating costs* of citizen reporting platforms.

Keywords: Information problems; public services; field experiment; citizen reporting; waste management;

Word Count: 11,228

1 Introduction

Governments around the world are building or adopting platforms to collect and process information from citizens about the delivery of public services. Relying on citizens who directly experience public services to report on service delivery promises to lower the costs and increase the coverage of information available for the management of services (Linders, 2012; Grossman, Humphreys and Sacramone-Lutz, 2014; Noveck, 2015, 2017; Clark, Zingale and Logan, 2017). By gaining better information on the delivery of public services, agencies can hold frontline providers accountable, optimize delivery efforts, or plan for improvements to services. Furthermore, by opening channels of communication and information sharing with citizens, governments can increase responsiveness to public concerns and generate goodwill, cooperation, and trust by citizens (Bertot, Jaeger and Grimes, 2010; O'Brien, 2018; Buntaine, Nielson and Skaggs, 2019; Jo and Nabatchi, 2019).

Despite optimism about citizen reporting as a strategy for the coproduction of public services, evidence about the effects of citizen reporting on service outcomes is limited. More generally, evidence about the empirical relationship between coproduction – the voluntary contribution by members of the public to the process of producing services with public agents (see Nabatchi, Sancino and Sicilia, 2017) – and effective service delivery is limited. Loeffler and Bovaird (2016, 1013) conclude that "the actual and potential impact of coproduction on citizen outcomes is as yet only sketchily researched." Nabatchi, Sancino and Sicilia (2017, 766) conclude in their recent review of the coproduction literature that "the evidence base for coproduction is relatively weak." On the ability of information and communication technologies (ICTs) to foster the successful coproduction of public services, Lember, Brandsen and Tonurist (2019, 2) conclude that "empirical evidence on the effects of new technologies in this area is still scarce, at best... Systematic empirical evidence is still very hard to come by." The lack of evidence limits our ability to refine theory and identify the conditions under which different types of coproduction are likely to improve the delivery of public services.

Moving from general optimism about citizen reporting to evidence-based practice is important because while data from citizens can be collected more broadly and in a more timely manner than many top-down approaches to monitoring public services, the adoption and operation of platforms that aim to foster coproduction can be difficult (Gil-García and Pardo, 2005; Heintze and Bretschneider, 2000). Processing new flows of data and turning them into information that can be used for decision-making requires new skills and capacities, potentially implying significant costs for public agencies. Being responsive to new information often requires a realignment of work effort, which can be administratively challenging, politically contentious, or limited by existing procedure (Laffin and Ormston, 2013; Liu and Yuan, 2015). Indeed, relying on citizen reporting entails more than just adopting a new technology or opening a new channel for feedback.

Using citizen reporting to produce public services can also be difficult because of the quality of citizen-sourced data. Often, citizen-sourced data is unstructured, noisy, off-topic, or inconsistent, making it difficult for public officials to act on immediately (Grossman, Platas and Rodden, 2018). If citizen-sourced data is not consistent enough to reduce the uncertainty managers face about decision-making, then its potential to improve the production and delivery of public services is eroded. Moreover, certain types of citizens might be more likely to provide information, rendering the resulting data unrepresentative of actual conditions or opinions (Parrado et al., 2013). Citizens who want governments to improve public services may send reports to attract attention, regardless of actual service quality.

We provide a large-scale, field experimental test of the impact of citizen reporting on the delivery of public services and first-hand qualitative analysis about the challenges of adopting and operating a citizen-reporting platform as a coproduction strategy. Our main contribution is to explain the conditions under which governments would benefit from relying on citizens to produce information for use in the process of providing public services. We offer formative, causal evidence about the impact of an attempt at coproduction on service quality, along with broader lessons about promising directions.

In partnership with the Kampala Capital City Authority (KCCA) in Uganda, we study the adoption of a new text-messaging platform to collect, process, and aggregate citizen feedback about waste collection services. We randomly assigned 100 neighborhoods to a citizen reporting program, with 50 citizens recruited to provide weekly reports to the municipal government about various aspects of solid waste management in each treated neighborhood. Volunteer citizens sent 23,862 reports on the delivery of solid waste services over the approximately nine-month study period. We measured and photographed 679 informal waste piles – indicators of a lack of access to formal disposal options – at baseline and twice after the reporting platform had operated for several months, both in the neighborhoods assigned to the citizen reporting program and in another 100 control neighborhoods not assigned to the citizen reporting program. We also recorded our observations about the operation of the platform systematically based on a unique opportunity to embed part of our research team at the KCCA. We conducted interviews with every staff member at the KCCA who interacted with the platform. We are thus in a position not only to report on a large-scale experiment testing how citizen reporting impacted service delivery, but also to offer first-hand lessons about the challenges of using citizen reporting to provide public services.

We find that neighborhoods assigned to the citizen reporting program did not experience reductions in informal dumping, as compared to neighborhoods not assigned to the citizen reporting program. We observe some promising results in terms of waste burning, pile organization, and pile containment at the first post-treatment audit of informal waste piles five months after the baseline, but these results do not persist to the second post-treatment audit of informal waste piles four months later. This primary result does not vary based on the amount of reporting or the political affiliation of the division councillor; nor is the result associated with differences in the content of reporting by neighborhood or the accessibility of the neighborhood to KCCA workers. During the implementation of the reporting program, we observed that staff at the KCCA questioned the effectiveness of coproduction for service provision. Eventually, managers at the KCCA chose to abandon the program altogether because of concerns about its cost and the perceived usefulness of citizen-sourced information.

Reliance on citizen reporting, even though it can be massive, timely, and localized, does not provide an easy solution for the problems facing public managers with limited budgets and who struggle to collect the information needed to effectively produce public services. While citizen reporting can reduce the cost of monitoring and allow for a greater proportion of available public resources to be spent on services, it is also likely to produce unreliable data in many settings, requiring significant effort for processing and interpretation.

2 Digital coproduction, information, and public services

Public agencies that would like to improve service delivery confront two fundamental management challenges. First, public agencies face resource constraints. Managers of agencies must decide how to allocate a limited pool of resources to maximize service delivery. Second, managers at public agencies lack perfect information about how services are actually delivered by their frontline agents. When public managers lack information about the delivery of services, they can neither oversee frontline providers effectively nor identify which changes in the allocation of resources would yield the largest improvements to services.

The severity of these challenges are related because managers need to allocate resources to access and process information. While information can help managers make better decisions, acquiring and processing information leaves fewer resources for delivering services. Alternatively, if managers decrease resources spent to acquire and process information, they can deliver more services, but they may do so less effectively because they do not have the information needed to make the best decisions. This means that as managers relax one constraint they tighten the other.

One way managers can navigate this trade-off is to rely on citizens to provide information about the extent and quality of service delivery. By relying on citizens to provide information that is helpful for decision-making, managers might simultaneously decrease their own costs of monitoring public services and improve the quality and breadth of information that they have available to make better decisions (McCubbins and Schwartz, 1984). For this reason, many public agencies have engaged citizens in a form of coproduction where citizens provide voluntary contributions of information and managers actively seek to use that information for decision-making about public services.

While other forms of coproduction exist (Nabatchi, Sancino and Sicilia, 2017), programs that encourage citizens to contribute information to public agencies constitute a common form of coproduction. Citizens rely on their daily experiences with public services to relay specific information about the quality and extent of service delivery to managers. Managers then use this information to improve decision-making about service provision. Traditionally, this type of coproduction has occurred in the context of group meetings between citizens and managers (Hock, Anderson and Potoski, 2013).

Yet, the provision of information by citizens in traditional, face-to-face forums is not always timely and participation is often limited to a small subset of citizens. Community meetings generate discrete information, while advances in public management increasingly involve addressing dynamic problems with real-time data (Mergel, Rethemeyer and Isett, 2016). Moreover, existing evidence suggests that wealthy and highly-educated citizens are more likely to provide information within coproduction programs (Pestoff, 2006; Clark, Brudney and Jang, 2013). As a result, the information that these exchanges generate may not be representative of citizens' observations or preferences broadly. Furthermore, organizing traditional forums for coproduction can be slow and costly (Irvin and Stansbury, 2004), particularly given that effective strategies to increase participation in civic meetings are largely unknown (Arceneaux and Butler, 2016).

Information and communication technologies (ICTs) might significantly expand coproduction opportunities across a variety of services by making it easier for citizens to provide information managers can use to improve public services. Indeed, there is broad optimism that ICTs might improve the volume, timeliness, and coverage of information useful for decision-making about public services, while also encouraging broader participation (Oates, 2003; Bovaird, 2007; Meijer, 2012; Grossman, Humphreys and Sacramone-Lutz, 2014; Charalabidis et al., 2012; Linders, 2012; Zurovac, Talisuna and Snow, 2012; Rotberg and Aker, 2013). If ICTs help managers collect citizen-sourced information broadly, accurately, in a timely manner, and at low costs, then they might simultaneously relax managers' information and budget constraints and subsequently improve service delivery.

Despite the promise that ICTs should facilitate new forms of coproduction, limited evidence is available about the overall effects of ICT-enabled coproduction on public services (Lember, Brandsen and Tonurist, 2019). The conditions, technologies, scales, and services where ICT-enabled coproduction is most likely to improve public services remain underspecified. For instance, while ICT-based coproduction might increase the information available to managers, deploying these platforms at scale might impose large costs on governments (Gil-García and Pardo, 2005; Heintze and Bretschneider, 2000). Alternatively, the inherent inconsistency of information from citizens might be tolerated for some tasks like long-term planning, but not others like deciding where to deploy crews for the maintenance of infrastructure. The under-specification of when and why ICT-enabled coproduction has the greatest potential to improve service delivery is particularly concerning given the proliferation of citizen reporting programs around the world (Linders, 2012).

2.1 Conditions for Successful Coproduction

We investigate several factors that are likely to determine whether ICT-enabled coproduction will improve public services: the *alignment* of citizen-produced data with the information problems that managers face; the *search costs* of detecting public services failures for managers; the *quality* of citizen-produced data; and the *operating costs* managers incur from deploying and operating ICT-based reporting platforms. We later use qualitative evidence to assess how these factors contributed to the overall effect of the coproduction on public services in our study setting, which we evaluate using a large-scale field experiment.

Alignment of Information and Uncertainty Public managers face a variety of information problems related to the provision of public services, including uncertainty about the performance of frontline providers, the most effective allocation of resources, public preferences for different service outcomes, and uncertainty about where the maintenance of public infrastructure is necessary. Resolving different types of uncertainty requires different types of information, which citizens may or may not be in a good position to provide. For example, matching long-term service improvements to citizen preferences requires representative information about public demands, while identifying maintenance tasks requires a single citizen to accurately report a specific need for agency action.

Citizens are most likely to have advantages in contributing two kinds of information through ICT-enabled reporting platforms: their own observations and their own preferences. If the main information problem that managers face is about where to direct efforts to discrete problems like potholes in public roads (Sjoberg, Mellon and Peixoto, 2017), then reporting platforms that collect precise spatial information based on citizens' observations might help to improve the targeting of agency responses. Alternatively, if managers need to decide what types of public investments to prioritize, new tools might enable a broader, more representative set of citizens to contribute information about their preferences (Stipak, 1980; Robbins, Simonsen and Feldman, 2008; Grossman, Humphreys and Sacramone-Lutz, 2014). However, incorporating citizen feedback into technical decisions requiring high levels of expertise might not solve the main uncertainties faced by public managers and could even detract from decision-making effectiveness (Irvin and Stansbury, 2004). If citizen reporting generates information that does not help reduce the particular kind of uncertainty public managers face, maintaining citizen reporting platforms only imposes costs on governments.

Search Costs of Public Service Failures Governments frequently are responsible for managing dynamic problems that are difficult to detect in real time, such as the location of crime or the maintenance of public infrastructure. Efficiently addressing these problems requires timely and specific knowledge about where to direct agency effort. When citizens have a comparative advantage in generating this kind of information, citizen reporting platforms might contribute positively to service delivery. For example, effective policing depends on identifying the most significant risks of crime and redirecting patrols accordingly. Increasing citizen reporting to the police about crime should improve the effectiveness of policing, since officers cannot patrol with enough frequency to have the same level of knowledge as residents (Bennett, Holloway and Farrington, 2006). However, when governments can effectively monitor service shortfalls themselves at low costs – e.g., tracking electricity blackouts using real time voltage data or tracking the performance of public transit using automated GPS systems – citizen reporting may not lead to more effective service provision. In these cases, the comparative search costs for information do not favor citizen reporting.

Thus, we should expect citizen reporting to be most effective when it provides governments with a low-cost option for detecting where the allocation of available resources generates substantial improvements in service delivery, relative to the internal monitoring strategies agencies have at their disposal. Related research suggests that sourcing information from a crowd is best applied in settings where organizations can turn problems that involve "distant searching" for information into problems that involve less-costly "local searching" (Afuah and Tucci, 2012). Citizen reporting is most likely to be effective when citizens themselves are the best "sensors" of the problems that managers would like to detect when providing services.

Quality of Citizen-Produced Information The quality of information provided through ICT-enabled citizen reporting and thus its usefulness for management are open questions. Many public managers perceive citizen-produced information to be unhelpful for many of the decisions that they face (Liao and Schachter, 2017). ICT-enabled coproduction might fall flat because it represents a broader but shallower form of engagement with citizens. ICTs deployed at scale greatly expand the flow of information from citizens but potentially limit the specificity of each data point that citizens relay. Citizens also may drop out of ICT-enabled coproduction more frequently than traditional forms (Yetano and Royo, 2017), potentially eroding the coverage of data if agencies cannot easily recruit additional citizen reporters. Therefore, the average quality and content of information sourced from ICTs is often lower (Grossman, Platas and Rodden, 2018), relative to more personal information exchanges between citizens and governments. If citizen reporting generates inconsistent or indecipherable information about where public managers should direct their effort, then it may not improve the delivery of services.

Operating Costs of Citizen-Produced Information The promise of ICT-enabled coproduction for managers is that it can generate an unprecedented amount of useful information at a low cost, relative to the other options for monitoring that managers have at their disposal. An assumption underlying this promise is that the only cost of operating an ICT-platform comes from maintenance, such as fixing technical glitches. However, it is likely that managers incur additional costs in practice. Pursuing ICT-enabled coproduction might strain the existing capacity of public agencies to process information, given the massive flow of data large citizen reporting platforms generate. Indeed, evidence suggests that many public officials face significant challenges in processing even simple flows of data (Masaki et al., 2017). Managers also might have to establish additional channels of communication with citizens to follow up on citizen reports, or otherwise significantly reorient work effort within their agency. Each of these tasks may require managers to make costly changes to the design and workflow of agencies, thereby undermining the promised cost-effectiveness of

ICT-enabled coproduction (Laffin and Ormston, 2013; Liu and Yuan, 2015). If managers have other options for collecting information they perceive to be more cost-effective, they may choose to abandon ICT-enabled coproduction altogether. Therefore, we should only expect ICT-enabled coproduction to lead to improved service provision when adopting ICT platforms does not place significant stress on an agency's capacity to process and act on information.

2.2 Theoretical Proposition

Strong empirical designs are needed to test theory about the conditions under which ICT-enabled coproduction can enhance the provision of public services (Linders, 2012; Charalabidis et al., 2012; Saxton, Oh and Kishore, 2013; Seltzer and Mahmoudi, 2013), along with the overall effects of citizen reporting on service outcomes. While several prominent platforms generate citizen monitoring of public services in developed countries (e.g., SeeClick-Fix, FixMyStreet, NoiseTube), these platforms are not designed to facilitate research about foundational questions of citizen-sourced data provision, quality, and impact. Our field experiment and qualitative research design provide a strong test of the following theoretical proposition:

> **Theoretical Proposition:** Citizen reporting that provides information to governments about deficiencies in public services will result in an improvement to public services (when information is aligned with uncertainty, addresses search costs for public service failures, is high-quality, and when platforms to collect it are not onerous to operate).

Our study is distinct from recent research that addresses how citizens can be motivated to contribute monitoring to governments (Grossman, Michelitch and Santamaria, 2017; O'Brien et al., 2017; Sjoberg, Mellon and Peixoto, 2017; Buntaine, Nielson and Skaggs, 2019; Blair, Littman and Paluck, 2019), as we study impacts of citizen reporting on public service outcomes, rather than citizen participation in coproduction. Only a limited set of studies is available on the relationship between coproduction and public outcomes. For example, there is mixed evidence that governments can actively encourage coproduction by parents of educational outcomes for their own children (Jakobsen, 2012; Thomsen and Jakobsen, 2015; Jakobsen and Andersen, 2013). Closer to the focus of this study on public services, evidence is available about the lack of impact on services when citizens report deficiencies to politicians (Grossman, Platas and Rodden, 2018). Yet, we lack a strong test of citizen reporting to a government agency and the bureaucrats directly responsible for public service provision, with a paired qualitative research design to interpret theoretical propositions about supporting conditions.

3 Research Design and Analytical Methods

3.1 Overview

We study the impact of citizen reporting on the delivery of solid waste services in Kampala by estimating the overall effect of an ICT-enabled coproduction program on service delivery based on a large-scale, randomized field experiment, while also collecting primary qualitative evidence about how supporting conditions theorized above contributed to the overall impact of the coproduction program. Studying coproduction in the context of waste management in Kampala is appropriate because the agency responsible for waste services faces significant resource and information constraints and has actively sought the voluntary contributions of information from citizens for service provision. Providing information is presently the most relevant of all the coproduction activities that citizens can take part in regarding waste management in Kampala.

3.2 Setting

A majority of solid waste in Kampala, a city of approximately 1.5 million residents, is dumped informally or openly burned in streets and alleys. These practices have created major public health challenges in terms of both air and water pollution. A large majority of residents are personally concerned with solid waste services (Buntaine, Nielson and Skaggs, 2019). The KCCA faces similar problems in monitoring and delivering solid waste management as other agencies around the world, as the rapid rate of urbanization in Kampala has outstripped its capacity to provide and oversee services in many parts of the city (Bhuiyan, 2010; Okot-Okumu and Nyenje, 2011; Vermeiren et al., 2012).

In the last few years, the KCCA adopted a public-private partnership (PPP) approach to deliver waste services. Under this approach, the KCCA contracts out the management of solid waste services to private concessionaires, which are responsible for collecting, transporting, and disposing solid waste from particular areas of the city. Under the PPP, the private concessionaires are allowed to charge the residents a specified amount of money in return for collecting their solid waste on a door-to-door basis. At the same time, they are contractually required to provide common collection points available to all residents regardless of ability to pay. The incentive to maximize revenue from citizens through door-to-door collection is at odds with requirements to make collection widely accessible, so contractors have mostly failed to establish and service common collection points. As a result, solid waste conditions have deteriorated in recent years for residents who are not able to afford door-to-door collection or who do not live in an area where it is offered.

The KCCA needs information about where services are not being provided to allocate oversight and supplementary cleanup efforts. Yet with a small office of professional staff, the waste management unit has not been in a position to widely monitor the performance of private contractors with existing resources. Problems are so widespread and pressing that it has chosen to spend most resources organizing haphazard clean-ups, rather than providing oversight.

Because of the resource and information constraints, the KCCA was enthusiastic about encouraging citizens to contribute information in ways that would expand its ability to exercise oversight at low cost and at a scale that matched the growing lack of access to formal services among residents. With better information from citizens about the locations and types of service failures, the KCCA anticipated that it could make more informed decisions about strategies, priorities, and oversight. The KCCA anticipated using information from citizens to direct changes to pick-up times, service routes, schedules, and pricing options – all of which are an essential parts of the waste management process. Experimenting with a new approach to collecting information was also viewed as an opportunity to learn about the effectiveness of this kind of coproduction program, given a broader interest at the highest levels of management in rolling out this type of approach across directorates for water supply, sanitation, and transportation.

Prior to the citizen-reporting program rolled out as part of this study, the KCCA collected unstructured information about waste management through toll-free phone lines, a general SMS shortcode, and social media websites. KCCA frontline staff, or Client Care Officers, were responsible for processing information received through these channels. Once processed, input from citizens was relayed to the appropriate supervisor within the KCCA, who then decided on how to address any problems. Staff estimate that 15-20 complaints relevant to solid waste management were received per working day. The KCCA also gained information from local leaders, such as parish councillors and zone chairpersons. Solid Waste Officers often employed a small number of informal scouts to obtain information. Yet these sources of information were not systematic enough for public managers to plan, allocate resources, or exercise oversight.

From the perspective of citizens, the adoption of a service system in which they were required to pay for the waste collection services provided a greater incentive to report service deficiencies. Additionally, citizens in Kampala are uniquely situated to provide much of the information the KCCA sought, since citizens directly observe informal waste piles, missed pick-ups, and patterns of collection efforts that do not match their needs for waste removal services. All of this information, if contributed to a motivated agency needing precise information about service failures, might become part of a management process that could lead to improved services.

3.3 Citizen reporting and the coproduction of information

The rapid proliferation of mobile phones in Kampala has created more opportunities for coproduction of information by citizens. The latest statistics in Kampala indicate that more than 90% of adults own a mobile phone (Uganda Bureau of Statistics, 2017), which might enable citizens to share valuable information broadly and at low costs.

Beginning in 2014, our research team approached the KCCA to investigate whether they would be interested in adopting and testing a platform that would enable citizens to send information about the quality of waste collection services in real-time and at the scale of neighborhoods. The idea was met with enthusiasm from key leadership, overcoming a key challenge for these kinds of efforts (Hansen and Norup, 2017). The KCCA co-developed a toll-free SMS-messaging platform with our research team over time, which it used to collect information from citizen reporters invited to make voluntary contributions of monitoring. Because we recruited these citizen-reporters in the field, all of the reports can be tagged to individual "zones" or neighborhoods throughout Kampala, which are the lowest-level administrative unit (LC1) in both the city and throughout Uganda. The program built on initiatives already under way at the KCCA, as new processes were being developed at the time for responding to complaints from citizens.

Between November 2015 to August 2017, we prompted citizens to provide reports about various aspects of solid waste management to a single, toll-free SMS shortcode established for the project. To process citizen reports, we employed a customized application of *SMSOne* procured by the KCCA. This platform offers a tested and convenient way to manage a large number of incoming and outgoing messages from mobile phones, and the KCCA currently is expanding its use to manage all types of communication with citizens. Our research team and the KCCA waste management unit co-designed the prompts sent to citizen reporters. For example, we used the following prompt at various points throughout the study period:

> When did the rubbish truck last collect your rubbish? A) never B) more than two weeks ago C) last week D) this week

3.4 Treatment

Treatment in our study is the assignment of a zone to the citizen-reporting program, which involved recruiting 50 volunteer reporters and then sending them prompts for information each week. Under this clustered-assigned design, treated neighborhoods ("zones") had reporters that were prompted to provide information to the KCCA over several months, while control neighborhoods did not have any reporters recruited or prompted to send information.[1] All reporters in treated zones received identical prompts for information. Each week, the platform sent a prompt to recruited reporters in treated zones from among a list of questions that the KCCA waste management unit identified as important for management. Additionally, all reporters were sent messages confirming that the KCCA was actively seeking to use the information they provided, following results that suggest responsiveness is key to sustaining citizen reporting (Buntaine, Nielson and Skaggs, 2019).

Because the unit of treatment is the zone in this field experiment, we recruited the number of reporters necessary to ensure that information was available from reporters each week in almost all zones assigned to treatment. We observed the rate of on-topic and usable reporting from citizens that we expected, averaging around a 10 percent response rate throughout the study period. To our knowledge, this is the best response rate for this kind of platform in a low-income country (see e.g., Grossman and Michelitch, 2018; Buntaine, Nielson and Skaggs, 2019). With this response rate, there was an average of 3-7 reports per week per treated zone, from among 50 recruited reporters. This means that the treatment succeeded in providing the KCCA with consistent information about treated zones that it did not have about control zones. In total, the KCCA received 17,538 verified and usable reports prior to the final waste audit, drawn from 23,862 raw reports.

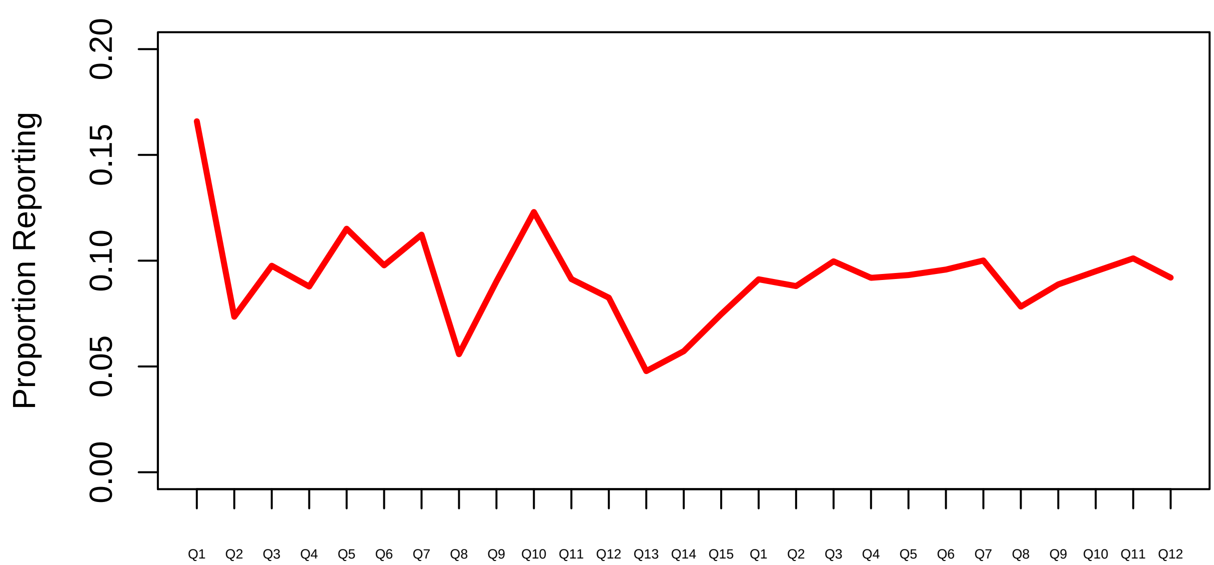


Figure 1: Reporting rates for all prompts during the study period.

[1] Appendix B of the SI details our recruitment protocol for citizen reporters.

Although the amount of reporting varies by zone and across weeks under this design, the zone-based randomization of the reporting program means that the amount of reporting delivered from treated zones is equivalent to the expected amount of reporting that would have been delivered in control zones had they been assigned to treatment. We do not seek to identify the effect of individual reports, but rather the effect of a zone-level citizen reporting program on zone-level waste outcomes.

Our research team transmitted all relevant reports to the KCCA on a weekly basis in a spreadsheet format, with the responses aggregated to the zone level, as requested by the KCCA. Our research team was not involved in planning or delivering responses to the reports.

3.5 Sample and Random Assignment

We randomly selected 200 of Kampala's 755 zones to form our sample of zones that could be assigned to treatment or control. We randomly selected an additional 50 zones to use as replacements for zones that were inaccessible to our enumerators, demolished at the time of enumeration, or for which at least two informal waste piles could not be identified by residents of the zone at baseline. We randomly assigned half of the zones to the citizen-reporting program using complete randomization, with the result displayed in Figure 2.

We intended to select a sample that included entirely new zones without any previous reporting. Due to an indexing error, we selected a sample that overlapped with the samples from earlier phases of the project where low levels of reporting had been organized. This error was not caught until after baseline data had been collected. The resulting treatment still adds 50 new reporters to each of these zones, on average boosting the number of reports considerably. Our baseline measure accounts for any differences in waste conditions that emerged as a function of citizen monitoring in earlier phases of the project in the sample. To account for variation that might be driven by this indexing error, we add an indicator of whether any citizen reporting was organized previously in each zone for all estimations.

A challenging aspect of this setting was that the KCCA is a single organization that could not be blinded to treatment assignment, since the delivery of reports would indicate that the zone had been treated. The threat to inference in this case is that that KCCA might redirect attention to some zones simply due to their assignment to treatment, rather than in

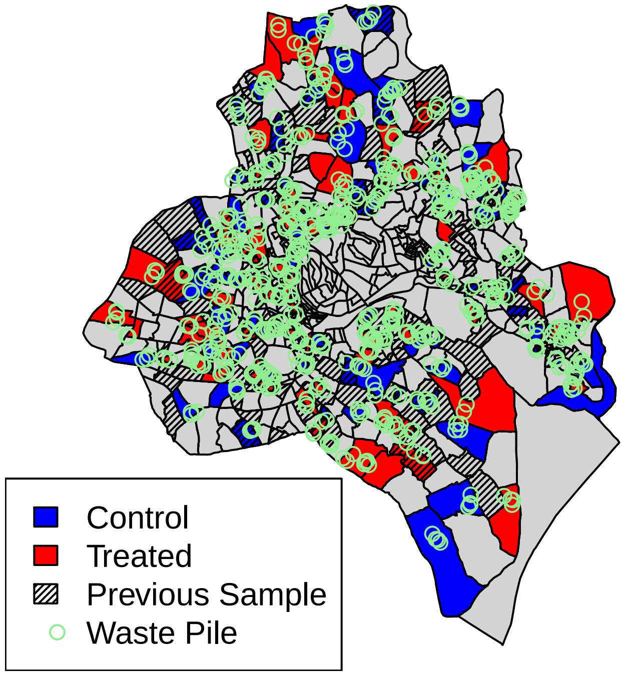


Figure 2: Experimental sample, including continuing reporting from previous phases.

response to the information about local service quality that citizen reporters provide. Our approach to this challenge was multifaceted. First, we operated at a scale that would make reallocation of effort to treated zones apart from the information provided very difficult and costly. The prompts addressed different aspects of waste management that enabled precise actions such as follow-up with contractors, the organization of cleanups, or the sensitization of communities regarding disposal practices at the zone level. Responses varied by zone and could not be feasibly rolled out indiscriminately given the large size of the sample. Second, we tracked that responses were at the zone-level and specific to information in reports. In particular, the KCCA shared their weekly action plans created in response to reports. An example action plan is displayed in SI Appendix K, which shows that responses to reports were largely specific to zones. Finally, we continued to collect and pass along reports from hundreds of zones in previous phases of the project, which would not enable the KCCA to precisely identify zones being measured in this experiment and makes the possibility of reallocation of effort based on assignment status alone even more difficult.

Figure I1 displays balance and descriptive statistics for pre-treatment covariates, none of which are inconsistent with random assignment. Figure 3 tracks the study design.

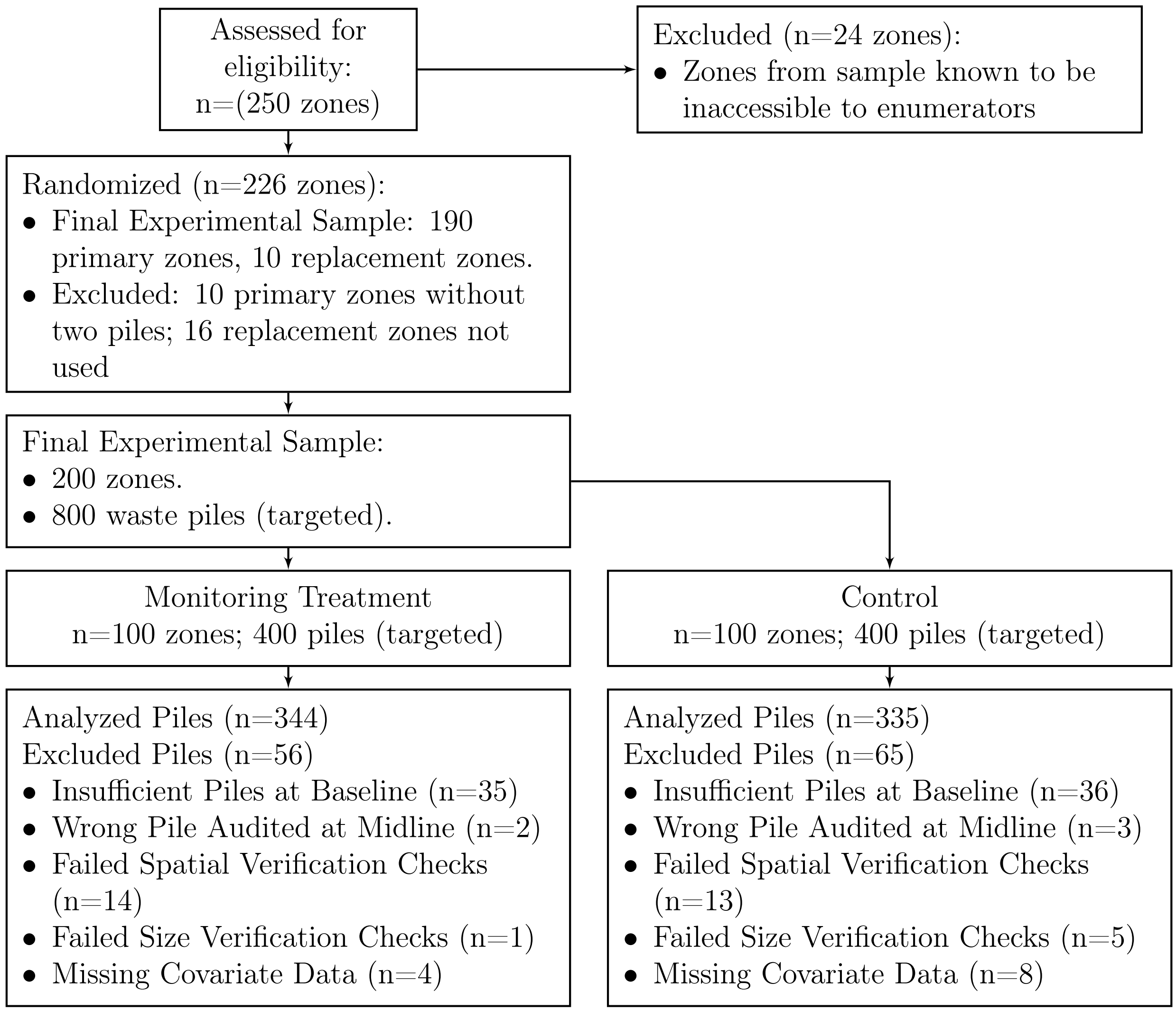


Figure 3: CONSORT diagram tracking study design.

3.6 Empirical Prediction

Both our research team and the KCCA predicted that information from the reporting platform could be used to improve services. Prior to the platform's launch, the KCCA lacked a method to collect data from a broad base of citizens, and relied on information from informally-employed "scouts" and administrative records on waste collection.[2] Information

[2]For a full description of how the KCCA uses multiple sources of information to design its waste services, see SI, Appendix F.

on waste conditions, therefore, was limited to a subset of easily-accessible areas. The manager that we worked with to co-develop the reporting platform was confident that many of the factors we expected to support a positive impact of ICT-enabled coproduction were present. In terms of the alignment of information and decision-making, the key gap identified by managers was the lack of spatial data on service failures, which could be used for oversight. In terms of search costs, existing methods of gaining information could not cover the growing scale of solid waste management challenges.[3] In terms of the quality of information produced by citizens, there was broad optimism that prompts for structured response categories based on factual observations of citizens would lead to high-quality information. In terms of operating costs, the KCCA was already making large-scale investments in programs to respond to citizen complaints and feedback, and anticipated that gaining systematic data might decrease the burden of responding in largely haphazard ways to individual complaints.

Thus, we expected that structured citizen reporting via the SMS-platform would increase the availability of information the KCCA could use to deliver services and improve their oversight of contractors, without tightening resource constraints. Our field experiment thus tests the following empirical hypothesis:

Empirical Prediction: Zones assigned to citizen reporting will experience a larger decrease in solid waste accumulation than zones assigned to control.

3.7 Measurement of Outcomes

To assess whether zones assigned to the citizen reporting program experienced improvements in KCCA waste services over the study period, we used field-based audits of informal waste piles (See SI Appendix A for details). We focus on the existence and characteristics of informal waste piles because they represent a direct outcome of low quality or inaccessible formal methods of waste disposal. In areas where access to high quality formal waste management services is limited, any improvement in the delivery of KCCA waste services should

[3] As one Waste Management Officer reported: “My area of supervision contains 23 parishes and over 200 zones. It is impossible for me to be in all those places at the same time. The citizen monitors enable me to keep tabs in those areas by keeping me up-to-date with what is going on” (interview I).

offset citizens' use of informal waste piles. Therefore, changes to informal waste piles should approximate whether zones experienced better KCCA waste services over the study period.

At baseline, we visited each zone in the experimental sample and asked residents to show us four informal waste piles that were of greatest concern to them. We measured the size of these waste piles, photographed them, recorded their locations by GPS, and mapped the easiest way to return to them. In both post-treatment audits, we revisited each sampled waste pile and remeasured its size. The core outcome of our field experiment is whether informal waste piles in treated zones have larger reductions in size than those in control zones, comparing baseline pile sizes to re-measurements at 5 and 9 months post-treatment.[4] Figure 4, Figure 5, and Figure 6 are representative examples of small, medium, and large waste piles, respectively.

We additionally recorded whether piles displayed evidence of rubbish burning, the composition of waste in each pile, and the organization of waste at each pile at each post-treatment audit. These measures allow us to quantify any secondary improvements to waste management short of full KCCA clean ups. For instance, KCCA staff often would organize rubbish and place it into containers for future transport if their collection trucks ran out of space. Measuring how waste is organized and contained at each pile allows us detect this action by the KCCA to improve the quality of waste services. Collecting evidence of waste burning at each informal waste pile allows us to investigate whether citizens experienced marginally better access to formal waste services, since citizens commonly burn their waste when they cannot utilize KCCA collection services. Reductions in the amount of waste burnt at each pile therefore suggest that citizens anticipate that KCCA waste services would perform clean ups in the future.

Pre-registered measures (from photographs and field measurements)

- Area of total waste accumulation (primary outcome)

[4]Even reductions in pile size short of full clean-ups should be indicative of improved KCCA services. The timing of waste pile audits likely aligned imperfectly with the KCCA responses to citizen reports. As such, our measurements of informal waste pile area potentially capture both the waste-reducing effects of KCCA clean-ups and any informal waste disposal that occurred following KCCA clean-ups but prior to each post-treatment audit. Space limitations on KCCA trucks sometimes also prevented KCCA staff from conducting full clean-ups of informal waste piles. When there was insufficient space on KCCA trucks to clear an informal waste pile completely, KCCA staff would clear as much of the waste pile as possible and return to clear the remaining waste later.

- Area of unmanaged waste accumulation
- Amount of burning
- Amount of non-organic waste

Figure 4: Small pile

Figure 5: Medium pile

Figure 6: Large pile

3.8 Estimation

Our core estimation strategy investigates the extent to which waste piles in treated zones differ from waste piles in control zones. We test the main empirical prediction using a series of ordinary least squares regressions, where the outcome measurements about the waste piles are the dependent variables and the treatment status of the zone in the main independent variable. While not necessary for unbiased estimates of the effect of treatment on waste outcomes, we also add a number of covariates to the regression to increase the precision of the estimated effects: zone-level treatment status in previous phases, baseline pile sizes, and zone-level measures of population, density of improved roads, and luminosity. We obtain our estimates of uncertainty from randomization inference, which computes the uncertainty in estimates of treatment effects from the experimental design and different possible randomization draws (Gerber and Green, 2012). In particular, we compute sharp null standard errors by assuming no effect and recording the treatment effect that would have been observed under each of 10,000 permissible randomization draws. The estimating equation used for this process for measures with both baseline and endline values is Equation 1.

$$y_{ij,t=b+n} = \alpha + \tau M_j^+ + \gamma y_{ij,t=b} + \boldsymbol{\beta}\mathbf{X_j} + \nu_h + \epsilon_j \tag{1}$$

where y is the relevant size measure for pile i in zone j at time b baseline plus some follow-up period n, τ is the treatment effect of interest, M_j^+ is a binary indicator of treatment assigned at the zone-level j, γ is the parameter estimating the relationship of baseline size measure $y_{ij,t=b}$ to the follow-up outcome measure, $\boldsymbol{\beta}\mathbf{X_j}$ is the estimated adjustment for pre-treatment, zone-level covariates including the treatment status of zones during previous phases, ν_h is a fixed effect for division, and ϵ_j is an error term clustered at zone, often irrelevant in our case because we report sharp null standard errors for analyses conducted by randomization inference. This estimation deviates from our pre-registered strategy in that it takes the pile, rather than the zone as the unit of analysis, which increases precision. Justifications of deviations from our pre-registered analytical strategy is available in SI Appendix D. Summary statistics for the effective sample used for analysis are available in SI Appendix, Table I10.

3.9 Qualitative Analysis

Our field experiment is designed to estimate the average effect of the citizen reporting program on levels of informal waste disposal at the neighborhood level. This estimate is informative about the overall effect of ICT-enabled coproduction on public service quality. However, the field experimental estimate of program effects does not provide direct evidence about how the features of the specific coproduction program that make it more or less likely to succeed at improving services, which we outline above: the alignment of citizen-produced data with the specific information problems managers face; the search costs of detecting public services failures; the quality of citizen-produced data; and the operating costs managers incur from deployed ICT-based reporting platforms.

To enhance the field experimental results, we rely on qualitative data to address key questions about the value of fostering coproduction for service provision. Our team was embedded in the KCCA waste management unit for close to one year. During this time, we interacted with a variety of KCCA staff members, from managers to frontline staff providing waste services. We had access to and reviewed KCCA documents, participated in KCCA meetings, and regularly observed interactions between the KCCA and its stakeholders. We recorded ongoing observations systematically. Following the last field audit, we conducted in-depth interviews with all individuals who interacted with the citizen reporting platform.

We use these qualitative data to shed light on the key factors that contributed to the overall effects estimated in the field experiment and to offer guidance about the conditions that are necessary for ICT-enabled citizen reporting to enhance public service provision more generally. We present the qualitative data in the theoretical categories outlined above – type of agency uncertainty, costs of monitoring public services, quality of citizen-produced information, and the cost of processing information. Taken together with the field experimental results, the qualitative analysis significantly expands our ability to explain when and why ICT-enabled coproduction might succeed.

4 Results

4.1 Field Experimental Results

4.1.1 Pile Sizes and Pile Clean-Up

Speaking directly to the impact of citizen reporting on the delivery of waste services, Table 1 shows that we cannot rule out a zero effect of treatment on waste accumulation in informal piles. We also test the degree to which treatment increases the probability that KCCA staff or contractors clear waste piles fully. We again cannot rule out a zero effect of treatment on the probability of waste pile clean ups. The proportion of cleaned piles in treated and control zones at both post-treatment audits are very similar (see also Figures 7 and 8). We also cannot rule out a zero effect for the more statistically powerful rank test, which we added to deal with a few unexpectedly large outliers and concern that the null result might be driven by low power. [5] Even when relaxing our coding of a cleaned pile to include sites for which all waste was collected into a single, transportable container, we find no difference in the proportion of cleaned sites among treatment and control groups inconsistent with a zero effect of treatment (Figures 7 and Figures 8, "Pile Cleaned, Adjusted" plots). Thus, we find no evidence that citizen reporting reduced waste accumulation in informal waste piles.

We consider whether these results are due to a lack of statistical power or due to spillover in treatment between contiguous zones. In SI Appendix J, we show that we have power to detect standardized effect sizes that are all < 0.2 in the main estimation, implying that the experiment had sufficient power. Spillover between zones may incorrectly suggest a null effect of treatment if zones assigned to the control condition received some form of citizen reporting that subsequently improved KCCA waste services proportional to simultaneous improvements in treated zones. SI Appendix H demonstrates that our results hold when using specifications that allow for the spillover in citizen reporting between contiguous zones in our sample. Therefore, we are confident that neither a lack of statistical power nor spillover in treatment are driving our results.

4.1.2 Pile Characteristics

While we find no evidence suggesting that treatment significantly reduced total waste accumulation or significantly increased waste pile clearance, we observe some promising effects of treatment on the amount of uncontained, disorganized, and burnt waste at the first post-treatment audit. Table 2a shows that treatment reduced the estimated proportion of burnt area among waste piles in treated zones in ways that are inconsistent with the null hypothesis. The effects of treatment on the area of uncontained and dispersed waste pile area are also indicative of a positive effect of treatment on KCCA service delivery at the first post-treatment audit (Table 2a). The results at the second post-treatment audit are less conclusive. While the point estimates of treatment on each outcome appear similar between audits, variation in measured pile sizes inflates our standard errors and thus prevents us from confidently ruling out a zero effect of treatment at the second post-treatment audit.

[5] We also test H1 using a difference-in-difference estimation strategy, which may give us more statistical power. Table I11 in the SI displays these results and similarly demonstrates that we cannot rule out the zero effect of treatment on informal waste pile area.

Table 1: RI Results, Primary Dependent Variables for Area (Cleaned)

	Pile Size	Pile Size	Pile Present	Pile Present	Pile Rank	Pile Rank
Audit	M1	M2	M1	M2	M1	M2
Treatment Effect	-4.23	-7.78	-0.03	-0.01	-11.11	-6.54
Standard Error	3.47	12.81	0.03	0.04	16.65	16.39
p-value	0.11	0.3	0.19	0.41	0.25	0.33
N	679	679	679	679	679	679

Note: results calculated using cleaned waste pile size measurements.

Description of Dependent Variables

1. ***Pile Size:*** *waste pile area (m^2), measured at the specified midline audit. Enumerators recorded waste pile dimensions at each audit. These dimensions were used to estimate waste pile area for each site in the sample.*
2. ***Pile Present****: binary indicator variable for whether a waste pile was cleaned or not at the specified midline audit. Recorded values of 0 indicate that no pile was present at the given midline audit (e.g. the pile had been cleaned); recorded values of 1 indicate the opposite.*
3. ***Pile Rank****: waste pile size rank, calculated at the specified midline audit. Due to high variance in the recorded waste pile sizes, we perform a rank test comparing the ranked change in pile size between the baseline audit and each midline audit. Waste piles were ranked at each audit based on their size relative to other waste piles.*

Table 2: RI Results, Secondary Dependent Variables for Area (Cleaned)

(a) Midline 1

	Uncontained	Uncontained	Disorganized	Disorganized	Burnt	Burnt
Variable Specification	A	B	A	B	A	B
Treatment Effect	-4.44	-4.52	-4.54	-4.55	-2.49	-2.30
Standard Error	3.35	3.34	3.44	3.4	0.86	0.78
p-value	0.09	0.09	0.10	0.09	<0.001	<0.001
BHY p-value	0.24	0.24	0.24	0.24	0.01	0.01
N	679	679	679	679	679	679

Note: results calculated using cleaned waste pile size measurements.

(b) Midline 2

	Uncontained	Uncontained	Disorganized	Disorganized	Burnt	Burnt
Variable Specification	A	B	A	B	A	B
Treatment Effect	-4.52	-7.66	-7.34	-7.22	-3.10	-2.00
Standard Error	3.35	10.60	12.75	12.73	2.45	1.94
p-value	0.09	0.29	0.31	0.31	0.12	0.17
BHY p-value	0.77	0.77	0.77	0.77	0.77	0.77
N	679	679	679	679	679	679

Note: results calculated using cleaned waste pile size measurements.

Description of Dependent Variables

1. ***Uncontained:*** *estimate of uncontained waste pile area (m^2). At each midline audit, enumerators recorded how rubbish was stored in each waste pile. Responses ranged from "all of the rubbish is neatly contained" to "no rubbish is contained in sacks or containers." Each response was assigned a scalar between 0.0 and 1.0, which was multiplied against the recorded waste pile area to estimate the uncontained waste pile area.*

2. ***Disorganized:*** *estimate of unorganized waste pile area (m^2). At each midline audit, enumerators recorded the dispersion of rubbish in each waste pile. Responses ranged from "all of the rubbish is collected in a single pile" to "rubbish is spread all around [with] no evidence of the rubbish being organized." Each response was assigned a scalar between 0.0 and 1.0, which was multiplied against the recorded waste pile area to estimate the unorganized waste pile area.*

3. ***Burnt:*** *estimate of burnt waste pile area (m^2). At each midline audit, enumerators recorded any evidence of burning they observed at each waste pile. Responses ranged from "no evidence of burning" to "more than half of the area of the rubbish pile contains evidence of burning." Each response was assigned a scalar between 0.0 and 1.0, which was multiplied against the recorded waste pile area to estimate the burnt waste pile area.*

Variable specification A is less conservative than specification B. Specification A assigns a smaller scalar to enumerator responses indicating less organization/storage and more burning. See SI E for description of scalars. BHY p-value is minimum family-wise false discovery rate under which the null hypothesis would be rejected for each test using the Benjamini-Hochberg-Yekutieli procedure.

Figure 7: Dependent Variables, Midline 1

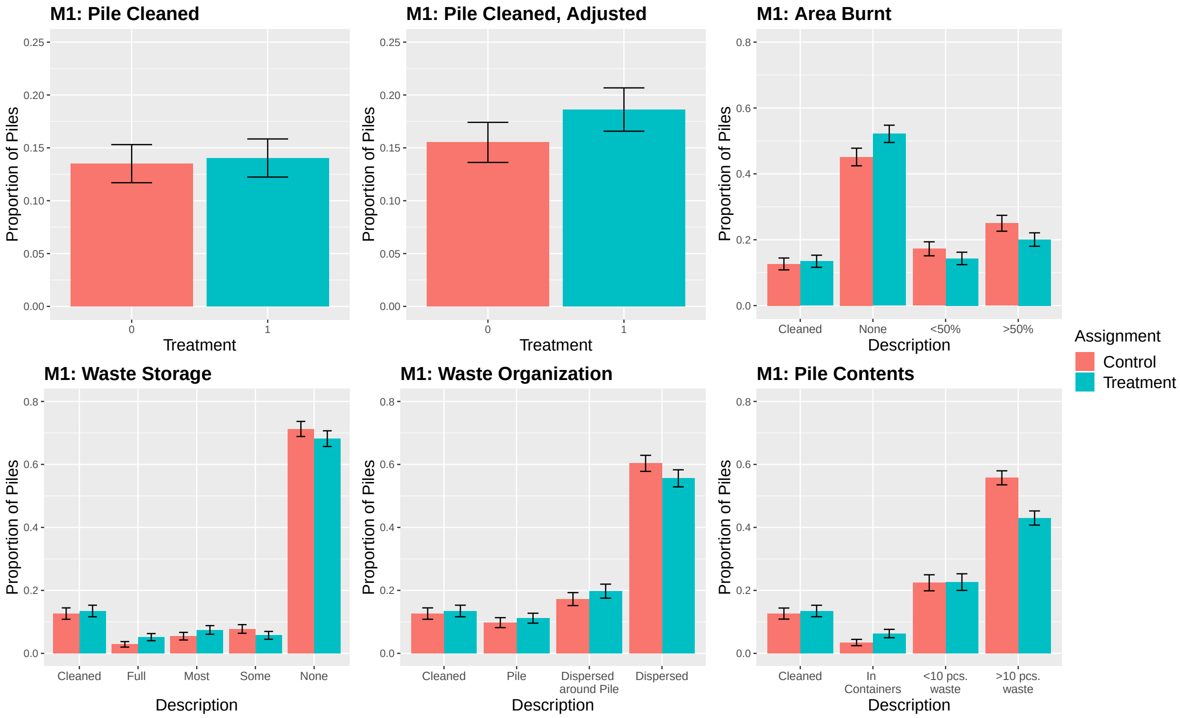
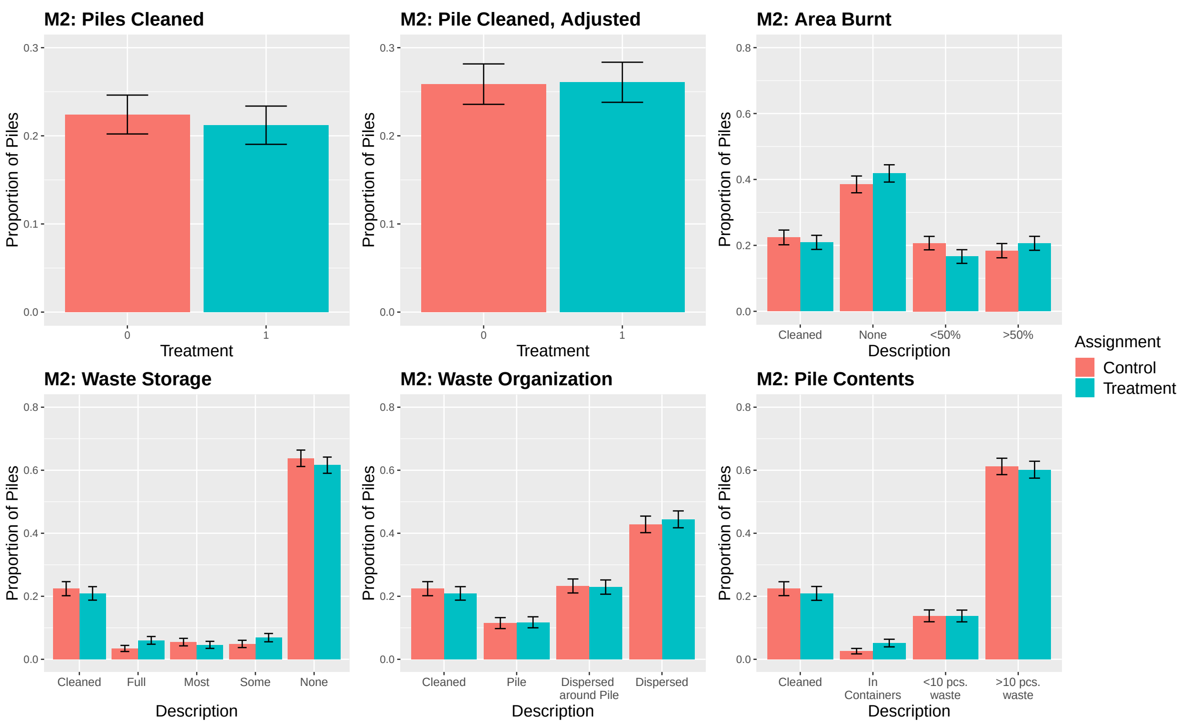


Figure 8: Dependent Variables, Midline 2



Figures 7 and 8 similarly display the weak persistence of improvements in some aspects of waste service delivery in treated zones from the first to second post-treatment audit. At the first post-treatment audit, we observe a larger proportion of waste piles in treated zones that show no evidence of waste burning compared to piles in control zones (te=0.07, p=0.04). We also see that a smaller proportion of piles in treated zones contain more than ten pieces of inorganic waste than do piles in control zones at the first midline audit (te=-0.13, p=0.0005). However, both of these effects attenuate at the second post-treatment audit, where the proportion of piles in treated zones displaying significant evidence of burning and the proportion of piles in treated zones with more than ten pieces of inorganic waste are statistically indistinguishable from the proportion of piles of a similar nature in control zones.

Only with respect to waste storage do we find evidence that the treatment effect we observe at the first post-treatment audit persists to the second post-treatment audit. Note that this evidence is only suggestive: while the proportion of fully contained piles in treated zones exceeds the proportion of fully contained piles in control zones (Figure 8), this effect is not very inconsistent with the null hypothesis (te=0.03, p=0.08). When estimating the uncontained area of waste piles, we find a similarly suggestive effect (Table 2b, p=0.10). However, there is more uncertainty about this effect when we use a more conservative estimate of uncontained waste pile area (Table 2b, p=0.27).

4.1.3 Robustness

It is possible that the results reported above mask treatment effects where they are most likely to occur by averaging across heterogeneity at the zone-level. We therefore investigate the heterogeneous effects of treatment across a number of zone-level characteristics that might condition the impact of citizen reporting on waste services. These analyses do not test pre-registered hypotheses, but instead represent additional robustness checks to ensure that null results we find in our main analysis are not the result of averaging across zone-level heterogeneity.

Political Targeting Several recent papers show that politicians often use public goods and services as a way to reward supporters in elections (Jablonski, 2014; Drazen and Eslava, 2010; Baldwin, 2013; Briggs, 2012). In the setting of our study, the National Resistance Movement (NRM) is the ruling party nationally, but faces generally low levels of political support within Kampala. In 2011, aiming to reverse the trend of entrenched opposition within the capital city, the municipal government was nationalized and responsibility for services transferred from the elected city council to the KCCA. Thus, the KCCA may have used their discretion to reward areas of the city that vote for NRM candidates, as compared to opposition or independent candidates, with disproportionate improvements to waste services.

We test for this possibility by examining both the baseline amount of waste accumulation and whether the reporting treatment was more effective where the winning candidate in 2016 division elections for the parish constituency was a member of the NRM ruling party. As displayed in Table I3, we fail to find evidence that the likelihood of waste pile clearance or the change in waste pile sizes is conditional on the party of the Division councillor.

Distance to KCCA Division Headquarters Part of the appeal of citizen reporting platforms is the possibility for managers to gather information on the status of service delivery in areas that otherwise would be costly to monitor. The KCCA in particular lacks information in on service delivery in zones that are distant from any of the organization's five division headquarter offices, for at least two reasons. First, it is more difficult for residents in zones located further away from KCCA headquarters to communicate with the KCCA under existing practice. Zones often send local representatives to KCCA headquarter offices to report on the quality of waste services. Second, it is more costly for the KCCA to send out its own scouts to zones that are located further away from division headquarters given the cost of transportation and time required to reach these zones.

If information is the binding constraint on effective service delivery, and it is very costly for managers to monitor service provision outlying areas, then we might expect citizen reporting to improve waste services only in zones that are distant from KCCA division headquarter offices. We construct two measures of zone-proximity to test this possibility. First, we measure proximity in terms of straight-line distance between the centroid of a given zone and the nearest KCCA division headquarters office. Second, we measure proximity in terms of the time required to travel on main roads from the centroid of a given zone to the nearest KCCA division headquarters office. Tables I8 and I9 display these results. We find no evidence suggesting that either measure of proximity conditions the effect of treatment, at the conventional level of statistical significance.

Reporting Rates and Message Content Vocal stakeholders often receive the most attention from public agencies. Under public pressure, KCCA officials might respond disproportionately to zones that either frequently or consistently report shortfalls in waste service provision. Alternatively, KCCA officials might respond disproportionately to zones where some citizen reporters express severe dissatisfaction with KCCA services.

Using the content of reports collected prior to the first post-treatment audit, we test these hypotheses. We calculate the average response rate across the study period per treated zone to examine if frequent reporting is associated with improved waste service provision among treated zones. We use the content of reports to create zone-level measures of reporting consistency, dissatisfaction with waste services, and waste problem severity. We find mixed results in these tests, none of which produce effects that are inconsistent with the null hypothesis and signed in the hypothesized direction. For instance, we see that poorer service provision at baseline is positively associated with a pile not being cleaned by the second post-treatment audit (Table I5). Higher levels of baseline dissatisfaction with KCCA services too are positively associated with a pile not being cleaned by the first post-treatment audit (Table I6). Otherwise, we do not find that the amount or content of reports affects waste pile size in ways that are inconsistent with the null hypothesis of no effect at each post-treatment audit (Tables I4, I5, I6, and I7).[6]

Zone-level reporting frequency and consistency, dissatisfaction with KCCA services, and waste problem severity are not associated with changes in waste accumulation among treated

[6]We operationalize "severity of waste management problems" in Table I5 from responses to a prompt asking citizen-monitors to report if a rubbish-collection truck visited their neighborhood. Possible responses include: yes, no, don't know. The latter two responses were coded as indicative of severe waste management problems. Following the logic outlined above, one would expect the KCCA to deploy trucks disproportionately to zones reporting that they had not received pick-up services recently. We additionally operationalize waste management problem severity using citizen-monitor reports commenting on rubbish burning, litter and illegal piles, rubbish spilling from KCCA trucks, and mistreatment by KCCA waste collectors.

zones. Together with the results on political targeting and accessibility, this analysis strengthens our conclusion that the platform did not improve waste management and gives us greater confidence that the null effect of treatment in the main analysis is not a consequence of averaging over heterogeneous effects.

4.2 Qualitative Results

The opportunity to embed part of our research team at the KCCA and interview the staff who interacted with the citizen reporting platform allows us to assess how several features of this co-production effort lead to the overall disappointing results: the quality of citizen-produced information; the operating costs of citizen reporting platforms; the search costs of public service failures; and the alignment of managerial uncertainty and the information citizen reporting produces. Challenges in each of these areas posed significant barriers to a greater impact of the reporting platform.

4.2.1 Reporting Quality and Operating Costs

Managers at the KCCA hoped that citizen reporting would produce reliable and consistent information on the location of waste service shortfalls, which could be used to improve service delivery. In practice, though, information from citizen reporters proved to be both inconsistent and unverifiable. Strategies to process the incoming information increased the cost to operate the platform for the KCCA, undermining the perceived effectiveness of ICT-based coproduction among KCCA staff.

Within zones, the consistency of citizen reports to the same prompts varied substantially. Figure 9 displays the average consistency of reporters indicating poor or good service quality over the entire study period.[7] A consistency of 0.5 means that managers receive an equal number of citizen reports indicating good and bad service quality within a given zone for each question, averaged over the study period. The more inconsistent the reports within a zone, the more uninformative the information from reporters about waste quality for managers.

[7] The categorical measure of poor service provision combined the following indicators: the frequency and accessibility of service provision, reported waste collector treatment of citizens outlined, and receipt of waste services, and satisfaction with waste services.

The mean rate of internal inconsistency for citizen reporting was twenty-one percent over the study period. On average, roughly one-fifth of responses disagreed with the modal response direction for each question in each zone. Moreover, thirty zones in the sample produced highly uncertain signals, with an average inconsistency in excess of thirty percent. This reporting inconsistency might be attributed to a number of factors. For instance, high rates of inconsistency could be a result of citizens accurately observing different waste conditions in different part of zones, pointing to the need to increase the spatial precision of observations. Alternatively, some reporters might have reported inaccurately based on faulty observations.

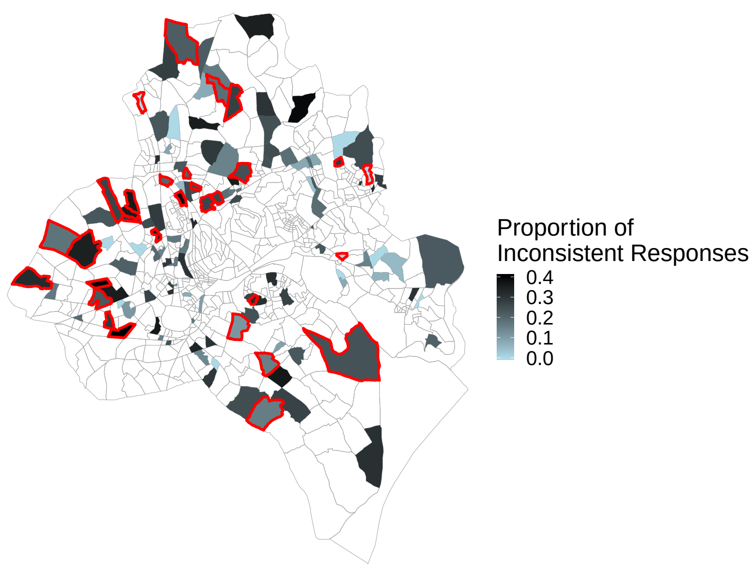


Figure 9: Consistency of reports from treated zones in the experimental sample. *Along a standardized measure of poor service provision, zones in red, indicated that KCCA service provision was poor on average. Zones with darker fills represent zones that inconsistently reported the quality of KCCA services, relative to the zone-level modal response, across all weeks and questions in the study period.*

KCCA staff employed a number of strategies to cope with the inconsistency of incoming citizen reports, including: (1) contacting individual reporters who sent consecutive contradictory reports; (2) following up with citizens where reporting inconsistency was high to get additional input on local waste conditions; (3) utilizing staff knowledge of reporting areas to interpret the information from the citizens; and (4) following up with other stakeholders in the service provision process (e.g., speaking with private contractors operating in a zone with inconsistent reporting). This verification process frustrated staff at the KCCA because it substantially increased the operating costs of the platform.[8] KCCA staff reported that it took between one and two working days for a staff member to transform the data received in a spreadsheet into actionable information. Since the KCCA adopted the citizen reporting platform to reduce the overall cost of acquiring information, KCCA management thought that the unexpectedly high operating costs of the citizen reporting platform detracted from its effectiveness as a tool for improving service delivery. Facing these costs, one Solid Waste Officer commented that the KCCA had "hit a dead-end" in terms of verifying information from citizen reporters (Interview B).

The verification process also undermined the trust of KCCA staff in citizen reporters. As the acting Supervisor of the Solid Waste Unit stated: "The data is not useful because its authenticity or accuracy cannot be verified... Those champions [i.e., the recruited citizen reporters] don't report to me... they reply according to whatever they want; and to me, that is very wrong." (interview J). The hostility to the KCCA expressed in a small number of reports was especially damaging to trust in the quality of the information.[9]

Beliefs that the monitoring platform had low response rates furthered the perception at the KCCA that the citizen reporting platform had unjustifiably high operating costs. On most occasions, the KCCA received reports from no more than 12 percent of citizen reporters enrolled in the program (see Figure 1). Given that the KCCA was billed for every SMS it sent to citizen reporters – even for reporters who failed to respond – several KCCA staff felt that a large portion of the program's budget was being wasted. This sentiment resonated among high-ranking officials in the KCCA as well. During a presentation of the results of previous phases of the project by our research team, the Deputy Executive Director of the KCCA expressly criticized the citizen reporting program for producing limited information on waste conditions at a high cost.

Comparing the monthly cost of citizen reporting to the monthly cost of employing a team

[8] Even Solid Waste Officers at the KCCA who were generally supportive of platform at baseline acknowledged that the poor quality of citizen reports undermined the cost-effectiveness of the citizen monitoring. One Solid Waste Officer commented "sometimes, they're [the messages citizen reporters send] are not genuine" (Interview H); while another commented "sometimes it [the platform] does not give us very accurate information" (Interview B).

[9] The acting Supervisor of the Solid Waste Unit commented: "I find it difficult to act on such messages when some are even insulting" (interview J).

of KCCA scouts – informal agency staff who monitored waste conditions on foot throughout Kampala – helps clarify staff concerns about operating costs. One engagement cycle of the SMS-reporting platform cost the KCCA UGX 915,000 ($254 USD), and on average yielded 750 responses from citizen reporters. Over the course of a month, KCCA would go through at least four engagement cycles. Without accounting for the cost of processing and verifying reports, the monthly cost of the citizen reporting program was approximately 3,660,000 UGX ($1016 USD). Complete funding for the 72-person team of KCCA Solid Waste scouts was approximately the same. However, incoming information from Scouts seldom required additional verification or processing, shielding the KCCA from the downstream costs it incurred planning responses to information.

Thus, while citizen reporting gave the KCCA access to a broader base of information, the quality of data it generated increased the platform's operating costs such that KCCA staff believed the platform was an ineffective strategy to improve the delivery of waste services. The current Supervisor of the Solid Waste Unit summarizes this sentiment bluntly: "For me, these messages are very expensive for nothing. That is why I was saying, 'Why don't we buy the scouts airtime and communicate on WhatsApp?' " (interview J).

4.2.2 Search Costs and the Alignment of Information and Uncertainty

At launch, KCCA staff believed that the ICT-based reporting platform would increase the agency's ability to hold third-party contractors accountable and spread information about proper methods of waste management among KCCA customers.[10] Acquiring information about these service failures imposed high search costs on the KCCA prior to launching the program, since KCCA staff could not patrol neighborhoods frequently enough either to monitor contractor performance or to measure citizens' knowledge of waste management.[11]

[10] Commenting on the usefulness of the platform and the information it provided, one Solid Waste Officer stated: "When this information is given out to the people...[they] can suggest ways how we can really change the systems of waste collection. And then, it helps people to come on board that these private people are mandated to do their work efficiently. So, a person can tell what time are they supposed to be at my door to collect my garbage. It helps the person to know, and to be very streamlined, in terms of waste storage...There is actually a lot that people didn't know, that this portal helps them to know."

[11] One Solid Waste Officer stated: "Now in Kawempe [their area of supervision] you have about 22 parishes, you can't move everywhere. But at least if you can get respondents from each, you know what is happening there, because sometimes you may not reach everywhere" (Interview H).

We co-designed the citizen reporting platform with these types of uncertainty in mind.

However, the KCCA underwent an unexpected staff restructuring process between May and July 2017. In total, around 120 people were transferred, fired, or newly-hired across all branches of KCCA. The KCCA's waste management unit was not exempt from this process. A number of staff were moved into and out of the unit, and those that remained in unit typically were reassigned to different roles. The most radical change occurred in the unit's leadership with the introduction of a new Supervisor. The incoming Supervisor played no role in launching the citizen reporting program, did not trust information from citizen reporters, and did not share broad views about the value of engaging with citizens for non-instrumental reasons.[12]

The incoming Supervisor believed that waste conditions in Kampala additionally stemmed from the illegal dumping of waste by citizens, not solely from poor waste contractor performance in delivering services.[13] Understanding where access to waste services are limited is a dynamic problem that the KCCA could only detect at a large scale by querying the recipients of services. Conversely, identifying illegal dump sites is a relatively static information problem that the incoming Supervisor thought could be resolved at low cost using scouts.[14] The type of information the citizen reporting platform produced did not align with the information problem the incoming Supervisor was attempting to solve, as citizen reporters were not asked to identify illegal dump sites.[15]

Therefore, the new Supervisor decided to discontinue the citizen reporting program in favor of expanding the KCCA scout program. Bluntly, the new Supervisor stated: "The phone project [i.e., the citizen monitoring platform] is not in my needs"(Interview J). He more than doubled the scout program at the beginning of his tenure – increasing the size

[12]Commenting on the usefulness of the monitoring platform, the incoming Supervisor stated: "I cannot tell whether the message which is sent is genuine. Where somebody is not being paid, even if they give you wrong information, how do you track?" (Interview J).

[13]During our interview, the new Supervisor both reiterated his need to "find illegal dump sites" and "track the dumping" and detailed the uncertainty he faced in arresting suspects of illegal dumping: "After dumping, if I get the suspects, how do I pick them?" (Interview J).

[14]On the use of scouts for tackling illegal dumping, the Supervisor stated: "I have a problem of illegal dumping. And I have my scouts. When they find a suspect, they use WhatsApp to send a message, I send a car to pick the suspect and take them to court" (Interview J).

[15]The new Supervisor claimed that he had "never seen a suspect being reprimanded" for illegal dumping using information from the citizen monitoring platform (Interview J).

of the program to 200 employees – and modified scouts' roles in the waste management unit. In addition to investigating illegal waste management practices, the new Supervisor insisted that scouts begin monitoring general waste conditions and service delivery, effectively subsuming the role of citizen reporters.

5 Discussion and Conclusions

Information and communication technologies create new spaces for governments and citizens to collaborate in the production of public services. There has been significant optimism that citizens collectively have advantages in producing information in volume and scope that could be used to improve public service delivery (Bertot, Jaeger and Grimes, 2010; Noveck, 2017). After all, citizens directly experience services, or the lack thereof, as part of their daily lives. Yet, it is increasingly recognized that the adoption and operation of technologies for coproduction raise a host of managerial, institutional, and political challenges (Gil-García and Pardo, 2005; Heintze and Bretschneider, 2000; Laffin and Ormston, 2013; Liu and Yuan, 2015). Despite the tension between these perspectives, there has been a surprising lack of empirical evidence about whether new forms of coproduction enabled by communication technologies actually improve public services (see Loeffler and Bovaird, 2016; Nabatchi, Sancino and Sicilia, 2017; Lember, Brandsen and Tonurist, 2019).

Our study contributes formative evidence about the challenges of using ICT-enabled citizen reporting to coproduce public services. We do not find evidence that zones assigned to citizen reporting experienced reductions in informal waste accumulation as predicted. In interviews with KCCA staff and our direct observations, we found that citizen reporters generated inconsistent information about service delivery, requiring the KCCA to adopt an extensive verification process that not only increased the costs of operating the platform beyond expectations, but also undermined the perceived effectiveness of citizen reporting among KCCA staff. Moreover, the qualitative evidence suggests that the platform produced information that, after an unexpected turnover in staff, became irrelevant to the way that new manager understood his decision-making problems. In particular, the problem of waste management came to be viewed as a problem of enforcing rules against illegal dumping by residents, rather than oversight of service provision by contractors. Given the relatively low cost of monitoring illegal dumping and that static nature of the information problem, it was little surprise that the KCCA chose to abandon the citizen reporting platform altogether.

Our study is one of the only field studies that systematically and independently tracks the impacts of ICT-enabled coproduction to the actual delivery of a targeted public service. We find similar results to Grossman, Platas and Rodden (2018), who report that recruiting citizens to send text messages to local politicians in Uganda did not result in significant improvements to public services. It is possible that effects in that study were hampered by the fact that text messages were sent to politicians who do not directly control services, rather than bureaucrats who are responsible for responding in operational ways to complaints. Our study confirms that the same types of problems with inconsistent reporting can lead to disappointing results even when information is sent to bureaucrats directly responsible for services.

The results of our study contrast those presented in Jakobsen and Andersen (2013), who found that equipping parents with tools to support the education of their children in coordination with public schools increased educational outcomes. It may be the case that enlisting parents in the coproduction of educational outcomes for their children is a special case, since the benefits of such investments of time and effort are largely internal to the family. It is likely significantly more challenging to find ways to impact large-scale, collective, public outcomes like waste management through reporting. The results of our study also contrast with the tentative conclusions of observational studies about citizen reporting and the coproduction of services. Both Sjoberg, Mellon and Peixoto (2017) and Allen et al. (2019) find evidence that some cities have made real efforts to respond to citizen reporting. While it is clear that many governments are attempting such approaches, the aggregate results of our study point to the importance of establishing clear counterfactual designs for research about impacts. Clearly, more research on supporting conditions is needed and these two studies suggest that reporting platforms that solve problems related to information consistency and specificity might overcome challenges brought to light in our study.

In addition to theorizing about the conditions under which ICT-enabled reporting might improve services, our study contributes to broader theory about coproduction. First, the challenges governments will face in processing and acting on information gained by coproduction have not been fully appreciated. Our study highlights how, when deployed at scale, the massive data citizens generate can overwhelm the processing capacity of public agencies with limited resources. The variable quality and consistency of data conveyed in citizen reports compounds this challenge, since it requires a greater commitment from agency staff to transform citizen-sourced data into actionable information. Indeed, surveys examining when officials use data to make decisions find that complexity is a key limiting factor (Ammons and Rivenbank, 2008; Masaki et al., 2017). Given that managing public services are complex tasks in themselves (Moynihan et al., 2011), the cost of processing and verifying unstructued data from citizens might divert resources away from key tasks for service production, making citizen reporting a non-starter for public agencies seeking to improve public service delivery. Our study confirms that many practical considerations, such as perceptions of data quality and the capacity to deal with data complexity, can ultimately stymie models of coproduction that rely on citizen-sourced data (Gil-García and Pardo, 2005).

Second, our study highlights the importance of managerial and organizational continuity for the effectiveness of efforts to coproduce public services. Instead of treating the adoption of a reporting platforms as a technical exercise, more emphasis should be placed on gaining broader managerial and staff buy-in within agencies for the goals of coproduction (Meijer and Bolivar, 2016). The platform we tested with the KCCA first coincided with a broader reorientation of effort towards citizen satisfaction that prioritized detecting when KCCA staff and contractors failed to deliver formal waste services. Following a turnover in staff, the incoming Supervisor for the Waste Management Unit discarded the platform because he valued neither its collaborative vision of governance nor the data the citizen monitors provided, since he believed that waste mismanagement in Kampala stemmed from illegal dumping. More evidence is needed on how continuity in government agencies affects the success of coproduction programs generally (see Meier and Hicklin, 2007; Boyne et al., 2011). Our study suggests that reasonable continuity is a necessary condition for effective coproduction strategies.

Third, understanding how ICT-enabled coproduction maps onto the specific information problems affecting the provision of different public services requires further attention. Using evidence from our study, we suggest that citizen reporting has the best chance to improve service provision in sectors where the search costs of detecting service failures are high. For example, it may be very difficult for a public manager to effectively locate damaged roadways or burned out street lights. In such cases, the advantages of citizen reporters in identifying problems and directing agency effort, even with some inconsistency, outstrip the ability of agencies to identify tasks for possible action on their own. The persistence of participation in platforms that solve these types of problems by both citizens and officials suggests that citizen reporting is best applied to settings where the allocation of effort by managers is very uncertain (see Sjoberg, Mellon and Peixoto, 2017). As Afuah and Tucci (2012) argue more generally, crowdsourced information is best applied in settings where organizations can turn problems that involve "distant searching" for information into problems that involve less-costly "local searching" by engaging with the crowd. Our study suggests that it will be most fruitful to focus on specific types of services within public management, rather than apply citizen reporting to complex services which require systematic knowledge.

Our study also suggests how governments might more effectively deploy ICT-enabled platforms for coproduction in the future. First, our study clearly highlights the need for governments to ensure that public agencies have sufficient capacity to process and act on incoming information prior to launching a citizen reporting platform. Limited processing capacity not only prevented KCCA staff from fully leveraging the information citizen reporters provided, but also contributed to perceptions that the platform had unjustifiably high operating costs. Working to build processing capacity within the KCCA prior to the platform's launch – hiring additional employees, providing existing employees training on SMS-based reporting platforms, etc. – might have reduced the strain that citizen reporting placed on the agency. To test this intuition, future research might consider how concurrent capacity-building programs condition the effect of citizen reporting on service provision.

Second, our interviews with KCCA staff emphasize the need to build and maintain buy-in for citizen reporting programs, both among top-level managers and other agency staff. While our team co-designed the reporting platform with the previous manager, an unexpected reorganization of the KCCA brought in a new manager who neither shared the collaborative vision of governance underpinning the platform nor felt that the platform reflected his best interests.[16] Even staff at the KCCA who were supportive of citizen reporting at baseline later expressed frustration with the platform given the variable quality of information citizens relayed and their inability to verify reports. Ultimately, the perceptions that citizens reported inaccurate, inconsistent, and offensive information to the KCCA contributed to the platform's termination. Future attempts to engage in coproduction through large-scale ICTs might work to strengthen relationships between citizen reporters and agency staff before reporting programs are fielded. This could be accomplished either prescriptively, by providing formal training and more specific reporting criteria to citizen reporters, or collaboratively, by holding events that increase interpersonal trust between each group. We leave it to future research to explore which engagement strategies are most effective.

We believe these lessons should apply broadly to the conduct of coproduction through ICT-enabled citizen reporting. However, there are limits to our study which should be kept in mind as the evidence for this kind of coproduction approach grows. First, the outcomes that we measured as part of the field experiment focused on short-term service quality, but this may not be the only goal of citizen reporting and coproduction more broadly. Information from citizen reporting might be used for long-term planning, to improve relations and trust between governments and citizens, or to more effectively contract with providers of services. Our study did was not in the field long enough to pick up on these kinds of outcomes. Second, our study focused on coproduction in a setting where the available resources to process information and respond to reports was relatively limited. While this is precisely the kind of setting where ICT-enabled coproduction might decrease the trade-off between acting and gaining information, it is possible that the kind of platform we study is better suited to government agencies with greater capacity. Finally, during the course of our study an unexpected administrative turnover occurred that could have short circuited the growing benefits of this kind of platform. Indeed, while we see some evidence of limited positive effects at the first post-treatment audit, these results do not persist after turnover in the manager of the unit receiving the reports. It is possible that this kind of approach to coproduction requires a sufficient period of stability that allows for "learning by doing" before benefits can

[16]In fact, the acting supervisor of the Solid Waste Unit "believe[d] that there was a problem with the consultation [for the platform]" since it did not serve his efforts to curb illegal dumping (Interview J).

be fully achieved. All of these limitations of our study suggest that this area of research will benefit from an accumulation of evidence both across settings and over longer periods of time.

While engaging citizens to produce information for the management of public services is promising because of the potential to expand the scope and volume of information available to public managers, we find that this promise is likely overstated due to the effort and cost involved in processing and interpreting inconsistent, citizen-sourced data. Citizen reporting will be helpful at improving public services when the data it produces is easy to process, consistent, low-cost relative to alternatives, and is brought to bear on well-defined decisions with high degrees of uncertainty about where to act. These conditions are unlikely to exist in many settings thought of as viable candidates for technology-enabled coproduction.

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Supporting Information

Contents

A Waste Pile Measurement Protocol

A.1 Background

The measurement of waste piles was carried out during the baseline and two midline audits of the study. Each individual waste pile was measured once during the baseline and once during each of the subsequent midline audits. The following sections contain the protocols and instruments used to implement the measurements. In the baseline audit, there is a protocol for locating the most problematic waste pile locations, as well as the waste-pile audit survey used to record the particulars of each waste pile. In the midline audits, the waste pile audit survey used in the baseline was modified to accommodate instances where the waste pile was cleared.

A.2 Baseline Waste Audit

This is the protocol given to the enumerators to guide them in locating the most problematic waste pile locations in each zone visited. The language is in second-person because the enumerators were supposed to read and follow these instructions.

Dividing Up The Zone

Upon arriving at the zone, the first activity is to divide it up into 4 sections. These sections should be as equal as possible. You will work with the LC1 to determine the boundaries of the zone, and divide it up into four sections. You will assign each of these sections a letter from A to D. For instance, here is an example of how a divided up zone will look like.

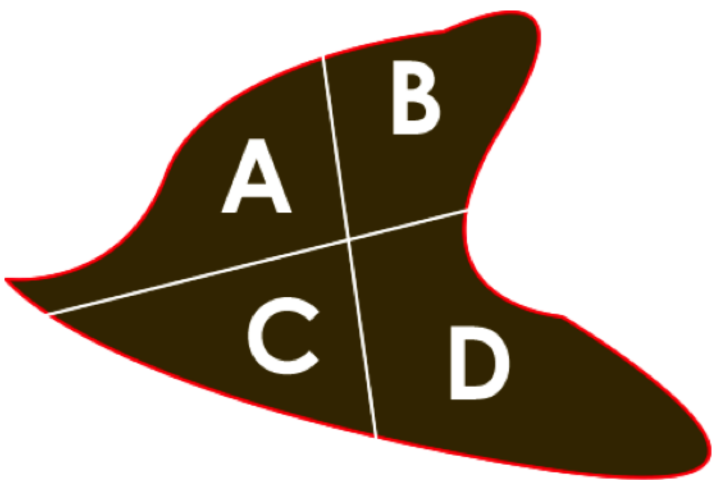

Figure A1: Dividing Up a Zone

Dividing up the zone is essential for collecting data which is representative of the entire zone. Each of the sections will form the basis of where the different activities will be carried out.

Locating A Solid Waste Pile

For each section, you must ask at least 4 people about the location of problem waste piles in that section. When asking anyone, please describe the boundaries of that section to the person, so that they know that you're referring to that particular section (and not the entire zone). Also try to find people who are residents within the particular section to ask them about possible waste pile locations.

If someone tells you that there is no solid waste pile, then probe. Probing is basically asking extra questions in order to elicit information. In this context, probe by suggesting the possible locations where waste might be located.

Examples include:

- Drainage channels
- Communal rubbish heaps
- Locations where the truck parks (sometimes there's spillage)
- Litter on the roadside or public places
- "Secret" locations where people dump rubbish at night

When probing, ask the person whether they know of any such location within that section of the zone. Even if the waste location isn't particularly large, as long as it exists and is located within the section, we want to know about it.

Here is a possible set of questions which you can use to guide you when locating a solid waste pile.

1. Do you know of any problem waste pile location in this section of the zone? (Describe the section basing on how you divided it up.)

   A. Yes

   B. No (SKIP TO Q5)

2. Is it one location or there more than one?

   A. One (Proceed to Q3)

   B. More than one (Skip to Q4)

3. Can you please direct me (or take me) there? FOLLOW DIRECTIONS TO LOCATION

4. Can you please direct me (or take me) to the most problematic location? FOLLOW DIRECTIONS TO LOCATION

5. Can't you think of any place which has rubbish e.g. drainage channel, rubbish heap, litter on the road side, or a place where people often dump their rubbish?

   A. No (PROCEED TO NEXT PERSON)

   B. Yes (GO BACK TO QUESTION 2)

If you ask four different people and all of them say that there's no waste pile location in that section of the zone, communicate that to your co-team member, fill in the waste pile audit and proceed to the next cell. If not a single waste pile location is found in a zone, then do not recruit subjects in the zone.

Measuring the Waste Pile (Waste Pile Audit Survey)

Name of Staff Member______

Name of Zone______

Name of Division *(SELECT)*

A. Central

B. Kawempe

C. Makindye

D. Nakawa

E. Rubaga

Name of Zone Section______

1. Did you find a waste pile location in this section of the zone?

   A. No (Skip to Q7)

   B. Yes

2. Name of Waste Pile (Enter exactly as recorded in GeoTracker)

3. Type of Disposal Site

   A. Household sack or bin for collection

   B. Pile within household for burning

   C. Pit within household for burning

   D. Small pile outside household

   E. Pit latrine

   F. Unofficial dumping site (used by many households)

   G. Official dumping site or container

   H. Littering in public space

   I. Other (specify)

4. Name or describe type of disposal site

5. Measurement of site (L*W)

6. Picture of Disposal Site

7. What is the most important reason why you couldn't find a waste pile location in the section of the zone?

   A. I asked 4 people and they all said there isn't any waste pile location in the section

   B. The waste pile location is in another section of the zone

   C. Other (specify)

8. Extra notes

B Reporter Recruitment Protocol

For any individual to qualify to be recruited as a citizen monitor, they had to meet certain criteria. The basic criteria were:

- They should be 18 years or above
- They should be residents of the recruitment zone
- They should possess a mobile phone
- They should be capable of reading and writing SMS text messages (or have access to someone who can assist them)
- They should be willing to become a citizen monitor

The recruitment method for the citizen monitors was random recruitment. This means that anyone the research team met, who satisfied the recruitment criteria was eligible for recruitment. To eliminate recruiter bias, the team was required to implement a random walk pattern when looking for people to recruit. The random walk pattern is described below:

1. Find an intersection in each of assigned cells in the zone. An intersection is the crossing of any road, path, or alley that leads to the entrance of residential dwellings. The starting intersection should be located by walking several minutes into the assigned cell.

2. Assign each direction leading from the intersection a number. Roll the dice and move in the direction selected randomly.

3. Any time you reach another intersection, assign each direction that moves forward from your walk path a number and roll the dice, moving in the direction selected randomly. You should only turn around if you reach a dead end or the edge of the assigned cell.

4. The only reason that the randomly chosen direction should not be an option is if you have already been down a path and you know that it leads to a dead end.

The team was required to follow the random walk pattern for 3 minutes, and attempted to recruit the next person they find. When recruiting people, the team members introduced themselves, the program, and ascertained whether the person was interested in being recruited as a citizen monitor. Interested citizens who met the specified criteria were recruited and contacted in subsequent weeks.

C Data Cleaning

The results reported in the following section are those arrived at after an extensive effort to clean the data. We had two kinds of cleaning that are particularly important to mention as part of the present analysis.

First, the data collection reported in this paper depended on the ability to visit the same area repeatedly to assess the area of waste accumulation. Because the amount of waste that people would add to unmanaged piles is directly related to the availability and use of formal pick ups, understanding changes in pile sizes that community members identified as most important should be a strong measure of waste services. We cross-checked the GPS locations of all piles in baseline and both midline waves and excluded from the data any pile location that was more than 100m from the baseline location, based on the field-tested accuracy of the tablets that we used for enumeration.

Second, there appears to be unit errors in each of audit files, with pile sizes recorded that are implausible given the associated photographs. For the reported analyses, we have completed a double-review of all piles. Certain piles with implausible and unverifiable baseline measurement sizes were excluded from our analyses altogether. The review process for the remaining piles was as follows:

1. Two reviewers examined the pile size measurements at each audit and corresponding photo.

2. Each reviewer recorded a score of 1-4 indicating their confidence in the reported pile measurement given the corresponding photograph. Lower scores indicate more confidence in the enumerator's measurement.

3. When applicable, each reviewer offered an alternative measurement based on their interpretation of the provided photograph.

4. Reports from each reviewer were relayed to a final reviewer for adjudication.

    a If either reviewer agreed with the enumerator's initial pile measurement, the original value entered by the enumerator was kept.

b If both reviewers disagree with the enumerator, but agree with each other closely, then agreed value is automatically kept. To the extent that the suggested pile sizes were reasonably close, the suggested size closer to the original enumerator value was kept without further checking.

c If both reviewers disagree with the enumerator and they disagree with each other, then the final reviewer checked and assigned a final measurement based on the pile's corresponding photograph.

C.1 Robustness to Exclusion Criteria

Using our recoded estimates of waste pile size does not change the nature of our results. While using our estimates of pile size does reduce the standard errors associated with treatment in the randomization inference, we still observe a null effect of treatment on changes in pile size and characteristics (see Tables I1, 1, I2, 2).

D Deviations from Pre-Analysis Plan

Timing We pre-registered the design and analysis of this study on November 18, 2016 prior to any research activities, including baseline data collection ([REDACTED]). That pre-analysis plan describes our research plan for the current study only, excluding earlier phases that dealt with promoting citizen reporting. We had originally planned a 7-month study period, but due to the holiday season at the end of 2016 and beginning of 2017, we suspended platform operation for a time. We extended the timing of the first and second post-treatment audits accordingly.

Analysis Our pre-registered estimating equation was:

$$\Delta Y_j = \alpha + \tau M_j^+ + \beta \mathbf{X_j} + \nu_h + \epsilon_h \tag{C1}$$

To increase power, we use this modify this analytical strategy and use the baseline pile size as a covariate as outlined in Eq. 1 instead of using it to directly transform the outcome variable, per guidance discussed in McKenzie (2012). Because we do not find significant treatment effects, we believe boosting power is desirable given relatively low autocorrelation in pile sizes between measurement waves. This gives us more confidence that the null effect is not driven by low power. Additionally, instead of aggregating to the zone level as pre-specified, we use individual piles as the unit of analysis. Since we were not able to find the same number of piles in all zones, this is a more straight-forward analytical strategy.

This pre-registered estimating equation indicates standard errors clustered at the division level. This is an error in pre-registration materials, since standard errors should be clustered at the level of assignment, which is the zone level. We implement zone-level clustering for all standard errors that we report, aside from primary tests where we report the sharp null standard error.

Outcomes As noted in our pre-analysis plan, our secondary hypotheses pertained to resident satisfaction with waste services, but our ability to measure satisfaction and test these hypotheses depended on our ability to raise additional funds. We were ultimately unsuccessful in raising additional funds, so we are not able to test any of the H2 hypotheses.

We include two additional dependent variables in our primary analyses: a binary indicator variable for whether or not enumerators found a waste pile and a rank of waste pile size. The binary indicator of waste pile presence is not among the set of preregistered dependent variables, which include the change in total waste pile area (m^2) and the change in waste pile area along a number of characteristics (e.g. total change in burnt waste pile area). However, we feel justified in its use given the large potential for measurement error in our primary pre-registered dependent variable, change in waste pile size (m^2).

As noted previously, we undertook multiple rounds of data cleaning and verification to address seemingly implausible waste pile measurements taken during enumerator audits. When possible, we used enumerators' photos of waste piles to verify or alter the recorded pile size, but frequently we were forced to exclude waste piles from the analyses given the poor quality of enumerator pictures and implausibly large measures (likely made by recording centimeters instead of meters). Therefore, using the binary indicator of pile presence proved a logical choice when conducting our analyses. At each audit, enumerators recorded whether or not the waste pile had been cleaned up at each location; even poor quality photos can be used to corroborate the accuracy of these reports. Notably, too, we find no major difference in the results when using the preregistered dependent variables and the dummy "pile cleaned" variable. Across all variable specifications, treatment has no statistically significant effect on waste pile size or presence.

Because of the presence of significant outliers in the area measures that dramatically increase variance of the randomization distribution, we additionally examine the effects of treatment on pile size rank, which is less sensitive to outliers. The goal of using these unregistered outcomes was to ensure that we rule out concerns about statistical power in interpreting the null results of the field experiment to the extent possible.

E Scalar Values for Alternate Dependent Variables

At each midline audit, enumerators recorded observations on a number of pile characteristics. These observations included commenting on how piles were organized, the dispersion of waste at each pile location, and the evidence of waste burning at each pile location. Table 2 contains example responses to these prompts.

We turned these observations of pile characteristics into two sets of scalar values to generate more- and less-conservative estimates of uncontained, disorganized, and burnt pile area. These scalar values can be found in Table tab-scalars. Variable specification A is less-conservative than specification B. As Table E1 shows, specification A assign larger scalar values to less-severe observations of waste containment, organization, and burning. Conversely, specification B assigns larger scalar values to more-severe observations of waste containment, organization, and burning.

F KCCA Administrative Set-Up

There are five key positions within the KCCA Waste Management Unit (WMU) which are responsible for ensuring that all waste produced within Kampala is collected, transported and properly disposed of in landfills. These are the Supervisor – Solid Waste, Solid Waste Officer, Contract Manager, Fleet Supervisor and Solid Waste Scout.

The Supervisor – Solid Waste (hereafter referred as the Supervisor) is the person in charge

Table E1: Scalar Values, Alternate Dependent Variables

Variable Specification A

Characteristic	Abbreviated Response	Scalar
Waste Containment	Pile Cleaned	0.00
Waste Containment	Fully Contained	0.00
Waste Containment	Mostly Contained	0.33
Waste Containment	Mostly Uncontained	0.67
Waste Containment	Uncontained	1.00
Waste Organization	Pile Cleaned	0.00
Waste Organization	Fully Organized	0.00
Waste Organization	Mostly Organized	0.33
Waste Organization	Mostly Unorganized	0.67
Waste Organization	Unorganized	1.00
Waste Burning	Pile Cleaned	0.00
Waste Burning	No Burning	0.00
Waste Burning	Less than 50% burnt	0.45
Waste Burning	More than 50% burnt	0.55

Variable Specification B

Characteristic	Abbreviated Response	Scalar
Waste Containment	Pile Cleaned	0.00
Waste Containment	Fully Contained	0.00
Waste Containment	Mostly Contained	0.25
Waste Containment	Mostly Uncontained	0.75
Waste Containment	Uncontained	1.00
Waste Organization	Pile Cleaned	0.00
Waste Organization	Fully Organized	0.00
Waste Organization	Mostly Organized	0.25
Waste Organization	Mostly Unorganized	0.75
Waste Organization	Unorganized	1.00
Waste Burning	Pile Cleaned	0.00
Waste Burning	No Burning	0.00
Waste Burning	Less than 50% burnt	0.33
Waste Burning	More than 50% burnt	0.67

of the WMU. They are charged with creating an overall strategy, assigning responsibilities and overseeing the operations of the unit. All staff within the unit report directly or indirectly to the Supervisor.

The Solid Waste Officer is responsible for the day-to-day running of operations which deal with the collection and transportation of solid waste. Each Solid Waste Officer is in charge of a division – one of the key administrative units within Kampala. Each division has its own waste trucks, collection equipment, and personnel (including Fleet Supervisors and Solid Waste Scouts). The Solid Waste Officer manages all these, and reports directly to the Supervisor.

The Fleet Supervisor is a casual worker who works within a Division under the Solid Waste Officer. Their main task is to identify the most efficient routes to be taken by the garbage trucks so that there is maximum impact in terms of garbage collected. Trucks generally make stopovers in different locations to collect garbage. It is the job of the Fleet Supervisor to plan the most efficient routes and communicate them to the drivers. Even under the PPP model, this job exists to manage the collection by the KCCA of waste from public spaces and markets.

The Solid Waste Scout is a casual worker who works within a specific location within a Division. The scouts are tasked with collecting waste management related information. Examples include the locations of illegal dumps, the main complaints of residents, and the operations of private contractors. They report directly to the Solid Waste Officer and are supposed to be the "eyes and ears" of the officer in different parts of the city.

The Contract Manager is the person responsible for monitoring the compliance of private contractors. Under the PPP arrangement to waste management, Kampala was divided into six waste management service zones. Three contractors were awarded concessions, with each covering two zones. A Contract Manager was appointed to monitor operations in each of the waste management service zones. At the time of implementing the project, each of the Solid Waste Officers was appointed to be the Contract Manager for one of the zones, and the sixth zone has the Supervisor as the Contract Manager.

Information and Allocating Waste Services in Kampala

The KCCA designs its waste services in Kampala based on each zone's unique waste management needs. For instance, the KCCA will send additional clean-up crews to zones where illegal dumping is problematic, or coordinate with private contractors in zones reporting infrequent truck visits. This localized style of service provision relies on the KCCA's ability to uniformly monitor the delivery of waste services throughout Kampala. When determining where and how to allocate services, the KCCA relies on three primary sources of information.

First, the KCCA uses administrative records to inform its delivery of waste services. Using current and projected population data from the Ugandan Bureau of Statistics, the KCCA estimates the amount of waste production in each zone and adjusts its services accordingly. Relatedly, the KCCA has administrative records noting the date, weight, and origin of all waste deposited at its Kiteezi dumpsite. While an imperfect source of data due to non-uniform waste collection efforts across Kampala, the KCCA uses this data to assess the current and future waste service needs of zones across the city.

Second, the KCCA uses its staff located throughout Kampala to informally monitor waste conditions and service delivery. According to the former Solid Waste Unit Supervior, the KCCA employs up to 200 casual workers—known as KCCA Solid Waste Scouts—to report on a variety of problematic waste conditions, such as illegal dump sites, open sewers, or leaking drainage pipes. While never systematized, reporting from Scouts allows the KCCA to internally monitor waste management needs across Kampala and accurately deploy services when required. In the words of the current Supervisor: “I have a problem of illegal dumping. And I have my scouts. When they find a suspect, they use WhatsApp to send a message, I send a car to pick the suspect and take them to court" (interview J).

Finally, the KCCA engages with citizens to collect information on waste management throughout the city. Using a number of channels—e.g. Twitter, WhatsApp, a toll-free line, office walk-ins, community outreach events—the KCCA informally seeks feedback from citizens to help identify zone-specific waste management needs. KCCA staff initially viewed the citizen monitoring program as a way to augment this flow of information. [17]

G List of KCCA Interviews

A Solid Waste Officer, 02/05/2018

B Solid Waste Officer, 02/05/2018

C IT Support Staff, 02/05/2018

D Solid Waste Officer, 02/06/2018

E Solid Waste Officer, 02/06/2018

F Solid Waste Officer, 02/06/2018

G Supervisor - Solid Waste Department (Former), 02/06/2018

H Solid Waste Officer, 02/07/2018

I Solid Waste Officer, 02/07/2018

J Supervisor - Solid Waste Department (Current), 02/08/2018

[17] Citizen monitor reports contained responses to a series of prompts asking monitors about waste conditions and services in their neighborhood. For instance, one prompt asked “Does a rubbish truck come into your neighborhood?" with response option "A) No", "B) Yes", and "C) I don’t know.” For this question, responses A and C indicate responses indicate a shortfall in the delivery of waste services: the citizen monitor has not seen or cannot recall if she has seen a collection truck recently. Citizen monitor responses to each prompt were aggregated by zone and delivered to the KCCA as indicators of zone-level waste conditions and service quality.

H Spillover

To probe sensitivity of the results to spillover, we conduct additional analyses that expands the definition of the ways that each of the zones can be exposed to treatment. In particular, we specify that each zone can be exposed to *direct* treatment based on its own treatment assignment and *indirect* treatment based on a contiguous zone being assigned to treatment. We define exposure in this way because there are likely to be efficiencies in concentrating collection in nearby areas. Thus, if contiguous zones are treated and responses are made to complaints either in terms of oversight or cleanup, those responses are most likely to spill over to nearby zones.

Because zones differ in the number of contiguous zones, they have unequal probability of exposure to indirect treatment. Thus, we complete this analysis be weighting each observation by the inverse of the probability that they will be exposed to their realized direct and indirect treatment condition. We find no evidence that among zone eligible for indirect treatment that treatment effects are conditional on spillover.

Some zones in the experimental sample are not contiguous with any other zones in the experimental sample and thus have zero probability of being exposed to indirect treatment. These zones offer the cleanest test of the effect of treatment to the extent that spillover in the way we have specified it is present. We see some evidence in rank tests that zones ineligible for spillover (i.e., those that without contiguous zones in the experimental sample) that treatment had predicted treatment effects (Table H2). However, given that this is a small subset relative to sample of piles, that we find little evidence that these rank results are consistent with the treatment effect of direct-only exposure in Table H1, and that treatment effects are not consistent across different operationalization of the dependent variable, we interpret this result with caution.

Table H1: Spillover Results, Primary Dependent Variables (Cleaned)

	DV: Cleaned (0: Yes, 1: No), Pile Size (m^2), Pile Size Rank					
	M1 Cleaned	M1 Size	M1 Rank	M2 Cleaned	M2 Size	M2 Rank
	(1)	(2)	(3)	(4)	(5)	(6)
Control, Indirect	0.001	−8.929	10.280	−0.003	−68.330	3.391
	(0.029)	(9.014)	(16.978)	(0.042)	(57.618)	(14.049)
Treated, No Indirect	0.011	1.422	6.689	0.040	35.496	18.014
	(0.032)	(7.440)	(16.091)	(0.042)	(42.806)	(12.987)
Treated, Indirect	−0.020	2.461	−3.356	−0.047	−32.015	−26.016
	(0.033)	(4.667)	(15.679)	(0.046)	(24.755)	(16.075)
Constant	1.110***	−8.466	177.610**	1.045***	−18.548	218.074***
	(0.136)	(21.319)	(73.886)	(0.186)	(106.761)	(58.661)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes
Observations	575	575	575	575	575	575
F Statistic	1.746*	5.342***	9.497***	1.726*	5.009***	8.691***

Note: two-tailed tests; weighted by inverse probability of assignment to exposure type; baseline is [control, no indirect]; rank variables are specific to the subset. For a full set of variable descriptions, see notes in Table 1. *p<0.1; **p<0.05; ***p<0.01.

Table H2: No Spillover Results, Primary Dependent Variables (Cleaned)

	DV: Cleaned (0: Yes, 1: No), Pile Size (m^2), Pile Size Rank					
	M1 Cleaned	M1 Size	M1 Rank	M2 Cleaned	M2 Size	M2 Rank
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	−0.137	3.393	−18.615***	−0.047	−2.578	−15.123***
	(0.094)	(5.295)	(5.047)	(0.071)	(6.748)	(5.047)
P1/P2 Monitoring	0.769**	−9.556	23.420	0.562*	−28.749	−7.821
	(0.321)	(10.861)	(18.205)	(0.294)	(19.090)	(18.205)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes
Observations	104	104	104	104	104	104
F Statistic	1.067	26.758***	3.079***	0.786	3.316***	3.073***

Note: two-tailed tests; analysis on subset of zones with zero probability of indirect spillover; rank variables are specific to the subset. For a full set of variable descriptions, see notes in Table 1.
*p<0.1; **p<0.05; ***p<0.01.

I Additional Figures and Tables

This section contains additional tables and figures referenced in the main text but omitted because of space constraints.

Figure I1: Balance on pre-treatment covariates

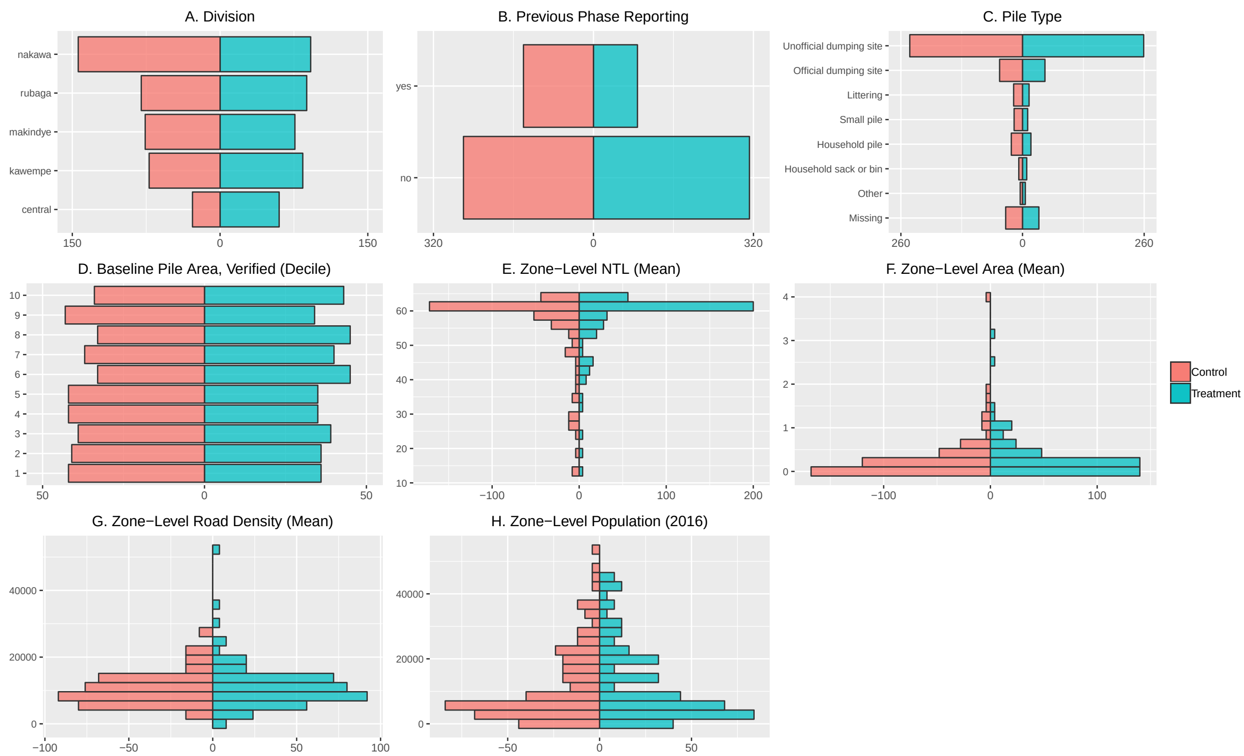

Figure Notes:

1. ***For Plot D:*** *to better visualize the data on pile sizes – which include significant outliers in both treatment and control groups – we placed piles into deciles based on their pile size. The first decile contained piles between 0 and 2* m^2*, the fifth decile contained piles between 7.5 and 9* m^2*, and the tenth decile contained piles between 50 and 3000* m^2*.*

2. ***For Plots E, F, G, and H:*** *figures use default binwidth specified by ggplot2.*

Table I1: RI Results, Primary Dependent Variables (Raw)

	Pile Size	Pile Size	Pile Cleaned	Pile Cleaned	Pile Rank	Pile Rank
Audit	M1	M2	M1	M2	M1	M2
Treatment Effect	16.57	-0.68	0	0	-10.57	-4.25
Standard Error	16.26	16.32	0.03	0.04	18.09	16.46
p-value	0.8	0.48	0.5	0.52	0.28	0.4
N	679	679	679	679	679	679

Note: results calculated using raw waste pile size measurements.

Description of Dependent Variables

1. ***Pile Size:*** *waste pile area (m^2), measured at the specified midline audit. Enumerators recorded waste pile dimensions at each audit. These dimensions were used to estimate waste pile area for each site in the sample.*
2. ***Pile Cleaned****: dummy variable indicating whether a waste pile was cleaned at the specified midline audit. Recorded values of 0 indicate that no pile was present at the given midline audit (e.g. the pile had been cleaned); recorded values of 1 indicate the opposite.*
3. ***Pile Rank****: waste pile size rank, calculated at the specified midline audit. Due to high variance in the recorded waste pile sizes, we perform a rank test comparing the ranked change in pile size between the baseline audit and each midline audit. Waste piles were ranked at each audit based on their size relative to other waste piles.*

Table I2: RI Results, Secondary Dependent Variables for Area (Raw)

(a) RI Results, Midline 1

	Storage	Storage	Organization	Organization	Burning	Burning
Variable Specification	A	B	A	B	A	B
Treatment Effect	16.35	16.3	16.35	16.34	-2.21	-2.28
Standard Error	16.15	16.08	16.18	16.09	0.87	0.99
p-value	0.79	0.79	0.8	0.8	0	0.01
N	679	679	679	679	679	679

Note: results calculated using cleaned waste pile size measurements.

(b) RI Results, Midline 2

	Storage	Storage	Organization	Organization	Burning	Burning
Variable Specification	A	B	A	B	A	B
Treatment Effect	16.3	-0.68	-0.34	-0.27	0.48	-1.23
Standard Error	16.08	14.53	16.28	16.49	3.25	3.28
p-value	0.8	0.47	0.49	0.49	0.55	0.36
N	679	679	679	679	679	679

Note: results calculated using cleaned waste pile size measurements.

Description of Dependent Variables

1. ***Storage:*** *estimate of uncontained waste pile area (m^2). At each midline audit, enumerators recorded how rubbish was stored in each waste pile. Responses ranged from "all of the rubbish is neatly contained with sacks or other containers" to "no rubbish is contained in sacks or containers." Each response was assigned a scalar between 0.0 and 1.0, which was multiplied against the recorded waste pile area to generate an estimate of uncontained waste pile area.*

2. ***Organization:*** *estimate of unorganized waste pile area (m^2). At each midline audit, enumerators recorded the dispersion of rubbish in each waste pile. Responses ranged from "all of the rubbish is collected in a single pile" to "rubbish is spread all around [with] no evidence of the rubbish being organized." Each response was assigned a scalar between 0.0 and 1.0, which was multiplied against the recorded waste pile area to generate an estimate of unorganized waste pile area.*

3. ***Burning:*** *estimate of burnt waste pile area (m^2) from midline 1 to midline 2. At each midline audit, enumerators recorded any evidence of burning they observed at each waste pile. Responses ranged from "no evidence of burning" to "more than half of the area of the rubbish pile contains evidence of burning." Each response was assigned a scalar between 0.0 and 1.0, which was multiplied against the recorded waste pile area to generate an estimate of burnt waste pile area.*

Variable specification A is less conservative than variable specification B. Specification A assigns a smaller scalar score to enumerator responses indicating less organization/storage and more burning.

Table I3: Treatment Effect of Citizen Reporting Conditional on the Party Affiliation of the Division Councillor Elected in 2016.

	DV: Status (0/1) or Waste Pile Size (m^2)			
	M1 Cleaned	M1 Size	M2 Cleaned	M2 Size
	(1)	(2)	(3)	(4)
Treatment	−0.029	−0.810	−0.018	11.626
	(0.059)	(0.887)	(0.077)	(0.251)
Indepedent	−0.081	0.043	−0.016	3.016
	(0.063)	(0.993)	(0.080)	(0.606)
Opposition	−0.075	17.006	0.029	4.222
	(0.063)	(0.255)	(0.085)	(0.693)
Baseline Pile Area		0.194***		0.062
		(0.0001)		(0.126)
Treatment X Indepedent	0.046	−1.713	−0.013	−13.613
	(0.094)	(0.818)	(0.113)	(0.357)
Treatment X Opposition	0.021	−14.037	−0.078	24.704
	(0.085)	(0.322)	(0.111)	(0.450)
Covariates	Yes	Yes	Yes	Yes
Observations	407	407	407	407
R^2	0.063	0.240	0.034	0.026
Adjusted R^2	0.032	0.213	0.003	−0.009
Residual Std. Error	0.318	40.909	0.425	106.380
F Statistic	2.022**	8.859***	1.078	0.752

Note: two-tailed tests — *p<0.1; **p<0.05; ***p<0.01

Table I4: Estimated Effects of Treatment Conditional on Zone-Level Response Rate

	DV: Cleaned (0: Yes, 1: No) or Waste Pile Size (m^2)			
	M1 Cleaned	M1 Size	M2 Cleaned	M2 Size
	(1)	(2)	(3)	(4)
Response Rate	0.283	−12.831	−0.043	−31.552
	(0.272)	(22.332)	(0.300)	(55.359)
Baseline Pile Area		0.165		0.080*
		(0.101)		(0.041)
P1/P2 Monitoring	0.100*	−0.433	−0.019	−8.463
	(0.053)	(2.958)	(0.068)	(10.114)
Covariates	Yes	Yes	Yes	Yes
Observations	344	344	344	344
R^2	0.059	0.218	0.023	0.018
Adjusted R^2	0.030	0.192	−0.007	−0.015
Residual Std. Error	0.336	30.914	0.407	117.148
F Statistic	2.075**	8.433***	0.777	0.554

Note: two-tailed tests *p<0.1; **p<0.05; ***p<0.01

Table I5: Estimated Effects of Treatment Conditional on Baseline Quality of Service Provision

	DV: Cleaned (0: Yes, 1: No) or Waste Pile Size (m^2)			
	M1 Cleaned	M1 Size	M2 Cleaned	M2 Size
	(1)	(2)	(3)	(4)
Reported Service Quality	0.043	−0.858	0.027	21.762
	(0.045)	(3.905)	(0.056)	(14.978)
Baseline Pile Area		0.165		0.083**
		(0.101)		(0.039)
P1/P2 Monitoring	0.100**	−0.316	−0.016	−6.044
	(0.051)	(2.973)	(0.068)	(9.805)
Covariates	Yes	Yes	Yes	Yes
Observations	344	344	344	344
R^2	0.057	0.218	0.024	0.024
Adjusted R^2	0.029	0.192	−0.006	−0.008
Residual Std. Error	0.336	30.930	0.406	116.769
F Statistic	2.022**	8.394***	0.805	0.754

Note: two-tailed tests *p<0.1; **p<0.05; ***p<0.01

Table I6: Estimated Effects of Treatment Conditional on Zone-Level Dissatisfaction at Baseline

	DV: Cleaned (0: Yes, 1: No) or Waste Pile Size (m^2)			
	M1 Cleaned	M1 Size	M2 Cleaned	M2 Size
	(1)	(2)	(3)	(4)
Dissatisfaction	0.058	−0.536	0.019	32.067
	(0.044)	(4.397)	(0.062)	(26.648)
Baseline Pile Area		0.163		0.067
		(0.103)		(0.042)
P1/P2 Monitoring	0.072	−0.594	−0.043	−13.759
	(0.051)	(3.078)	(0.069)	(13.123)
Covariates	Yes	Yes	Yes	Yes
Observations	328	328	328	328
R^2	0.059	0.243	0.026	0.029
Adjusted R^2	0.029	0.216	−0.005	−0.005
Residual Std. Error	0.333	28.368	0.405	114.301
F Statistic	1.973**	9.207***	0.832	0.844

Note: two-tailed tests *p<0.1; **p<0.05; ***p<0.01

Table I7: Treatment Effect of Citizen Reporting Conditional on Consistency of Zone-Level Reports on Service Quality

	DV: Cleaned (0: Yes, 1: No) or Waste Pile Size (m^2)			
	M1 Cleaned	M1 Size	M2 Cleaned	M2 Size
	(1)	(2)	(3)	(4)
Inconsistency	−0.066	−8.310	−0.339	−131.438
	(0.221)	(19.395)	(0.313)	(120.071)
Baseline Pile Area		0.166		0.092**
		(0.101)		(0.043)
P1/P2 Monitoring	0.097*	−0.123	−0.014	−6.156
	(0.051)	(3.002)	(0.067)	(8.908)
Covariates	Yes	Yes	Yes	Yes
Observations	344	344	344	344
R^2	0.054	0.218	0.027	0.025
Adjusted R^2	0.026	0.192	−0.002	−0.007
Residual Std. Error	0.336	30.926	0.406	116.734
F Statistic	1.913**	8.405***	0.919	0.772

Note: two-tailed tests *p<0.1; **p<0.05; ***p<0.01

We use data from baseline surveys deployed in treated zones to measure the consistency of citizen-monitor reports within zones. We construct our overall measure of service quality using information from the baseline surveys on the following: the frequency and accessibility of service provision, reported waste collector treatment of citizens outlined, and the amount of waste burning or litter. The variable "Inconsistency" measures the proportion of reports that citizen monitors submitted which disagreed with their zone-level modal response. To construct this measure, we take a weekly count of the citizen reports, per question, that are inconsistent with the modal report within a given zone. We then sum these weekly-question counts over the entire study period, resulting in a total count of inconsistent responses that originated from each treated zone. Finally, we divide the number of inconsistent responses by the total responses from each zone to calculate the proportion of inconsistent responses at the zone-level.

Table I8: Treatment Effect of Citizen Reporting Conditional on Distance (km) to Nearest KCCA Division HQ

	DV: Cleaned (0: Yes, 1: No) or Waste Pile Size (m^2)			
	M1 Cleaned	M1 Size	M2 Cleaned	M2 Size
	(1)	(2)	(3)	(4)
Treatment	−0.141	−0.025	−5.962	−0.040
	(5.490)	(0.060)	(13.625)	(0.075)
Distance	5.426**	−0.0002	3.307	−0.011
	(2.753)	(0.019)	(4.852)	(0.022)
Baseline Pile Area	0.128**	−0.0001	0.158**	−0.0002*
	(0.055)	(0.0001)	(0.064)	(0.0001)
P1/P2 Monitoring	−1.081	0.050*	−14.355	−0.006
	(3.262)	(0.030)	(10.894)	(0.038)
Treatment*Distance	−1.660	0.009	−0.746	0.015
	(2.051)	(0.021)	(3.264)	(0.023)
Covariates	Yes	Yes	Yes	Yes
Observations	679	679	679	679
R^2	0.159	0.034	0.041	0.024
Adjusted R^2	0.142	0.015	0.023	0.005
Residual Std. Error	42.592	0.335	138.586	0.407
F Statistic	9.645***	1.777**	2.213***	1.251

Note: two-tailed tests *p<0.1; **p<0.05; ***p<0.01

Table I9: Treatment Effect of Citizen Reporting Conditional on Travel Time (min.) to Nearest KCCA Division HQ

	DV: Cleaned (0: Yes, 1: No) or Waste Pile Size (m^2)			
	M1 Cleaned	M1 Size	M2 Cleaned	M2 Size
	(1)	(2)	(3)	(4)
Treatment	−2.055	−0.023	−11.997	−0.056
	(5.216)	(0.065)	(19.969)	(0.083)
Travel Time	3.453*	0.004	0.575	0.006
	(1.894)	(0.016)	(2.874)	(0.019)
Baseline Pile Area	0.128**	−0.0001	0.158**	−0.0002*
	(0.055)	(0.0001)	(0.064)	(0.0001)
P1/P2 Monitoring	−1.620	0.050*	−14.651	−0.007
	(3.216)	(0.030)	(11.015)	(0.038)
Treatment*Travel Time	−0.769	0.006	1.119	0.015
	(1.478)	(0.016)	(2.576)	(0.019)
Covariates	Yes	Yes	Yes	Yes
Observations	679	679	679	679
R^2	0.156	0.034	0.041	0.026
Adjusted R^2	0.140	0.015	0.023	0.007
Residual Std. Error	42.646	0.335	138.599	0.407
F Statistic	9.491***	1.788**	2.202***	1.347

Note: two-tailed tests — *p<0.1; **p<0.05; ***p<0.01

Table I10: Summary Statistics, Variables in Tables 1, I1

	Variable	Mean	Min	Max	Modal
Outcomes	Pile Size, M1 (m^2)	18.29	0.00	600.00	-
	Pile Size, M2 (m^2)	25.65	0.00	2500.00	-
	Pile Dummy, M1	0.86	0	1	-
	Pile Dummy, M2	0.78	0	1	-
Covariates	Division	-	-	-	Nakawa
	P1/P2 Monitoring	0.33	0	1	-
	Pile Area, Baseline (m^2)	38.10	0.50	2000.00	-
	Zone-NTL ($nWcm^{-2}sr^{-1}$)	55.66	12.33	63.00	-
	Zone-Road Density (km/km^2)	10776.94	833.87	53072.92	-
	Zone-Area (km^2)	0.34	0.01	4.00	-
	Zone-Population	12668.83	45.00	53662.00	-

Table I11: RI Results, Diff-in-Diff, Pile Size (Cleaned)

	Pile Size (m^2)
Treatment*Post-Treatment	4.48
Standard Error	8.56
p-value	0.69
N	2037.00

Note: results calculated using cleaned waste pile size measurements.

J Reverse Power Analysis

Our primary hypothesis was that citizen reporting would decrease the size of informal waste piles. We did not find consistent evidence of this effect, whether considering reduction in size, a binary indicator of pile presence, or the rank of pile sizes (see Table 1). In light of the null effect for our main hypothesis and its various operationalizations, we examine the power of these tests to detect a treatment effect of pile reductions using simulations.

First, we assume that the outcome data revealed are generated by a sharp null process where each pile will take the same size regardless of treatment condition. We then add various average treatment effects to the revealed data according to a pile clean up process. In particular, we calculate the total amount of pile size reduction that would result in various average treatment effects (e.g., for 10 treated piles with an assumed ATE of $-2m^2$, the total amount of reduction is $-20m^2$). We specify an algorithm that cleans up piles in random order in hypothetical draws of the treatment group until the total treatment effect is reached (the final pile in the series is partially cleaned). We use the resulting pile sizes to re-calculate binary indicators of pile presence and pile size rank in each iteration. For each specified ATE, we consider whether the pile size, pile presence, and rank tests on these hypothetical data are able to reject the null hypothesis of zero effect with at least 0.8 probability, a common target for statistical power. Table J1 displays the minimum ATE in pile size reduction that will translated to sufficient power for each of the three tests in Table 1, along with their interpretation as standard effect sizes. We see that almost all of the tests have low minimum detectable effects. Because of outliers in the Midline 2 pile sizes, there is no effect less than than mean pile size that reaches target power. However, the binary and rank tests have sufficient power.

Table J1: Minimum Detectable Effects (m^2)

	Pile Size	Pile Present	Pile Rank
Midline 1	-8.4	-1.9	-2.7
	(0.15)	(0.03)	(0.05)
Midline 2	–	-1.8	-2.6
	–	(0.01)	(0.02)

Notes: Table displays minimum detectable effects in (m^2) for each of the tests in Table 1, assuming random pile cleaning process described above. These effects are transformed into standardized effect sizes by dividing by the standard deviation of the control group in parentheses.

K Example KCCA Action Plan

For the first four weeks of the study period, the KCCA waste management unit created action plans to respond to the reports from citizens. These reports show that responses were specifically formulated at the zone-level and based on the delivery of reports from the platform.

Action Plan Week 2-Phase 3

KAWEMPE DIVISION

Title	**Improving waste collection services in Kawempe division**		
Outline of (1) Area and (2) Your office	Kawempe division Solid waste management office		
Problems and Causes	**Problems**		**Causes**
	Inadequate information about presence of garbage truck		Low commitment by local leaders
	Inaccessible areas in Kisalosalo Kyebando		Limited communication strategies.
	Behavioral change is slow		Low enforcement on poor waste management practices.
			Limited resources to diversify behavioral change communication strategies.
Stakeholders	LC, area councilors,SWMO, fleet supervisor community members and the enforcement,		
Final Goal	**Having a garbage free environment**		
Step by Step Goal	1st Step	Intensifying sensitization in Mpererwe on privatization of waste collection services.	
	2nd Step	Empowering local leaders to trigger community participation in proper waste management	
	3rd Step	Choosing a focal person in areas far from the roadside (Kyebando central).	

Action Plan Week 2-Phase 3

<table>
<tr><td></td><td>4th Step</td><td colspan="2">Call the complainant about waste disposal in channel, in Jambula make do inspection, issue nuisance and follow up and about</td></tr>
<tr><td></td><td>5th Step</td><td colspan="2">Call the complainant and carry out a community assessment of the sanitation situation in JAKANA (Nabukalu zone).</td></tr>
<tr><td></td><td>6th step</td><td colspan="2">Enforce where the residents do not want to bring garbage on trucks.</td></tr>
<tr><td>Duration</td><td colspan="3">13th – 6th March,2017</td></tr>
<tr><td rowspan="5">Activities & Responsible Organization</td><td colspan="2">Activities</td><td>Responsible Organization</td></tr>
<tr><td colspan="2">Mobilization the community
Liaising with community leaders to coordinate with residents who leave far from the road.</td><td>KCCA-solid waste management</td></tr>
<tr><td colspan="2">Sensitization meetings in the zones
Increase cleaning exercises in communities</td><td>KCCA -solid waste management</td></tr>
<tr><td colspan="2">Monitoring of compliance on proper solid waste management practices.</td><td>KCCA -solid waste management</td></tr>
<tr><td colspan="2">Calling individual complainants</td><td>Solid waste management officer</td></tr>
</table>

Action Plan Week 2-Phase 3

Your own role in the Project	• Mobilize and facilitate community meetings on waste management • To intensify garbage collection services and communicate the programme for deployment of garbage trucks. • Using different communication strategies to disseminate policies and solid waste ordinance.

MAKINDYE DIVISION

Title	Solid Waste Management in Makindye Division	
Outline of (1) Area and, (2) Your office	(1) Kibuye, Katwe, Ggaba, Kibuye ii, Kisugu, Wabigalo, Luwafu, (2) Solid waste management office.	
Problems and Causes	Problems	Causes
	Burning of Rubbish. Throwing garbage in a ditch. Throw in a rubbish in a pile. Delayed waste collection Piles Uncollected heaps	• Lack of better solid waste disposal ways • Negligence of key stakeholders such as landlords • Lack of waste bins/gunny bags • Poor road network in Kisugu and Kibuye ii. • Failure of residents to pay for services.

	of garbage.	• Failure of the concessionaire to make a timely follow up. • Inadequate information tools • Communication gap between the service provider and customers.
Stakeholders	KCCA SWMO, concessionaire, key informants, leadership structures.	
Final Goal	Avail timely and affordable garbage collection services.	
Step by Step Goal	1st Step	Induction of stake holders to latest modalities of waste management
	2nd Step	Enhance sensitization program on PPP and upscale community engagement
	3rd Step	Reinforce the concessionaire approach and entry points into the communities
Duration	Three(3) weeks(from 14th February to 7th March 2017)	
Activities & Responsible Organization	Activities	Responsible Organization
	Consultation and coordination meetings with stakeholders	Local leadership, SWMO, Homeklin. Ward administrators
	Door to door sensitization on proper solid waste management.	SWMO, Homeklin.

Action Plan Week 2-Phase 3

	Issuance of Nuisance Notices.	SWMO
Your own role in the Project	Effective supervision on private companies and sharing of waste management models	
Points to keep in mind (Your Policy)	Increased volume of garbage collected	

CENTRAL DIVISION

Title	SOLID WASTE MANAGEMENT-CENTRAL DIVISION	
Outline of (1) Area and (2) Your office	(1) Market area-Kamwokya, Rubaga road B, Sapoba, Village D-Kamwokya, Industrial area, Mengo Flats, Jambula, Kifumbira 1&2, Kakajo-Kisenyi and Kakajo 1-Bukesa, Kisenyi II, Namalwa II, Nanozi, Old Kampala I (2) Solid waste management office-Feedback from Citizen monitoring dated 9th February ,2017	
Problems and Causes	Problems	Causes
	1. Not happy with the rubbish collection services	• Garbage trucks taking long to collect garbage • High charges levied by private garbage collectors • Burning rubbish is because they are ignorant of the solid waste ordinance.

Action Plan Week 2-Phase 3

	2. Common practice of disposing of waste	• People are also not sensitized on the dangers of burning rubbish
Stakeholders	Local leaders, the community, SWMO, Field scouts, fleet supervisors, private garbage collection companies in the area.	
Final Goal	To increase garbage collection in all zones of the division	
Step by Step Goal	1st Step	• Continued sensitization on the new solid waste PPP, explaining and guiding on prices charged • Sensitization on the dangers of burning waste and the solid waste ordinance will be done
	2nd Step	• Engage private companies to increase on garbage collection; use a system of going deep into the communities on foot and bring waste where it can be accessed. • Engaging field supervisors and scouts to ensure garbage in communities is taken away in the right manner. • Carry out sensitization on illegal dumping especially in drainage channels.

Action Plan Week 2-Phase 3

		• Engage private companies to introduce garbage collection schedules for communities
	3rd Step	Monitoring compliance to the above
Duration	2 weeks (from 14th -28th February 2017)	
Activities & Responsible Organization	Activities	Responsible Organization
	Sensitization meetings on solid waste management in communities	KCCA
	Engagement of private companies on the highlighted challenges	KCCA/PRIVATE COMPANIES
	Mediation meetings between concessionaires and clients	KCCA/PRIVATE COMPANIES
Your own role in the Project	• To engage the parties involved on the highlighted issues • To create a team to monitor compliance to the above	
Points to keep in mind (Your Policy)	• Oversee complete garbage collection in the highlighted areas • Supervise compliance to the above	

NAKAWA DIVISION

Action Plan Week 2-Phase 3

Title	Improving waste collection services in Nakawa division	
Outline of (1) Area and (2) Your office	Banda B6,Upper Estate ki21, Kyanja Kondogoro, UPK Unise, Bukoto 1 Katende A Solid waste office	
Problems and Causes	Problems	Causes
	Irregular garbage collection	• Inaccessibility • Lack of enough resources
Stakeholders	Ward administrators ,LC, area councilors and SWMO	
Final Goal	Having door to door service	
Step by Step Goal	1st Step	Organize cleanups in inaccessible places
	2nd Step	Partnering with local leaders to ensure communities manage their garbage well
	3rd Step	Intensify community sensitization
	4th step	Engage the Kampala solid waste management consortium to collect from all residents in the mentioned areas.
Duration	3 weeks (from 14th February-7th March 2017)	
Activities & Responsible Organization	Activities	Responsible Organization
	Mobilization	KCCA
	Holding Sensitization meeting with the community heads.	KCCA and local leaders
	Carrying out clean ups	KCCA and local leaders
	Ensure that clients get a	Kampala Solid Waste

	door to door service	Management Consortium
Your own role in the Project	• To carry out community cleanups in communities that are not accessible • Coordinate sensitization programmes	

LUBAGA DIVISION

Title	Improving waste collection services in Lubaga division	
Outline of (1) Area and (2) Your office	Lugala, Kawaala, Kyobe Solid waste management office	
Problems and Causes	Problems	Causes
	Garbage burning	Lack of awareness
	Garbage piles	• Political sabotage of PPP. • Delays in collection of waste especially in Lugala
Stakeholders	Ward administrators ,LC, area councilors ,SWMO and fleet supervisors	
Final Goal	Garbage free and non-polluted community.	
Step by Step Goal	1st Step	Sensitization in Kyobe zone.
	2nd Step	Organize Clean ups
	3rd step	Follow up on non-compliance with PPP
Duration	3 weeks (from 14th February-7th March 2017)	

Action Plan Week 2-Phase 3

	Activities	Responsible Organization
Activities & Responsible Organization	Clean ups	KCCA
	Holding sensitization meetings with the community heads.	KCCA and local leaders
Your own role in the Project	Intensify supervision and monitoring of the activities of the concessionaires	