SOLID WASTE ACCOUNTABILITY PLATFORM
Non-Recurring Deliverables

Activity 4.5: Complete Data Analysis & Findings Report

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CONTENTS

CONTENTS 2

ACRONYMS AND ABBREVIATIONS 4

1. EXECUTIVE SUMMARY 5

SWAP INTERVENTION 5
KEY FINDINGS 8
CONSTRAINTS AND LIMITATIONS 9
POLICY IMPLICATIONS AND RECOMMENDATIONS 9

2. CONTEXT AND DEVELOPMENT CHALLENGE 12

3. SWAP OVERVIEW 13

WASTETRACKER APP TREATMENT 14
WASTETRACKER REPORT TREATMENT 17

4. EVALUATION METHODS 19

EVALUATION DESIGN 19
SAMPLING 20
ENDLINE DATA COLLECTION 22
OUTCOME INDICATORS 27
ANALYTICAL APPROACH 28
LIMITATIONS AND CAUTIONS 30

5. APP UPTAKE 31

FACTORS DRIVING LOW APP ENGAGEMENT 35

6. OUTCOME FAMILY 1: WASTE DISPOSAL METHODS 38

SUMMARY OF KEY FINDINGS 38
TRENDS OVER TIME 38
PRIMARY RESULTS 40

7. OUTCOME FAMILY 2: OPINIONS ON WASTE ISSUES 42

SUMMARY OF KEY FINDINGS 42
TRENDS OVER TIME 42
PRIMARY RESULTS 44

8. OUTCOME FAMILY 3: ACCOUNTABILITY AND RESPONSIVENESS 46

SUMMARY OF KEY FINDINGS 46
TRENDS OVER TIME 46
PRIMARY RESULTS 47

9. OUTCOME FAMILY 4: WILLINGNESS TO PAY 48

SUMMARY OF KEY FINDINGS 48

Trends over time 48
Primary Results 49

10. OUTCOME FAMILY 5: VILLAGE CLEANLINESS 51

Summary of Key Findings 51
Trends over time 51
Primary Results 52

11. ADDITIONAL ANALYSIS OF SURVEY EXPERIMENTS 53

List Experiment on Elections 53
List Experiment on Payment for Waste Collection Services 55
Conjoint Experiment on Public Services 57

12. RECOMMENDATIONS AND LESSONS LEARNED 59

13. ANNEX I: TELEPHONE PROMOTION SCRIPT 61

14. ANNEX II: BASELINE DIFFERENCE-IN-MEANS TABLES 62

15. ANNEX III: DIFFERENCE-IN-DIFFERENCES PLOTS 64

ACRONYMS AND ABBREVIATIONS

App	Smartphone Application
APSARA	Authority for the Protection of the Site and Management of the Region of Angkor
CINTRI	CINTRI (Cambodia) Ltd.
COMPOSTED	Cambodian Education and Waste Management Organization
COVID-19	Coronavirus SARS-CoV2
DevLab	DevLab@Duke University
GAEA	Global Action for Environment Awareness
ICC	Intra Cluster Correlation
IE	Impact Evaluation
ISAF	Implementing Social Accountability Framework
KC	Kampong Cham
MDES	Minimum detectable effect size
M&E	Monitoring and Evaluation
NGO	Non-Governmental Organization
PSU	Primary Sampling Unit
RCT	Randomized Control Trial
RDS	Realtime Data Solutions
SR	Siem Reap
SS	Stueng Saen
SWAP	Solid Waste Accountability Platform
SWM	Solid Waste Management
SWSP	Solid Waste Service Providers
TAF	The Asia Foundation
TE	Triangle Environmental
USAID	United States Agency of International Development
VA	Voice Ambassador

1. EXECUTIVE SUMMARY

Cambodia's rapid growth and urbanization have generated increasing problems with municipal solid waste, its disposal, and the government's role in the collection and treatment of garbage. Both the Royal Government of Cambodia and citizens have highlighted uncollected solid waste and irregular collection as key threats to their health and welfare.[1] However, even as this problem continues to gain national and international attention, many local governments do not have the technical support and resources to fully address their waste management responsibilities.

Three development challenges are thought to inhibit municipal governments' oversight and management of private waste management providers: logistical challenges, lack of accountability to citizens, and lack of information. Municipal governments are unable to engage in high quality waste management because of inadequate waste disposal equipment or because citizens do not throw out their garbage properly, making it too difficult or costly to collect and dispose of waste. Municipal governments also may choose not to oversee waste management adequately because of inexperience. Finally, municipal governments may not have the information required to fulfill their waste management oversight role.

The Solid Waste Accountability Platform (SWAP) aimed to address these problems by bringing timely information on waste collection issues to responsible government officials and waste management companies, providing citizens with a tool to pinpoint exactly where and what types of problems they observed. Because policy and service issues can be sensitive in Cambodia, the project developed a mobile phone application (app), where citizens could anonymously report information directly to project hubs in the offices of waste management companies and indirectly to local government officials through public reports posted to Telegram channels, a mobile chat application to which they were subscribed. Citizens could also identify themselves in their reports, if they wished.

SWAP intervention

In light of Cambodia's continual challenges with solid waste management (SWM), the Solid Waste Accountability Platform (SWAP), funded by United States Agency of International Development (USAID) and led by Triangle Environmental Health Initiative (TEHI) in partnership with the DevLab@Duke University, The Asia Foundation (TAF), The Environment Education and Recycling Organization (COMPOSTED), and Waste Voice (WV), took an innovative and collaborative approach to improving municipal solid waste collection and management. The project was implemented from October 2019 to October 2022 in three urban centers of Cambodia: Siem Reap (SR), Stueng Saen (SS) and Kampong Cham (KC), as shown in Figure 1. Working with private waste collection firms, local stakeholders, and residents, the SWAP

[1] See the Sub-decree 113 on Management of Garbage and Solid Waste of Downtowns put forth by the Royal Government of Cambodia on August 27, 2015, which cites citizen satisfaction with solid waste management and lays out plans for addressing the issues. (https://www.ajne.org/sites/default/files/resource/laws/7216/sub-decree-113-on-garbage-and-municipal-waste_management-translated.pdf).

intervention aimed to increase the accountability and responsiveness of service providers, operating at the municipal level of government, by developing a mechanism for citizen-led oversight of the waste service sector.

Originally, the project comprised two primary treatments:

1. ***WasteTracker* App:** The first treatment entailed the development of a mobile application, *WasteTracker,* allowing users to pinpoint unresolved waste collection problems and other waste issues on a map of their community. They were also able to label the type of solid waste problem (illegal dumping or burning, uncollected bins, etc.). Solid waste service providers (SWSP) had terminals allowing them to see the issues reported by the community and respond to them, as well as publicly update the status of the issue. Issues and resolution statuses were aggregated into a public-facing report on a monthly basis and disseminated to public officials in the sangkat and municipality through a Telegram channel. Households receiving the *WasteTracker* App Treatment received a phone call informing them of the existence of the app, inviting them to download the app, and assisting them with downloads and usage.

2. **Community meetings:** The second treatment intended to combine the *WasteTracker* app with a community meeting, in which citizens residing in the same block would be brought together to discuss waste collection issues and to brainstorm potential communal decisions that might improve service delivery through cost-sharing and collective efforts.

   However, the onset of the COVID-19 pandemic in early 2020 and the ensuing risks associated with face-to-face interactions posed substantial challenges for the implementation of the intervention as planned. Both safety concerns and government restrictions necessitated the abandonment of the community meetings treatment and any activities involving sustained in-person interaction. The following treatment was implemented instead of the Community Meetings treatment:

2. ***WasteTracker* Report:** This treatment entailed the delivery of a hard-copy report to the home of a randomly sampled set of baseline respondents. The report provided information on the number of waste issues reported in their community on the *WasteTracker* app along with a website URL and QR code directing residents to the *WasteTracker* website for more information about the performance of the SWSP in their community.

The SWAP intervention was implemented in 20 sangkats, 129 villages, 540 blocks (community neighborhoods), and 5,000 households across the three municipalities. Given significant heterogeneity in the size of villages across the study areas, the block served as the primary

sampling unit (PSU) for this project. The size of a block is equal to the size of the smallest "normal" village within the sample,[2] or approximately 100 households.

The *WasteTracker* App Treatment was assigned at the level of the block, with 2,281 households receiving a phone call inviting them to download the *WasteTracker* app, and 2,731 households assigned to the control group. The assignment of the *WasteTracker* Report Treatment was "cross-randomized" at the level of the household, such that household treatment status for the Report Treatment is independent of a household's treatment status for the App Treatment.

This report presents the results of an impact evaluation (IE) of the two interventions implemented by SWAP: the *WasteTracker* application ("App Treatment") and the dissemination of the *WasteTracker* report ("Report Treatment"). The objective of this report is to determine the effectiveness of the interventions in meeting the project's three objectives:

Objective 1: To improve solid waste service provision in urban Cambodia.

Objective 2: To increase municipal government and solid waste service provider accountability in Cambodia's solid waste sector.

Objective 3: To provide an inexpensive and scalable framework for such an improvement outside of the municipalities enrolled in the project.

The analysis for the report relies primarily on an endline survey of 5,012 households across three municipalities; 75% of those households were able to be interviewed in both the baseline and endline surveys, producing a household panel dataset with 3,478 households. The data from the household surveys is supplemented with several additional data sources, including: longitudinal data from an observational survey of waste issues in 246 blocks from March 2021 to June 2022; a panel dataset of the village chief or deputy village chief from 122 villages; high frequency usage and engagement data from the *WasteTracker* app; and information from key informant interviews conducted with 26 SWSPs, municipal authorities, and Sangkat leaders both at baseline and endline.

To assess the impact of the SWAP intervention, we develop five "outcome families," or thematic groupings of potential effects of the intervention: Waste Disposal Methods, Opinions on Waste Issues, Accountability and Responsiveness, Willingness to Pay for Waste Services, and Village Cleanliness. The primary indicators within each of the outcome families are derived from the household panel data set, with the exception of the final two indicators for the Village Cleanliness outcome category, which are drawn from the village chief panel dataset and the observational data respectively.

[2] We define "normal" as being outside the range of severe outliers in the data. The sangkat of Kampong Thom in Stueng Saen has multiple villages with very few households. In practice, these were combined to create one block of approximately 100 households.

We support the primary analysis with descriptive statistics based on the household panel, as well as with analysis of the observational survey and village chief survey. Additionally, we report the findings of three survey experiments pertaining to households' willingness to use elections as a tool of accountability, the rate of non-payment for formal waste collection services, and household's propensity to rely on various officials for accessing public services. Finally, we incorporate qualitative findings from key informant interviews throughout the report.

Key Findings

The evaluation finds:

- There is widespread citizen awareness of SWAP among households in the study, and a relatively impressive 6.5% of all households in the panel dataset downloaded the app; that rose to 9.4% among households that received both the App and Report Treatments.
- High download rates did not translate into high usage rates among panel households, who were surveyed at endline. Less than 1% of surveyed households used the app to make a report, and the platform only received 29 total issues from households in the study. Of those 29 issues, 7 were resolved by the service provider.
- Data from the *WasteTracker* app indicates that app usage in the general population was higher than indicated from the panel dataset: 122 waste issues were reported on the app during the study period, with weekly opens of the app peaking at 650 users in June 2022.
- We find a large increase in the use of formal collection services and reduction in the use of illegal waste disposal methods from baseline to endline, but neither of the treatment arms had an observable effect that was greater than control group.
- The App and the Report Treatment both had a negative impact on households' consideration of cleanliness when choosing their method of waste disposal. The App Treatment also had a negative impact on households' consideration of the environment when disposing of waste.
- We find mixed evidence on the effect of the treatments on the frequency of waste collection. Those who received the App Treatment report significantly *more* frequent waste collection, while those who received the Report Treatment report significantly *less* frequent waste collection.
- Between baseline and endline, there is a general improvement in citizen attitudes toward waste issues. Those improvements were not, however, a result of either the App or Report Treatments.
- The App Treatment has a *negative* effect on citizen attitudes toward waste. Treated households are 6-7% *less* likely to agree that burning trash or dumping it on the road is disrespectful, and they are less likely to agree that waste disposal is an important issue and that one should not litter.
- Neither the App nor Report Treatments have any measurable impact on citizen perceptions of service satisfaction or the responsiveness of service providers in terms of the frequency of collection or improvements in the perceived quality of service.
- Between baseline and endline, there is a noteworthy increase in citizens' willingness to pay for both home and neighborhood collection of waste. But neither the App nor Report treatments contributed to these positive trends. The App Treatment actually has a

statistically significant *negative* effect on the willingness of households to pay for neighborhood collection. In other words, willingness to pay increased for all respondents over the study period, but increased at a slower rate among those receiving the App Treatment.

- We find that neither the App nor the Report Treatments have a statistically significant impact on village cleanliness as reported by citizens, village officials, or as measured in the observational survey.

Constraints and Limitations

The evaluation faced several challenges that limited our capacity to assess SWAP as originally designed. First, COVID-19 imposed significant constraints on the project. In light of rolling lockdowns and local ordinances associated with the pandemic, the implementation team was unable to disseminate the app through face-to-face interactions as envisioned in the IE design report. In lieu of face-to-face promotion to treatment households, the implementation and evaluations teams decided to promote the app as broadly as possible, including via market kiosks and over Facebook. This broad dissemination is likely to have led to spillovers, in which households outside of the App Treatment blocks or households which did not receive the Report Treatment were plausibly aware of *WasteTracker* and the related programming. These spillovers likely reduce our capacity to find a significant effect of the program through the App Treatment described below, since households in the control group may have heard of *WasteTracker* via Facebook or other advertising. If anything, however, this should have militated in favor of high rates of app usage in both treatment and control groups, which is not what we find.

Second, the *WasteTracker* app itself proved glitchy, particularly in its earlier iterations. One potential result is that citizens' initial experiences with the app were frustrating and reduced usage. We see some evidence of this in relatively high download rates but much lower usage rates. We also report qualitative evidence of users reporting difficulties in downloading and reporting. Thus, one should not draw broad conclusions about the efficacy of citizen tech more generally, or its capacity to contribute to accountability in undemocratic local governments more particularly.

Third, the Report Treatment suffered from several challenges in implementation. Despite several safeguards to ensure the report was delivered in a rigorous way to households selected for treatment, it is clear from evidence in the endline survey that: a) many households assigned to treatment did not receive reports; and b) many households assigned to control indicate that they did receive reports. It is unclear how much of these findings result from confusion among households as to what constituted the SWAP report, but it is clear that the Report Treatment was not terribly clean. Those failures of implementation militate against finding an effect of the Report Treatment, because both treatment and some control households received reports.

Policy Implications and Recommendations

- It is possible to disseminate new citizen tech and achieve downloads of a new app, even during challenging times.

- Overall improvements in service delivery and cleanliness may result from broad promotion of the app and other SWAP programming in municipalities, which put pressure on waste service providers and local government officials, even in the absence of direct evidence of widespread app usage.
- The combination of sensitizing citizens to a new technology for addressing service quality when that new tech itself performs erratically may have negative effects on citizens' attitudes and openness to citizen tech. This may be especially true for uneducated or low-skilled citizens, who are not facile with digital technology.
- Opportunities for participation without observed government responsiveness can backfire, as individuals are made more aware of issues and spend time reporting problems, but do not receive satisfactory solutions to their problems. Digital governance in non-democratic states should be aware of this risk.
- Consider relying on existing, customizable apps for citizen-oriented tech instead of developing new, proprietary technologies. There are now many low-cost, reliable, and easily modified options available for citizen tech. The project followed best practices in hiring a local vendor and building off existing local technology. Unfortunately, designing an app from scratch proved to be technically difficult in the time period covered by the program. This was exacerbated by the fact pandemic, which necessitated the use of a new developer, who had to start from scratch, and faced staffing and architecture issues of their own Consequently, technical glitches impeded the *WasteTracker* app's functionality, especially in the earlier phase of app rollout (when the app treatment was administered). While many technical issues with the app were eventually resolved, for some users it was likely too late as they had already disengaged with the app.
- Improving government accountability and oversight is difficult when formal rules prevent direct engagement with government officials. Municipal and sangkat officials indicated enthusiasm and interest in the *WasteTracker* app; however, a lack of knowledge about the app's functionality hindered officials' ability to incorporate the app into their daily operations. Obviously, this policy lesson conflicts with USG policy regarding Democracy and Governance programing in Cambodia, which precludes direct engagement with government.
- IEs are a smart investment to ensure taxpayer dollars are spent on maximizing program impacts. In this IE, as in any applied research endeavor, even null results are helpful for providing concrete feedback on program successes and failures, potential unexpected consequences, and the need to adapt or redesign activities. Without the rigorous design of an RCT for the phone promotion app and report distribution, it would have been easy to rely only on qualitative feedback from a small number of stakeholders that reported overall satisfaction with the program and decide that the SWAP model should be scaled.
- Citizen tech interventions like SWAP may need a longer runway for a successful implementation as it can take time to successfully develop, test, and promote an app to a new population. And it can take even longer for new technology to be accepted and

frequently used by the target audience. It is possible that a longer evaluation period is needed to observe significant effects.

2. CONTEXT AND DEVELOPMENT CHALLENGE

As Cambodia continues to grow and urbanize, the issue of municipal solid waste, its disposal, and the government's role in the collection and treatment of waste, has become one of the most important issues in the country. Both the Royal Government of Cambodia and its citizenry have identified waste management as one of the most challenging issues facing Cambodia today.[3] However, even as this issue continues to gain national and international attention, many municipalities do not have the technical support and resources to fully address their waste management responsibilities.

Because of the importance of waste management, Cambodia has adopted a national strategy for decentralization and the promotion of social accountability through the Implementing Social Accountability Framework (ISAF). In parallel, to improve citizens' participation and voice in local decision-making nationwide, the Ministry of Interior issued a sub-decree to decentralize the management of solid waste management services to the district and municipal levels in 2015. The sub-decree also provides the authority for local governments to put in place contracts (for up to ten years) setting up a fee structure for the regular collection of waste with local SWSPs, such as GAEA and CINTRI, which have exclusive long-term contracts with many municipalities.

Three development challenges, however, are thought to inhibit municipal governments' oversight and management of private waste management providers: logistical challenges, lack of accountability to citizens, and lack of information. Municipal governments may be unable to oversee high quality waste management because of inadequate waste disposal equipment or because citizens do not dispose of their waste properly, making it too difficult or costly to collect and dispose of waste. Municipal governments also may choose not to oversee waste management adequately because of capacity deficits or inexperience, which could be remedied if the government was more accountable to its citizens. Lastly, municipal governments may not have the information required to fulfill their waste management oversight role. These standard problems are compounded by the increasingly narrow space for civil society in Cambodia due to the country's recent political developments.

[3] See the Sub-decree 113 on Management of Garbage and Solid Waste of Downtowns put forth by the Royal Government of Cambodia on August 27, 2015, which cites citizen satisfaction with solid waste management and lays out plans for addressing the issues. (https://www.ajne.org/sites/default/files/resource/laws/7216/sub-decree-113-on-garbage-and-municipal-waste_management-translated.pdf).

3. SWAP OVERVIEW

This section describes the SWAP interventions that are evaluated in this report. SWAP collaborated with private waste collection firms, local stakeholders, and residents to test interventions designed to increase accountability and responsiveness in municipal solid waste collection and management in three urban centers of Cambodia from October 2019 to October 2022.

The impact evaluation assesses two interventions:

- ***WasteTracker* App:** The first treatment entailed the development of a mobile application, *WasteTracker,* allowing users to pinpoint unresolved waste collection problems and other waste issues on a map of their community. They were also able to label the type of solid waste problem (illegal dumping or burning, uncollected bins, etc.). SWSPs had terminals allowing them to see the issues reported by the community and respond to them, as well as publicly update the status of the issue. Issues and resolution statuses were aggregated on a weekly basis by teams and disseminated to public officials in the sangkat and municipality in a public-facing report through a Telegram channel. Households receiving the *WasteTracker* App Treatment received a phone call informing them of the existence of the app, inviting them to download the app, and assisting them with downloads and usage.

- ***WasteTracker* Report:** The second treatment entailed the delivery of a hard-copy report to the home of a randomly sampled set of baseline respondents. The report provided information on the number of waste issues reported in their community on the *WasteTracker* app along with a web URL and QR code directing residents to the *WasteTracker* website for more information about the performance of the SWSP in their community.

The interventions were implemented in three municipalities: Kampong Cham, Siem Reap, and Stueng Saen. These municipalities are in geographically adjacent provinces and contain an overall population of approximately 222,000 citizens and 69,000 households (see Figure 3.1). Two private waste service providers, CINTRI and GAEA, are responsible for waste services in the municipalities under study; Kampong Cham is serviced solely by CINTRI, Siem Reap is serviced by both CINTRI and GAEA,[4] and Stueng Saen is serviced by GAEA. The three municipalities were selected to receive the intervention due to the extent to which these municipalities are underserviced compared to other larger urban areas in the country, the relative economic development of the municipalities and existence of local business associations, and the experience of SWAP implementing partners in these locales. The selection of three separate project sites further allows for the study to look at how the intervention impacts service in areas managed by different SWSPs. Activities associated with the SWAP intervention took place

[4] A third SWSP called V Green works only in the Angkor Wat temple complex, which does include some residential communities and is under the authority of APSARA. We dropped these communities from our sampling design because the reporting and management of APSARA is different than other WSPs in the country.

in 20 sangkats, 129 villages, and 540 blocks (community neighborhoods) across the three municipalities.

Figure 3.1: SWAP target municipalities in Cambodia

WasteTracker App Treatment

The fundamental ideas underpinning the design of the *WasteTracker* App Treatment are:

1. To translate citizen knowledge about local waste problems into the hands of government and service providers; and

II. To provide a mechanism for citizen-led oversight in the waste service sector.

The *WasteTracker* App

WasteTracker is a smartphone application which crowdsources information about waste issues. Citizens can geotag photos and descriptions of waste issues in their community as well as view issues posted by others. Issues can be posted anonymously. Government officials and service providers can view these issues through a Telegram channel, where public reports were posted. Service providers can also respond to these issues, reporting the issues as resolved on the platform when they are resolved in the real world.

WasteTracker users are invited to geotag the location of waste problems in their community through the *WasteTracker* app, such that other individuals in his or her community can see the exact location of the issue and answer a few close-ended questions to categorize, date, and score the severity of the issue. The individual can also post a picture of the problem site (see **Figure 3.2**). As shown in **Figure 3.3**, a map of all the reported issues is displayed on the homepage, allowing issues to be verified by other users of the app.

Figure 3.2: Reported Waste Issues on *WasteTracker* Website

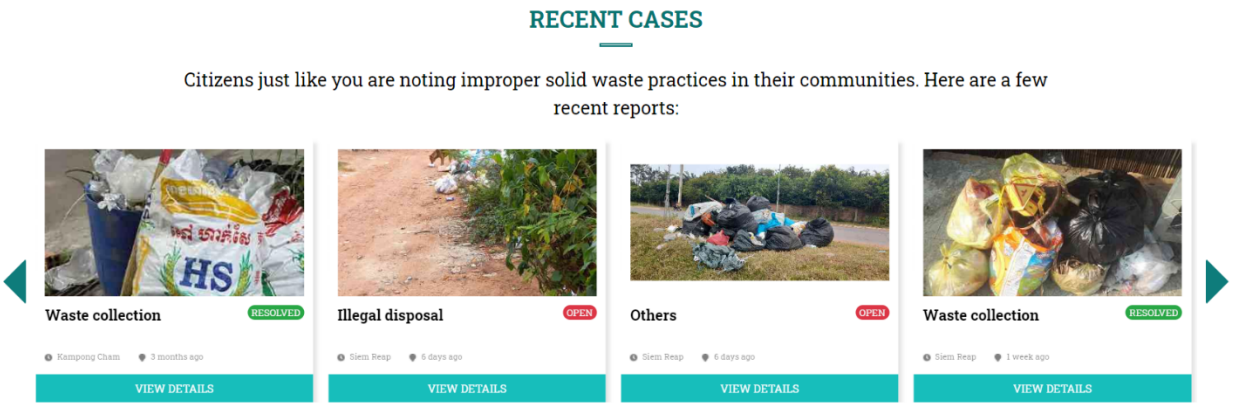
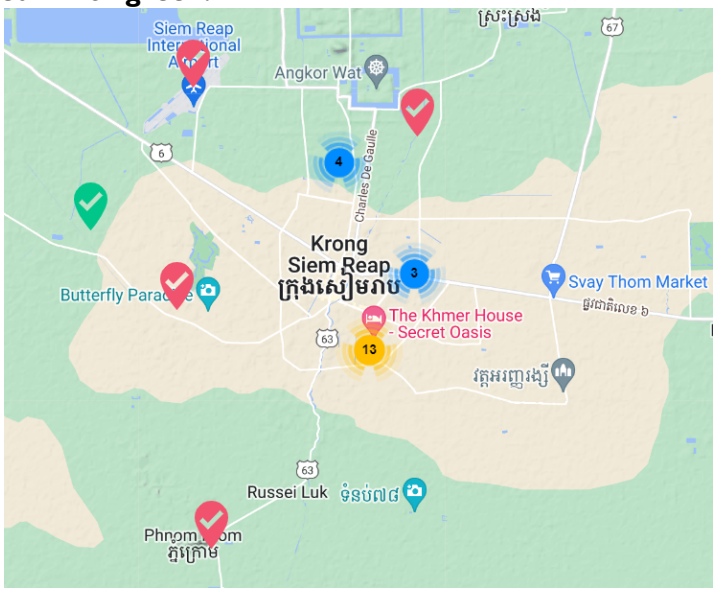


Figure 3.3: Map of Reported Issues and Resolution in Siem Reap from *WasteTracker* Website. "Open" reported cases are displayed with red points, "In Progress" cases with yellow, and "Resolved" with green.



Representatives of the SWSPs can also create accounts on the platform to view complaints, respond to citizens, and inform citizens when issues have been resolved. Using this tool, SWSPs can receive information at low cost, allowing them to identify and rectify waste problems that they may otherwise have not known about. The app further allows for the streamlining and optimization of waste collection services by offering a means of identifying the areas most in-need of waste services. The app tracks the time from which a user complaint is posted to the time in which it is resolved, holding the government and service providers accountable to respond in a timely manner.

Telephone-Based Promotion

Due to the COVID-19 pandemic, the original plan for in-person promotion of *WasteTracker* through the assignment of kiosks and door-to-door visits in randomly assigned blocks had to be

abandoned. As a substitute, the implementation shifted to contacting respondents using phone or text messaging, depending on the preferences of the respondent. Treated respondents were all baseline survey respondents who lived in the blocks randomly selected for promotion of the *WasteTracker* app. These respondents were called on the phone by a Voice Ambassador (VA), 22 project employees working in project hubs in the three municipalities who were responsible for promotion and providing technical assistance to users.[5]

VAs called respondents using the numbers provided in the baseline survey. When they reached them, they read the following script:

> *Hello, my name is XXXX. I am a Voice Ambassador (focal point) for the WasteTracker app, which is part of the Solid Waste Accountability Platform (SWAP), funded by USAID. We interviewed you for the baseline survey early this year. I hope you remember SWAP, you may specifically remember being interviewed by one of our local staff members. "WasteTracker" is an exciting new app that can help to reduce problems with garbage in your neighborhood and improve garbage collection services in your neighborhood, as well as your entire city. WasteTracker is designed to fix waste problems by putting you directly into contact with your waste service provider, local government, and fellow citizens! With this app, you can take photos of trash problems in your community and upload them using the application. Your service provider, local government, and fellow citizens can see the picture and description of the issue you post. You can then see if the authorities are able to make the problem better, and if not, you and your fellow citizens can continue to make it known until it is fixed. There is also an interactive map where you can see the details of any issue posted by in your city! By mapping issues and responses in the city we can improve the community. We'd like to tell you about this app and how to use it. This can take between 5 and 15 minutes. May I share information about our WasteTracker app with you now?*

If the respondent indicated that they did want to hear more about the *WasteTracker* app, but they did not have time on this first call, the VA asked them if there was a better time to call or they would prefer that app download and usage instructions be sent to them over the Telegram messaging app.

If the respondent indicated that they did want more information, the VA went on to read a second script that articulated how exactly the app and map provided information to service providers, the benefits of using it, reinforced the anonymity of reporting, and provided instructions on downloading and usage.[6] It concluded with an inspirational pitch about the benefits of *WasteTracker*: "Using the app will lead to a cleaner community with a more responsive and thorough solid waste service provider. A cleaner community is a healthier community, a community better for business and travelers, a more beautiful community, and one to be even more proud of! Working together, we can create a cleaner and healthier city!"

VAs verified that the respondent had actually downloaded the app by requesting a screenshot from the user's phone that demonstrated a successful download. At the end of the call, respondents were informed that they could reach out to the VA for further assistance if they struggled with using *WasteTracker* and that the VA would bear all expenses associated with the additional assistance.

[5] There were thirteen VAs in Siem Reap, four in Kampong Cham, and five in Stueng Saen.
[6] See Annex 1 for the scripts used to provide treated households with more details on the app, and to direct treated households to resources to help them download and use the app.

Theory of Change

The theory of change for the *WasteTracker* App Treatment may be put into an if-then statement:

> **If** a community monitoring system is introduced that allows citizens to send waste management complaints to the municipal government and service providers, **then** the municipal government and service providers will have the information required to be responsive and provide proper waste services.

WasteTracker Report Treatment

The *WasteTracker* Report Intervention was a treatment administered at the level of the household, in which treatment households were delivered a paper report providing information about the number of waste issues reported in their community on *WasteTracker.* The *WasteTracker* Report was printed on cardstock, sealed in an envelope, and delivered to the household by hand by a member of the enumeration team. Households in the treatment group were located using the address and GPS location that was collected from the household during the baseline. Households in the control group received nothing.

Figure 3.4 displays one of the reports delivered to treatment households in Siem Reap. The report included information on the number of *WasteTracker* issue reports in their community, and the types of waste issues most commonly reported in their area. The bottom of the report featured a web URL and QR code that directed report recipients to the *WasteTracker* website for more information.

Figure 3.4: Example of Report Delivered to Respondents

A unique ID for each recipient was printed on the envelope containing the report. Report recipients could input their unique ID into a landing page before viewing the *WasteTracker*

website, allowing us to track which respondents searched for information online, and to match these respondents with their baseline and endline survey responses.

Theory of Change

If a household receives information provided by the report showing how fellow citizens are using the app to report waste issues , **then** citizens will have increased willingness to pay for waste services and improve views of the government.

If a household was randomized into the treatment group in the original *WasteTracker* phone promotion, the report is expected to enhance the effectiveness of the phone promotion with additional information on the uses and benefits of the *WasteTracker* app. For this group, we expect that the Report Treatment will increase app usage and improve views of waste service delivery.

4. EVALUATION METHODS

Evaluation Design

SWAP was designed to be implemented as a randomized control trial (RCT). The random assignment of treatment and control units is the most scientifically rigorous way to establish a causal relationship between an intervention and outcome and is considered the "gold standard" in policy evaluation. This methodology is also a fair way to distribute scarce resources, since no group receives special consideration or preferential treatment—each unit has an equal likelihood of receiving programming. As described above and below, the original IE design was significantly modified in the face of COVID-19.

The full sample for this project includes three municipalities in urban Cambodia: Siem Reap, Stueng Saen, and Kampong Cham. We estimate that there are 170 villages within these three municipalities. However, only 131 were eligible to be included in the intervention, as the others met only one of two critical eligibility criteria for elimination: 1) in accessibility to field researchers (floating villages); and 2) area under management of the Authority for the Protection of the Site and Management of the Region of Angkor (APSARA), which operates outside of the authority of the Siem Reap Municipality, who we did not have agreements to work with. Two of the 131 villages were selected to serve as pilot villages, resulting in 129 total villages with the potential to receive the intervention.

There are no widely available maps of village boundaries in Cambodia, and multiple attempts at identifying them failed.[7] To combat this problem, we developed a method of creating borders, which involved SWAP staff interviewing sangkat and/or village leaders to draw village boundaries. SWAP staff went around the village boundary with each village leader and then took notes on paper or pinned the location of related landmarks on maps created by using Google MyMaps in tablets. Then, boundaries were drawn in Google MyMaps on laptops together with the Village Leader. The leader was asked to review and agree on the boundary drawn in Google MyMaps. After boundaries of all villages of a sangkat were drawn, SWAP staff set up a meeting with all of the village leaders in that sangkat, showed them the map, and made sure all of them agreed on it. Village border drawing was completed on November 13, 2020.

The block is the primary sampling unit (PSU) for this project. The size of a block is equal to the size of the smallest "normal" village within the sample: 94 households.[8] We round to 100 households for ease of calculation. Therefore, there is one block in the smallest village, with the largest village having up to 2,300 or more households, and thus up to 24 blocks.

Blocks of 100 households were drawn of equal size within villages. Villages are composed of multiple blocks, with villages split into blocks using demographic information, village boundaries provided by sangkat and/or village leaders, and Google Earth/other imagery sources to identify

[7] We considered three options: Administrative data, GIS data, and satellite data.
[8] We define "normal" as being outside the range of severe outliers in the data. The sangkat of Kampong Thom in Stueng Saen has multiple villages with very few households. These will be combined to create one block in practice.

roughly where the population is distributed within the village boundaries to make equal sized blocks. Block border drawing was completed in December 2020.

Randomization for the *WasteTracker* App Intervention was performed in two stages. First, the sample was randomized at the village, with 1/3 of villages, and all blocks within those villages, receiving no treatment ("pure control villages"), and the other 2/3 of villages receiving treatment in at least some blocks. In the second level of randomization, we keep only those villages that were randomized into treatment. We then randomized blocks within this treatment, with 1/3 of blocks receiving no treatment ("control blocks"), and the remaining 2/3 of blocks receiving treatment ("treatment blocks"). All households within the treatment blocks that were surveyed at baseline were assigned to receive the phone treatment, for a total of 2,281 households in the App Treatment group The procedures for randomly sampling the households within each block for surveying are described in greater detail below.

Randomization for the *WasteTracker* Report Treatment was performed at the level of the household following a straightforward procedure: approximately 50% of households from the 5,012 households surveyed at baseline were randomly selected to receive the report, constituting the "Report Treatment" group. The remaining roughly 50% of households were assigned to the "report control" group. Treatment assignment for the *WasteTracker* Report Intervention was "cross-randomized," or independent of treatment assignment for the *WasteTracker* App intervention. Therefore, as shown in **Table 4.1**, a household in the *WasteTracker* App control group could receive the Report Treatment, or vice versa, and a household in the *WasteTracker* App Treatment group could also be randomized into the Report Treatment.

The cross-randomization generates four evaluation groups: those receiving both the App and Report Treatment (1,137); those receiving only the App (1,144) or only the Report (1,350); and a pure control receiving neither treatment (1,381).

Table 4.1: Treatment Assignment for all Baseline Respondents

		Delivered Report on *WasteTracker* Performance	
		Control	*Treatment*
Received Phone Call about *WasteTracker*	*Control*	1,381	1,350
	Treatment	1,144	1,137

Sampling

The smallest sampling unit within the sample frame is the household. Households were selected from within blocks which, by design, should have equal sizes, implying that household probabilities of selection are the same. The sampling interval is based on the number of "household-dwellings." We use the unit of household dwelling because we have information on the number of households in a village, but are only able to see the distribution of dwellings with

Google Earth. Thus, we use the distribution of dwellings to approximate the distribution of households.

The "household-dwelling" sampling interval uses three pieces of information: (1) the number of households per village (obtained from Village Leaders), (2) the distribution of buildings from satellite imagery, and (3) the number of identified multi-unit buildings. The Sampling Interval for a block was equal to the total number of households in that block divided by the number of interviews to be completed in that block. An adjusted sampling interval was used during baseline household data collection – 60% of the interval generated by the calculation above. For example, the Sampling Interval for a block of 100 households with a target of 10 interviews would be '10.' In this case, we asked enumerators to use an interval of six in the field.[9] At the start of each baseline interview, the enumerator asked the respondent "how many households live in this dwelling," and count any number greater than 1 towards the next household-dwelling interval.

The starting point for the walking sampling procedure was the intersection of the largest road in the Block and the largest road that crosses it. Starting at this point, RDS identified the closest household-dwelling and began the walking sampling procedure from there ('House 0'), moving in the direction that has household-dwellings on the enumerator's right-hand side. The next household was selected by determining the sampling interval, *n* (Household selection interval = Number of households divided by sample size - 40% adjustment) – this interval was shared with enumerators via the Block Statistics Google Sheet. Using interval *n*, enumerators selected every n^{th} household thereafter as they walked through the Block using the 'right-hand side' method. If the enumerator reached the end of the household-dwellings in the Block and had not conducted the required number of interviews for the Block, they repeated the process by identifying a new starting household ('House 0') -- the second closest household to the starting point) -- and continued to sample every n^{th} household until they had filled their interview quota.

In multi-household dwelling structures (like blocks of flats or multi household building/flat, compounds with multiple households, or backyard dwellings for renters, relatives, or household workers), each household is treated as a separate sampling unit. The enumerator stopped at every n^{th} unit with *n* calculated based on the number of households in the bloc. In contrast, for apartment or condominium buildings, each building was treated as one household-dwelling. There are two reasons why we consider these buildings one household-dwelling: First, tenants in these buildings pay their waste collection fee to their landlord, and it is the landlord who interacts with solid waste collection services – therefore it is the landlord's perspective that is most relevant to SWAP. Second, the majority of residents in these buildings are likely to be Western expatriates rather than permanent residents of Cambodia, therefore they are not the population of interest for this study. While these two assumptions may not have held for every apartment or condominium building, it was reasonable to assume that they would apply in most

[9] The purpose of this adjustment is to account for probable overestimates in Village Leaders' household counts (a phenomenon documented by Realtime Data Solutions (RDS) over their extensive experience conducting field work in Cambodia), and to avoid unreasonable laps of each block by enumerators. Both parties agree that 60% of the full Sampling Interval will result in a representative and random sample.

cases. Therefore, we instructed enumerators that when they encounter these buildings, they only interviewed landlords or building managers who also live in the building.

Endline Data Collection

Household Survey
Endline data collection took place between July 2022 and September 2022. The household survey was conducted using tablets, with data entered directly into the cloud-based survey platform SurveyCTO. RealTime Data Solutions (RDS), a Phnom Penh-based data collection firm, conducted the endline data collection in close collaboration with TAF, TE, and DevLab. RDS also conducted the baseline data collection in early 2021.

Enumerator training took place in Siem Reap from July 13 through July 16, 2022. A Pilot Survey was done on July 17, 2022, in Siem Reap municipality, as an extension of enumerator training. The Pilot Survey was designed to mimic the endline survey in order to test (and improve on) SWAP's questionnaire, protocols for recontacting baseline respondents, and data analysis procedures. The pilot household survey was implemented across 50 households and 7 blocks in the village of Pou Banteay Chey.

We began the endline household survey on July 21, 2022, after one day of enumerator refresher training in enumerators' field sites on July 20, 2022. Three separate sessions were held simultaneously in Siem Reap, Stueng Saen, and Kampong Cham. The endline household survey was conducted between July 21 and September 18, 2022, using the SWAP household questionnaire. RDS deployed Team Leaders and enumerators in SWAP's three municipalities simultaneously, to collect a total of 5,012 interviews with Cambodian households. Approximately 30 enumerators were involved in the SWAP endline data collection.

The SWAP team monitored RDS especially closely during their first week of interviews, so as to catch and correct any misunderstandings as early as possible. The SWAP team circulated between the three municipalities in order to provide support and make observations in person. While the in-country SWAP team members monitored the conduct of the enumeration team, the DevLab research team produced daily and weekly summary reports of the data coming in as part of the quality control process. Overall, we were very pleased with RDS' performance - both the openness and diligence of their leadership and the professionalism and enthusiasm of the individual enumerators.

Data Quality
DevLab and RDS each had stringent quality control processes in place. The DevLab team set up communication channels to share all findings and track follow-up efforts. Our QC measures included:

- Regular data quality checks: DevLab ran daily and weekly reports analyzing the incoming data and followed up with RDS about any issues of concern.
- Interview location tracking: GPS coordinates were recorded in Survey CTO to create maps that plotted each interview against the relevant Block.

- Audio auditing: We set up the Survey CTO form to record audio for a random selection of interviews (after some initial coding errors, the final version of the questionnaire recorded 25% of total interviews). RDS led a team in auditing these recordings and distributed a Weekly Audio Report outlining (1) new issues found and (2) progress in addressing past issues.

Reidentifying Baseline Households

At endline, household surveys were conducted as panel surveys, and as many baseline respondents as possible were re-interviewed at endline. To increase the likelihood that baseline households could be tracked down and resurveyed, enumerators were provided with basic information that could be used to identify the household, including the respondent's name, gender, age, occupation, and phone number digital, as well as with digital maps indicating the GPS location of baseline households that could be viewed on the enumerators' smart phones.

Enumerators were instructed to make at least five attempts to contact the baseline household by phone, then at least two attempts to contact the household in person. If the baseline household was re-identified, but the original respondent within the household could not be interviewed, the original respondent was replaced with another adult in the household. In the case that the baseline household could not be re-identified or refused participation, the household was considered to have attrited from the survey, and enumerators were instructed to survey the household directly to the right of the baseline household as a replacement.

Attrition

Overall, 74.78% of the households interviewed at baseline were resurveyed at endline. Attrition was particularly low in Stueng Saen, with enumerators managing to resurvey 89.90% of the households interviewed at baseline. Kampong Cham had the highest rates of attrition, where only 60.76% of households were able to be re-surveyed at endline. The most common reason for attrition in Kampong Cham was refusal to participate in the endline survey. Enumerators report that household heads in Kampong Cham often worked outside of the municipality in agricultural sites, aquaculture farms, or in businesses in other provinces, and were not home to participate in the survey. Attrition in Siem Reap fell in the middle of the other two municipalities, with a resurvey rate of 72.94%.

Perhaps the most substantial obstacle to re-contacting households interviewed at baseline was the COVID-19 pandemic, and the economic disruption and internal migration it prompted in Cambodia. Notably, the onset of the pandemic resulted in a near-complete cessation of international tourism to Cambodia, causing major disruptions to the local economy in Siem Reap, which relies heavily on the inflow of international tourists visiting Angkor Wat. In addition, major road construction projects in thirty-eight locations forced the relocation of many respondents to new areas that prevented re-contact. Unsurprisingly, nearly 25% of the attritted households in our sample are households in Siem Reap that moved away since the baseline survey and could not be contacted.

Table 4.2: Reasons for Household Attrition by Municipality

	Kampong Cham	Siem Reap	Stueng Saen	**Overall**
Household could not be contacted by phone or in-person (unclear whether household moved).	96	150	32	**278**
Household moved to a new home and could not be contacted	94	318	31	**443**
Household refused to participate	151	270	49	**470**
No adult in household was able to be surveyed	12	21	6	**39**
Other	10	20	4	**34**
Total	**363**	**779**	**122**	**1264**

Characteristics of Household Panel

Altogether, the household panel dataset contains 3,748 households that were interviewed at both baseline and endline. The characteristics of households in our panel can be found in **Table 4.3** below. We see that the sample skews female, with females constituting a little over 68% of all respondents interviewed at endline. This same gender proportion was observed in our baseline survey. The average age of respondents in the panel survey at endline is nearly 46 years old, with some variation in average age across municipalities. Encouragingly, we find that 74.5% of panel respondents interviewed at endline have a smartphone, meaning that a large majority of the participants in the panel survey had the basic equipment necessary to access the *WasteTracker* app. However, there is substantial variation in the share of participants with smartphones across municipalities, with Stueng Saen having the lowest incidence of smartphone ownership at 67.4% of respondents and Kampong Cham having the highest incidence at 83.5%.

Table 4.3: Panel Characteristics by Municipality

	Kampong Cham	Siem Reap	Stueng Saen	**Overall**
Number of households	562	2100	1086	**3748**
Percent of female respondents	66.19%	67.19%	71.09%	**68.17%**
Average age of respondents	47.78	43.32	49.86	**45.88**
Average household size	4.68	5.09	4.63	**4.9**
Percent of respondents that own a smartphone	83.45%	75.71%	67.40%	**74.47%**
Treatment Status				
Percent of respondents receiving App Treatment	45.37%	45.81%	43.46%	**45.06%**
Percent of respondents receiving Report Treatment	51.07%	47.95%	50.55%	**49.17%**
Percent of respondents receiving Both Treatments	23.67%	22.62%	20.81%	**22.25%**

Village Chief Survey

The Village Chief Survey took place simultaneously with the household endline survey. While we determined that village officials were not eligible for our household survey, the survey team was instructed to administer village chiefs a brief survey containing questions about the cleanliness of the village, public service issues in the village, and the regularity of leaders'

interaction with villagers. This survey was typically administered during the courtesy visit that RDS Team Leaders would pay to village chiefs when arriving in a new village for enumeration. In the case that the village chief was not available to participate, the survey was administered to the deputy village chief. If neither the village chief nor deputy was available to participate in the survey in person, then the survey was administered by phone.

Table 4.4 below shows the characteristics of endline respondents in the Village Chief panel survey. Officials from 122 villages had valid interviews at both baseline and endline. Of the village officials in the panel interviewed at endline, 19.7% were female, and 16.4% held the position of deputy village chief rather than village chief. On average, respondents had held their position in the village for a little over 14 years.

Table 4.4: Village Chief Panel Characteristics by Municipality

	Kampong Cham	Siem Reap	Stueng Saen	**Overall**
Number of villages in Village Chief Panel	32	56	34	**122**
Percent of female respondents	37.50%	5.36%	26.47%	**19.67%**
Percent of respondents that are Deputy Village Chief (rather than Village Chief)	15.62%	14.29%	20.59%	**16.39%**
Average years in the position	13.59	13.52	16.03	**14.24**

Observational Survey

The Observational Survey was conducted from March 18, 2021, to July 1, 2022. During the baseline data collection during March 2021, teams visited every one of SWAP's 540 blocks to identify the largest waste issue in each block. Once an issue was chosen for a block, the team member collected data on its size, appearance, and other attributes. While the "largest waste issue" is a subjective judgement, team members were given four criteria to factor into their decisions: size (which one is biggest (using an eight-point scale)?), smell (three-point scale) and appearance (which one is 'grossest' using a three-point scale?), location (which one might bother the people who live there the most?), and environmental impact (which one might hurt nature the most?).[10]

[10] **Size:** 1 = Tiny (a few pieces of loose trash); 2 = 1 small pile (approximately 1-5 bags of trash); 3 = 1 medium pile (approximately 6-10 bags of trash); 4 = 1 large pile (approximately 10+ bags of trash); 5 = Multiple small piles; 6 = Multiple medium piles; 7 = Multiple large piles; 8 = Multiple piles of varied sizes.

Smell: 1 = no smell; 2 = slightly bad – can smell when beside it ; 3 = really bad – can smell from 2 meters away

Appearance: 1 = acceptable – the trash is tidy; 2 = slightly gross – it is starting to rot, animals may have raided it, etc.; 3 =disgusting – it is rotten, has flies, etc.

Issues in 246 blocks were then selected to be monitored by the survey team on a regular basis, in order to produce an Observational Monitoring Dataset. For the next 15 months, enumerators revisited the largest waste issue identified in the baseline data collection and noted the size, smell and appearance of the pile, along with whether the pile had been cleaned up since the last visit. The exact frequency with which blocks were revisited by survey teams varied, however most sites were monitored about once a month, with the last observations collected in June 2022. For the sake of the impact evaluation, we compare characteristics of the "largest waste issue" at baseline with the characteristics of the issue in the last (i.e., most recent) survey, irrespective of when that survey took place. We also use to data from the monitoring survey to determine if the waste issue was ever cleaned up over the course of the study period.

Table 4.5 shows the characteristics of the waste issues at endline. We see drastic disparities across provinces in the share of the waste issues that were resolved at least once prior to endline: in Stueng Saen, nearly 89% of the 53 observed waste issues had been cleaned up at least once in the 15-month observation period, while in Siem Reap, only 24% of issues had been resolved. Similarly, Stueng Saen consistently has the best outcomes in terms of the size, smell, and appearance of waste issues at endline, while Siem Reap has the worst.

Table 4.5: Characteristics of Largest Waste Issues by Municipality

	Kampong Cham	Siem Reap	Stueng Saen	**Total**
Number of waste issues monitored	55	138	53	**246**
Percent of waste issues resolved by endline	47.27%	23.91%	88.68%	**43.09%**
Average size of waste issue at endline (0-8)	2.05	2.76	2.02	**2.44**
Average smell of waste issue at endline (0-3)	1.24	1.84	0.58	**1.43**
Average appearance of waste issue at endline (0-3)	1.67	2.07	0.58	**1.70**

Stakeholder Administrative Interviews

The Administrative Interviews were conducted between September and October 2022. In total, 26 interviews were conducted with three types of respondents: service providers, municipal authorities, and Sangkat Chiefs (sangkat leaders), including chiefs, first deputy chiefs, and second deputy chiefs (20). **Table 4.6** indicates the number of interviews conducted with each type of respondent across the three municipalities. There were three separate interview protocols for each category of interview subject: service providers, municipal authorities, and Sangkat Chiefs.

The interviews were conducted in-person and in Khmer. We did not record the audio of the interviews – we decided that the cost of making the subject more cautious with their responses was not worth the benefit of having more exact records. The SWAP team took notes by hand in Khmer during the interviews, then translated these to English while typing them afterwards.

Table 4.6: Administrative Interviews by Municipality

	Kampong Cham	Siem Reap	Stueng Saen	**Overall**
Municipal Authorities	1	1	1	**3**
Sangkat Chief or Deputy Chief	4	8	8	**20**
Solid Waste Service Provider	1	1	1	**3**
Total	**6**	**10**	**10**	**26**

Outcome Indicators

The primary hypotheses of interest for the study are as follows:

- ***WasteTracker* Application Hypothesis:** Receiving encouragement to download the application will improve waste service provision and disposal behaviors in the treatment group relative to those in the control group. Improved waste service provision and behaviors will be reflected in 1) greater usage of formal and legal disposal methods; 2) beliefs that waste collection is improving in their communities; 3) beliefs that villages are becoming cleaner; 4) greater willingness to pay for waste services; and 5) cleaner villages.
    - **Mechanism I:** Improvements in waste service provision will occur through greater government responsiveness, which will be reflected in perceptions of the government and local government responsiveness to their service needs.
    - **Mechanism II:** Improvements in waste service provision will occur through enhanced SWSP logistical capabilities, which will be reflected in the perception of waste service provider efficiency and service delivery, the use of formal waste collection methods, and the willingness to pay for formal collection services.
    - **Mechanism III:** Improvements in waste disposal behaviors will occur through increased household awareness about the undesirability of behaviors that aggravate community waste issues and increased salience of waste issues, which will be reflected in household opinions about waste issues and household engagement in illegal disposal methods.
- ***WasteTracker* Report Hypothesis:** Exposure to the report leads to improved views of governance, improved perceptions of the performance of the waste service provider, and increased willingness to pay for waste collection.
- **Combined Hypothesis:** Receipt of the App and/or Report Treatment will reduce the size and severity of waste issues in objective terms.

Following from the theory of change and hypotheses laid out above, we develop five "outcome families," or thematic groupings of potential effects of the intervention: Waste Disposal Methods, Opinions on Waste Issues, Accountability and Responsiveness, Willingness to Pay for Waste Services, and Village Cleanliness. The primary indicators within each of the outcome families are derived from the household panel data set, with the exception of the final two

indicators for the Village Cleanliness outcome category, which are drawn from the village chief panel data set and the observational data respectively.

Table 4.7: Hypotheses and Primary Indicators

Outcome Family	Hypothesis	Primary Indicators

Waste Disposal Methods	• ***WasteTracker Application Hypothesis***
	  ○ ***Mechanism II***
	  ○ ***Mechanism III***
	• ***WasteTracker Report Hypothesis***
		A1: HH receives formal collection services
		A2: HH burns waste
		A3: HH buries waste
		A4: HH dumps waste
		A5: HH uses their current disposal method because it is clean
		A6: HH uses their current disposal method because of the environment
		A7: HH has no access to formal collection services from a SWSP
		A8: Frequency of formal collection by the SWSP

Opinions on Waste Issues	• ***WasteTracker Application Hypothesis*** ○ ***Mechanism III***	**B1:** Agree that dumping trash on the road is disrespectful **B2:** Agree that burning trash is disrespectful **B3:** Agree that waste disposal is an important issue. **B4:** Agree that one should not litter.

Accountability and Responsiveness	• ***WasteTracker Application Hypothesis***
	  ○ ***Mechanism I***
	  ○ ***Mechanism II***
	• ***WasteTracker Report Hypothesis***
		C1: HH satisfaction with village waste provision
		C2: Agree that contacting the waste service provider is effective

Willingness to Pay for Waste Services	• ***WasteTracker Application Hypothesis*** ○ ***Mechanism II*** • ***WasteTracker Report Hypothesis***	**D1:** Amount HH is willing to pay monthly for regular household waste collection **D2:** Amount HH is willing to pay monthly for regular neighborhood waste collection
Village Cleanliness	• ***Combined Hypothesis***	**E1:** HH agrees that the village is clean **E2:** Village cleanliness according to village officials **E3:** Resolution status of largest waste issues

Analytical Approach

We take three distinct analytical approaches to assessing the impact of the SWAP intervention. We describe each method in detail below.

Endline Difference-in-Means

Provided that the treatment and control groups are balanced on baseline,[11] the endline difference-in-means between the treatment and control groups provides an intuitive measure of the difference in outcomes between these groups as a result of the intervention. A difference-in-means approach simply looks at aggregate differences between the mean value of the outcome indicator for the treatment and control groups. When treatment and control groups are balanced at baseline, we can assume that individual characteristics (gender, age, ethnicity) or block characteristics (economic development, leadership, size) are not responsible for any observed differences at endline between the groups. The only meaningful factor is the differential assignment to the treatment group.

Endline Difference-in-Differences

In order to evaluate the effectiveness of the intervention, we also implement a differences-in-differences framework. In this framework, we identify our program's impact first by calculating the difference in the outcome indicator from endline to baseline, for both the treatment group and the control group. We then compare the treatment group difference from baseline to endline to the control group difference from baseline to endline, which provides us the "difference in differences" between the treatment and control group. This method allows us to causally identify the impact of our program by examining how each group changed over time, after controlling for potential differences in these groups at baseline.

In practice, to attain this difference-in-differences value, or the effect of the App and Report Treatments on the household-level indicators, we estimate the following model:

$$y_i = \beta_0 + \beta_1 treat_i + \beta_2 post_i + \beta_3 treat_i * post_i + \epsilon$$

Where y is the outcome of interest for household i, $treat$ is a dummy that takes the value of 1 if household i was assigned to receive the treatment (either the App Treatment or Report Treatment), $post$ is a dummy that indicates whether the outcome was measured before or after the treatment was administered, and ϵ are robust standard errors clustered by block. The coefficient β_3 on the interaction term gives us the "treatment effect", or the difference between the treatment and control groups in the value of the indicator from baseline to endline. If the p-value of the β_3 coefficient is below 0.1, the treatment is considered to have had a statistically significant effect on the outcome in question.

To estimate the combined effect of the App and Report Treatment, we estimate a slightly more complex equation:

$$y_i = \beta_0 + \beta_1 App_i + \beta_2 Report_i + \beta_3 post_i + \beta_4 App_i * post_i + \beta_5 Report_i * post_i + \beta_6 App_i * Report_i + \beta_7 App_i * Report_i * post_i + \epsilon$$

[11] We report the results from baseline difference-in-means tests in Annex II. Overall, we find very few significant differences between the treatment and control groups at baseline, allowing us to treat the baseline sample as balanced.

Where the coefficient β_7 on the triple interaction gives us the treatment effect for the combined treatments. Again, we cluster the standard errors at the level of the block. If the p-value on the β_7 falls below 0.1, then the combined treatment is said to have had a statistically significant effect on the given indicator.

For ease of interpretation, we present the results from the difference-in-differences analysis in a series of plots, plotting the β_3 and β_7 coefficients from the separate treatments and combined treatment, respectively, along with 95% confidence intervals. These plots appear in Annex 3.

Intention to Treat Effects (ITE)

Note that both the difference-in-means and difference-in-differences framework outlined above measures the effect of the *intention to treat* households, meaning that households that were intended to receive treatment (as dictated by their treatment assignment) are compared to households that were intended to *not* receive treatment. The intention to treat does not necessarily entail the *successful uptake* of treatment: households that received the phone call encouraging them to download the app might not have ever done so; just as households that were supposed to receive the report might not have ever read it or might not have successfully received it. However, unlike the assignment of treatment, who *takes up* treatment is not assigned at random. Households with greater levels of education, more assets, or higher expectations of public services might be more likely to download *WasteTracker* or read through the report. Comparing that group of households to the control group would thus invalidate the research design.

Descriptive Analysis

In addition to the rigorous causal analysis of program impacts, we also present descriptive analyses of the panel dataset, comparing mean values of key indicators across municipalities between baseline and endline. While we cannot directly attribute the change in attitudes and behaviors over time to the SWAP intervention, the results of the descriptive analysis help to shed light on the larger trends in waste service management throughout the study area and to point out clear differences in both trends and behaviors across the three municipalities. The results of the descriptive analysis are interwoven throughout the discussion of our key findings in Sections 6 through 10 of this report.

Limitations and Cautions

The evaluation faced several challenges that limited our capacity to assess SWAP as originally designed. First, COVID-19 imposed significant constraints on the project. In light of rolling lockdowns and local ordinances associated with the pandemic, the implementation team was unable to disseminate the app through face-to-face interactions as envisioned in the IE design report. In lieu of face-to-face promotion to treatment households, the implementation and evaluations teams decided to promote the app as broadly as possible, including via market kiosks and over Facebook. This broad dissemination is likely to have led to spillovers, in which households outside of the App and Report Treatments were plausibly aware of *WasteTracker* and the related programming. These spillovers likely reduce our capacity to find a significant effect of the program through the App Treatment described below, since households in the

control group may have heard of *WasteTracker* via Facebook or other advertising. If anything, however, this should have militated in favor of high rates of app usage in both treatment and control groups, which, as discussed in Section 5, is not what we find.

Second, the *WasteTracker* app itself proved glitchy, particularly in its earlier iterations. One potential result is that citizens' initial experiences with the app were frustrating and reduced usage. We see some evidence of this in relatively high download rates but much lower usage rates. We also report qualitative evidence of users reporting difficulties in downloading and reporting. Thus, one should not draw broad conclusions about the efficacy of citizen tech more generally, or its capacity to contribute to accountability in undemocratic local governments more particularly.

Third, the Report Treatment suffered from several challenges in implementation. Despite several safeguards to ensure the report was delivered in a rigorous way to households selected for treatment, **Table 4.8** indicates that only 33% of households assigned to treatment reported receiving the *WasteTracker* report during the endline survey, while 26% of households assigned to the control group said at endline that they received the *WasteTracker* report as well (when they should have reported not receiving the report). It is unclear how much of this finding is the result of confusion among households as to what constituted the *WasteTracker* report when asked during the endline survey, but it is clear that the Report Treatment was not terribly clean. Those failures of implementation militate against finding an effect of the Report Treatment, because it is clear that fewer treatment households received reports than were supposed to and that some control households erroneously received reports.

Table 4.8: Receipt of *WasteTracker* Report by Treatment Status

	Report Treatment Group	Report Control Group	**Overall**
Number of Households	1843	1905	**3748**
Share of HHs that received report	33.04%	26.14%	**29.54%**
Number of HHs that received report	609	498	**1107**

5. APP UPTAKE

Table 5.1 shows that when re-surveyed at endline, nearly 24% of respondents were familiar with the *WasteTracker* app, indicative of the success of the efforts to promote the *WasteTracker* app across the three municipalities. The table also shows that the download rate of the app was fairly high. Indeed, the download rate of 9.4% among those households that were in the App plus Report Treatment group is quite high by the standards of new app adoption; all told, 6.5% of respondents across treatment and control groups downloaded the app.

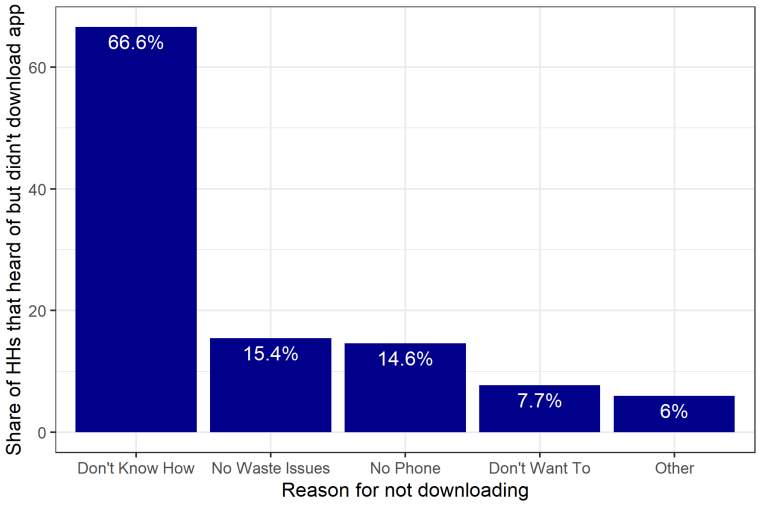
As shown in **Figure 5.1,** the biggest barrier to increased download rates appears to be a lack of knowledge about how to access the app: when respondents who were familiar with *WasteTracker* were asked why they did not download the app, the vast majority said that they

did not know how. Some respondents' inability to download the app, despite wanting to, is likely in part attributable to the changes made to the App Treatment encouragement design to accommodate pandemic restrictions. It is reasonable to assume that for some segments of the population, particularly older, less tech savvy, and less educated respondents, receiving instructions on how to download and use the app over the phone was not sufficient in facilitating access to the app.

Table 5.1: App Familiarity and Usage by Treatment Status

	App Only	Report Only	Both App and Report	Pure Control	**Overall**
Number of households	855	1009	834	1050	**3748**
Share of HHs that heard of the *WasteTracker* app	26.78%	23.09%	27.10%	19.62%	**23.85%**
Share of HHs that downloaded the *WasteTracker* app	8.42%	4.66%	9.35%	4.48%	**6.51%**
Share of HHs that used the *WasteTracker* app to report an issue	0.82%	0.10%	0.96%	0.38%	**0.53%**
Number of HHs that downloaded the *WasteTracker* app	72	47	78	47	**244**
Number of HHs that used the *WasteTracker* app to report an issue	7	1	8	4	**20**
Number of issues reported on the *WasteTracker* app	8	1	13	7	**29**
Number of reported issues that were resolved	2	0	2	3	**7**

Figure 5.1: Reasons for not downloading *WasteTracker* app, among respondents that report hearing of but not downloading app



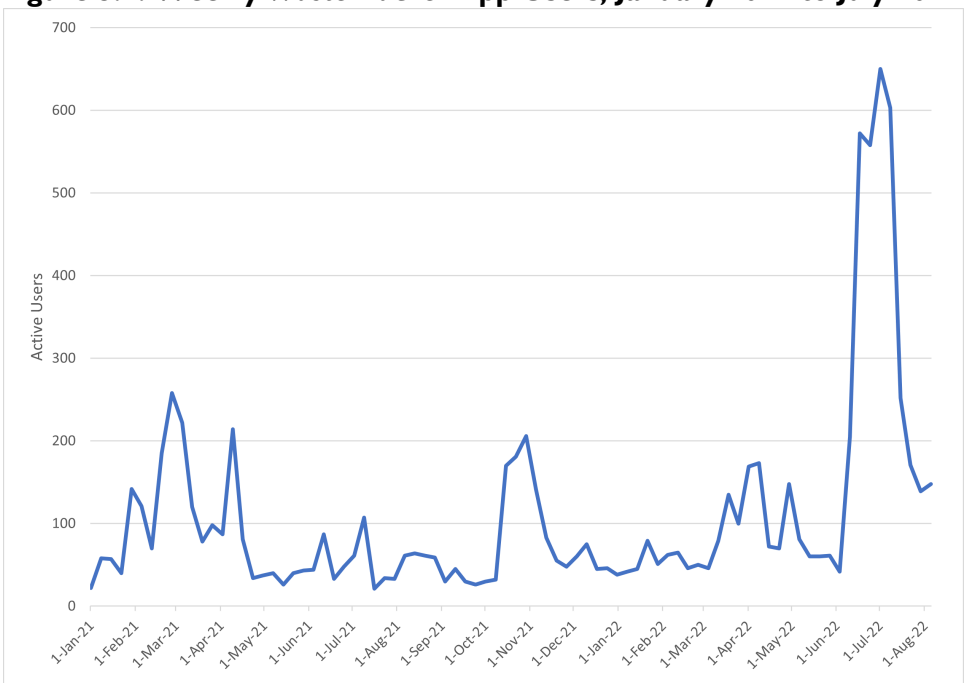
Unfortunately, the relatively high download rate of 6.5% that we observe among survey respondents did not translate into considerable usage of the app. Only 0.5% of all respondents in the panel survey used the app to report a waste issue, and that only rose to 1% among those who received both the App and Report Treatment. All told, only 20 respondents in the panel survey reported using *WasteTracker* to report an issue. This relatively low usage rate was reiterated in key informant interviews, where there were relatively few mentions of the app by government officials. Of the 29 issues that respondents say they reported on the platform, 7 were said to be resolved by the service provider.[12]

However, the *WasteTracker* app was made available to a larger population than only those in the survey sample. Non-randomized SWAP activities such as kiosks and social media advertisements were designed to promote app awareness and usage among *all* residents of the three municipalities – not just treated residents or those included in the survey – and thus the endline survey might underestimate the number of overall app users and wider uptake of the app. Data collected by the *WasteTracker* app itself about the number of active users and the location of waste issue reports provide us with an overall view of the use of the application among all residents of the municipalities in our study.

Figure 5.2 reports the number of active users of the *WasteTracker* App each week in our study period. An "active user" is any user that opens the app on their device, regardless of how much time they spend on the app or whether they engage with any of the app features. We find app use increased greatly in October and November 2021 during the administering of the App Treatment, where VAs made phone calls to the households in the App Treatment group encouraging them to download *WasteTracker.* We see another large peak from June to July 2022 with the distribution of the *WasteTracker* reports – during the period of report distribution and kiosk promotion in Siem Reap, the number of weekly active users peaked at 650. The graph below shows that while treatment activities appear to have had instant and perceptible effects on the number of users downloading and viewing *WasteTracker,* the effects were for the most part not sustained, with engagement dropping off after each period of promotion.

[12] There is anecdotal evidence that one SWSP was responding to issues reported on SWAP but was not updating the app with this information. This could be a result of inadequate training of lack of interest in using WasteTracker from their end.

Figure 5.2: Weekly *WasteTracker* App Users, January 2021 to July 2022



While **Figure 5.2** suggests that far more individuals downloaded and viewed the *WasteTracker* app than is captured by the household data alone, this metric does not necessarily serve as an indicator of *use* of the app to report waste collection issues. As reported in **Table 5.2**, we find both app usage and issue resolution among all app users to be quite low. By the beginning of endline data collection, only 122 waste issues had been reported on the *WasteTracker* app, with the vast majority of issues reported in Siem Reap.[13] App usage was particularly low in Kampong Cham, where only 12 issues were reported during the study period. Resolution rates for all waste issues reported on the app is quite low, with only 26 of 122 (21%) of the reported issues having been marked as resolved by November 2022.

Table 5.2: Waste Issue Reports by Municipality

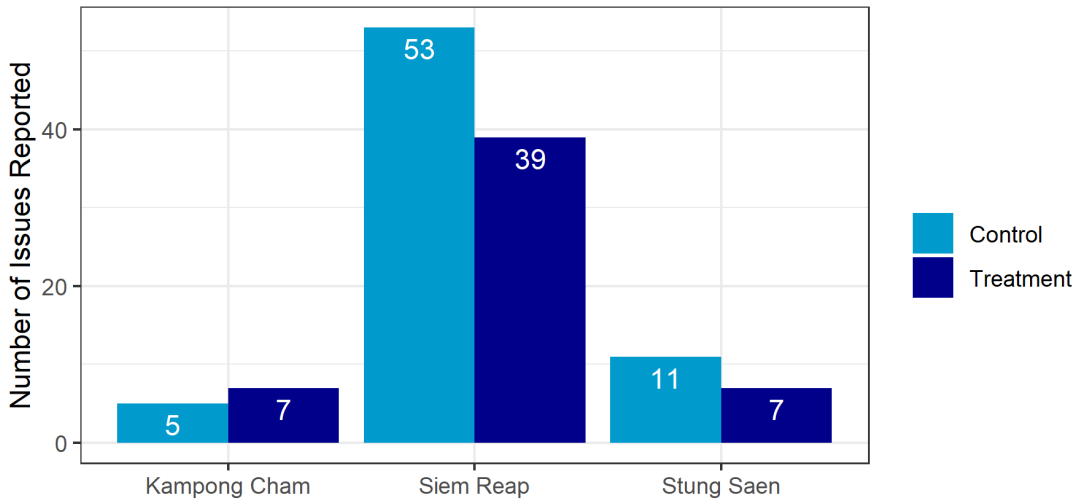
	Kampong Cham	Siem Reap	Stueng Saen	**Overall**
Waste Issues Reported on *WasteTracker* App	12	92	18	**122**
Waste Issues Resolved by Service Providers	3	19	4	**26**

The app data also shed light on the inefficacy of the App Treatment – the phone call from a Voice Ambassador encouraging individuals to download the app – in driving app usage. **Figure 5.3** below reports the number of issues reported on *WasteTracker* prior to endline data collection for each of the three municipalities, distinguishing between issues reported in control

[13] We note that between the start of endline data collection in July 2022 and the writing of this report in November 2022, 20 additional waste issues have been reported on the *WasteTracker* app.

blocks, where *no* households received the App Treatment, and in treatment blocks, where all surveyed households (or approximately 10 households per block) received the App Treatment. In both Siem Reap and Stueng Saen, we see more issues reported in control blocks than treatment blocks. In the case of Siem Reap, the difference is quite large, with 36% more issues reported in control blocks than treatment blocks.

Figure 5.3: Number of Issues Reported on *WasteTracker*



Overall, the summaries drawn from both the household panel dataset and the *WasteTracker* app data indicate that despite both the randomized and non-randomized activities that took place under the SWAP intervention, use of the app by households and service providers remained limited. The section below draws on data, anecdotal evidence, and qualitative interviews to posit three factors that we believe influenced the relatively low uptake and usage of the *WasteTracker* app by households as well as SWSPs and public officials.

Factors Driving Low App Engagement

Issues with App Functionality

Throughout the roll-out of the *WasteTracker* app, several technical issues disrupted the functionality of the app. Voice Ambassadors (VAs) who were charged with helping address citizens' questions about the app reported frequent crashes that often ended up locking users out of the app, especially in the early days of the intervention. When this occurred, the only way to recontinue use of the app was to either update the app or remove it from the mobile

device and then redownload.[14] The time and cognitive costs of regularly updating, or redownloading, the app likely prompted many early users to abandon use of the app entirely.

Additionally, VAs and members of the SWAP team received complaints of several other issues that annoyed users and impeded app functionality. First, in line with standard practice, the app required users to request a verification code by SMS and then enter the code into the app to sign back into their existing account, creating a minor, but time-consuming, obstacle to regular engagement on the app. Second, users reported experiencing crashes when clicking the submit button on an issue report, thus requiring users to re-open the app and re-enter information about the issue in order to submit their report. Finally, the app infrastructure proved to be poorly suited to handle multiple devices at one time, again resulting in crashes, long load times, and loss of app functionalities.

Lack of Familiarity with App's Functions

In addition to low app usage among households, *WasteTracker* struggled to be taken up by government officials. Interviews with municipal officials and sangkat chiefs suggest that while government representatives are familiar with the existence of the *WasteTracker* app, they are not familiar with its functions or its use by citizens.

Sangkat officials showed the lowest familiarity with the app. Most sangkat chiefs showed no awareness of the app whatsoever and had little knowledge of any SWAP activities. Others seemed to be aware of the app's existence but knew little about the app's functionalities—one chief in Siem Reap reported installing the app but not having any idea how to use it. None of the interviewed sangkat chiefs cited the app as a means by which citizens communicated about waste service issues.

Municipal officials all had heard of the app, thanks to SWAP presentations at municipal offices, but no officials at the municipal level had incorporated the app into their daily operations. Despite receiving monthly reports on a Telegram channel, officials from all three municipalities demonstrated no knowledge of how many issue reports had been made, how many had been resolved, whether service providers were using the app, and how widespread usage was throughout the municipality. These signs all indicate that officials in the municipalities did not use *WasteTracker* as a tool to aid in providing oversight of solid waste collection services. Unfortunately, USAID restrictions on democracy and governance funding prevented direct training officials on how to learn from and respond to app posts.

Overall, SWSPs exhibited much more familiarity with the app than government officials. Familiarity was the lowest in Kampong Cham, where an official from CINTRI reported that "CINTRI hasn't integrated SWAP or *WasteTracker* into our operations, though I have heard of

[14] This may have resulted from capacity issues in the architecture. An abundance of test posts slowed down app functions.

the SWAP project and used to assign staffs to participate in the training." In contrast, officials from GAEA in both Stueng Saen and Siem Reap report having incorporated the app into their daily operations. GAEA in Siem Reap had assigned two staff members to field and resolve complaints reported on the app, while GAEA representatives in Stueng Saen praised the app for allowing service providers to easily export and respond to issues. However, representatives in Siem Reap and Stueng Saen both noted that the limited usage of the app by citizens renders it a less common channel for complaints than existing channels employed by GAEA.

Alternative Means of Communicating Waste Issues

An additional factor potentially limiting the uptake of *WasteTracker* is the existence of several alternative, widely employed, and easy means for both government officials and citizens to communicate waste issues to the service providers. In Kampong Cham, municipal and sangkat leaders repeatedly referred to a WhatsApp group containing the deputy provincial governor of Kampong Cham, the municipal governor, sangkat chiefs, sangkat councilors, village leaders, CINTRI representatives, and a few citizens as their primary means of communicating about waste collection issues. Leaders reported using the WhatsApp group to report late waste collection to CINTRI, send photos of waste issues to CINTRI, and to track CINTRI's overall performance. Similarly, officials in Stueng Saen reported using a Telegram channel with provincial, municipal, sangkat, and village officials, representatives from GAEA, and a handful of citizens to communicate about and resolve issues with waste collection.

In Siem Reap and Stueng Saen, GAEA described several longstanding methods by which customers can report issues and complaints to company representatives, including a phone hotline, the company Facebook page, and face-to-face interactions with on-the-ground customer service teams. While GAEA now regularly checks the *WasteTracker* app as well, representatives in both municipalities reported that it is still more common for the company to receive complaints by phone hotline rather than on the app. Representatives in both municipalities report receiving as many as 7-8 issues a day via the phone hotline, which are fielded by designated staff members.

Use of alternative communication tools was anticipated during the ideation phase, and aspects of the app were designed to parallel these chat systems. In later iterations, programmers even designed a method to send issues directly to a Kampong Telegram group to better integrate WasteTracker with existing methods.

6. OUTCOME FAMILY 1: WASTE DISPOSAL METHODS

Summary of Key Findings

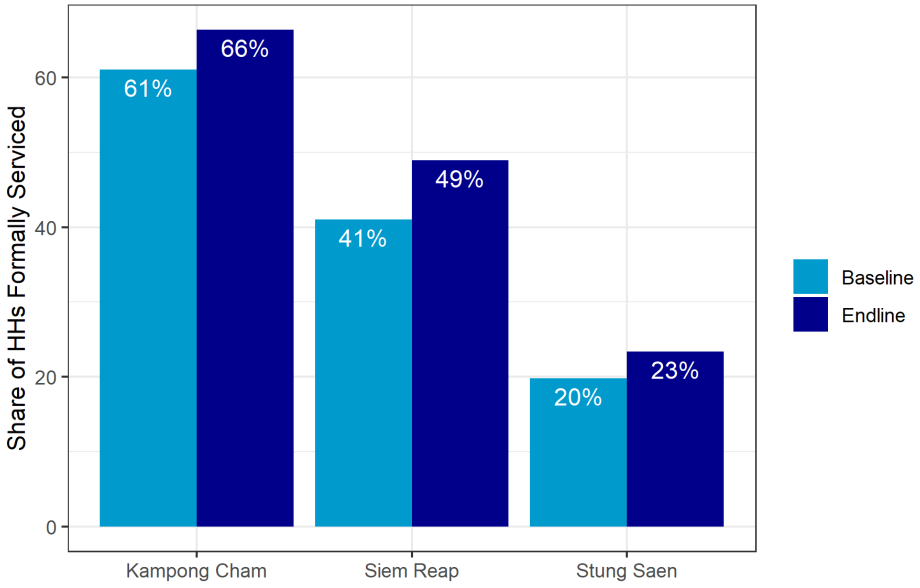
We find the SWAP intervention to have had the following effects on waste disposal methods:

- We find no evidence that either treatment increased households' use of formal collection services; however, we do see a large increase in the use of formal collection services from baseline to endline.
- Receiving the Report Treatment increased a household's likelihood of burying their waste but did not affect households' use of other methods of illegal disposal, burning and dumping. Receiving the App Treatment had no effect on households' use of illegal waste disposal methods. Nonetheless, from baseline to endline, we see substantial decreases in the use of illegal waste disposal methods.
- The App and the Report Treatment both had a negative impact on households' consideration of cleanliness when choosing their method of waste disposal. The App Treatment also had a negative impact on households' consideration of the environment when disposing of waste.
- We find no evidence that either treatment improved access to formal waste collection services. However, we find that the number of households with access to waste services increases in both Siem Reap and Stueng Saen in the period between baseline to endline.
- We find mixed evidence on the effect of the treatments on the frequency of waste collection. Those who received the App Treatment reported significantly more frequent waste collection, while those who received the Report Treatment reported significantly less frequent waste collection.

Trends over time

Between baseline and endline data collection, we see a major increase in the use of formal waste collection services in all three of the municipalities in the study area (see **Figure 6.1**). Whereas roughly 38% of households were using formal waste collection services as their primary means of waste disposal at baseline, at endline 44% of households reported the use of formal services as their primary means of disposal. In line with this trend, we also find substantial decreases in the use of all three illegal waste disposal methods (burning, burying, and dumping). Most notably, 55% of households reported dumping waste as one means of disposal at endline, compared to 65% of households at baseline; this constitutes a nearly 16% decrease in the number of households that use dumping as one method of waste disposal over the course of the study period.

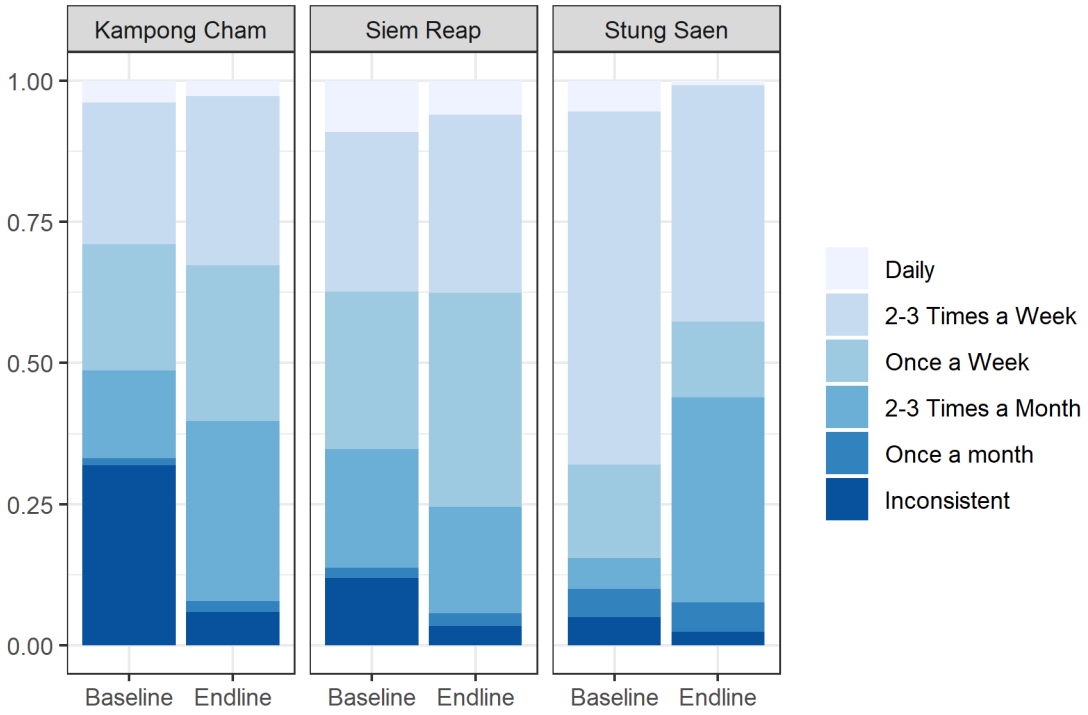
Figure 6.1 Use of Formal Waste Collection Services



In addition to improvements over time in households' waste disposal behaviors, we also see some evidence of improvements in the quality of service offered by the SWSPs over the course of the study period. The share of households with no access to formal collection services decreases modestly from 32.5% to 29.5%. This increase in access to formal services is seen across all municipalities except Kampong Cham, where slightly more respondents report lacking access to waste collection services at endline than at baseline. However, as can be seen in **Figure 6.2**, we see a substantial decrease in the inconsistency of waste collection in Kampong Cham. At the same time, the frequency of waste collection in Stueng Saen seems to drop off: whereas the plurality of households reported at baseline that collection occurred 2-3 times a week, at endline we see a large increase in the share of households receiving waste collection only 2-3 times a month.

Overall, then, we find consistent and substantial improvements in household waste disposal behaviors across all three municipalities over the course of the study period, and in some cases, positive improvements in quality of services provided by the SWSPs. While these improvements cannot be directly attributed to the SWAP intervention, they do point to the potential positive effects that the various non-randomized educational components of SWAP had on both individual and firm behaviors. At the very least, these findings are indicative of positive trends in Cambodia's solid waste management over time.

Figure 6.2: Frequency of Formal Collection



Primary Results

Table 6.1 below presents the endline difference-in-means, or the difference in the average value of the indicator between the treatment and the control group, for the primary indicators in the Waste Disposal Methods outcome family. In cases where the difference-in-means reaches a standard level of significance (indicated by a p-value less than 0.10), we mark the significance level using stars, where * indicates $p < 0.10$, ** indicates $p < 0.05$, and *** indicates $p < 0.01$

Surprisingly, we find a number of negative and significant differences at endline between the treatment groups and control groups, suggestive of *negative* effects of the treatments on waste disposal behaviors. While the *WasteTracker* App Treatment seems to have had no effect on household's use of legal or illegal waste disposal methods, we find that the share of households burying their waste is higher among households that received the Report Treatment: 5.2% of households in the *WasteTracker* Report Treatment group admitted to burying their trash as one method of disposal, compared to 3.7% of households in the control group. Similarly, we find that the treatments seem to have a negative effect on households' consideration of cleanliness or environmental concerns when disposing of their trash.

We see no evidence that either treatment increased households' access to formal waste collection services. However, we do find perplexing effects of both treatments on the frequency of waste collection: serviced households in the App Treatment group reported *more* frequent collection than serviced households in the App control group, while serviced households in the Report Treatment group reported *less* frequent collection than serviced

households in the Report control group. Interestingly, the difference between the treatment and control groups is the same magnitude for both treatments.

Table 6.1: Endline Difference in Means for Outcome Family 1

	Obs	App Treatment	Report Treatment
HH receives formal collection services	3748	0.017	-0.015
HH burns waste	3748	-0.002	0.027
HH buries waste	3748	0.007	0.015**
HH dumps waste	3748	-0.002	0.002
HH uses current disposal method because it is clean	3747	-0.034**	-0.033**
HH uses current disposal method because of the environment	3747	-0.035**	-0.020
HH has no access to formal collection services	3748	0.008	0.024
Frequency of formal collection (1 = least frequent, 6 = most frequent)	1630	0.148***	-0.148***

7. OUTCOME FAMILY 2: OPINIONS ON WASTE ISSUES

Summary of Key Findings

- Between baseline and endline, there is a general improvement in citizen attitudes toward waste issues. Those improvements were not, however, a result of either the App or Report Treatment
- The App Treatment has a negative effect on citizen attitudes toward waste. Treated households are 6-7% *less* likely to agree that burning trash or dumping it on the road is disrespectful,
- Households that received the App Treatment are also less likely to agree that waste disposal is an important issue and that one should not litter.

Trends over time

As **Figure 7.1** through **Figure 7.4** demonstrate, attitudes about proper waste disposal improved between the baseline and endline survey for both treatment and control respondents; however, the improvement was simply greater for citizens in the control groups, leading to the differences in levels we observed in the endline survey.

Figure 7.1 demonstrates that respondents in all three municipalities were more likely to agree with the statement that dumping trash on the road is disrespectful to neighbors at endline (1.01) than at baseline (0.72) on the -2 to 2 point scale, growing 39.7% over time. Growth rates were greater in Kampong Cham (55%) and Siem Reap (59%) than in Stueng Sean (11%).

Figure 7.1: Agree that dumping on road is disrespectful

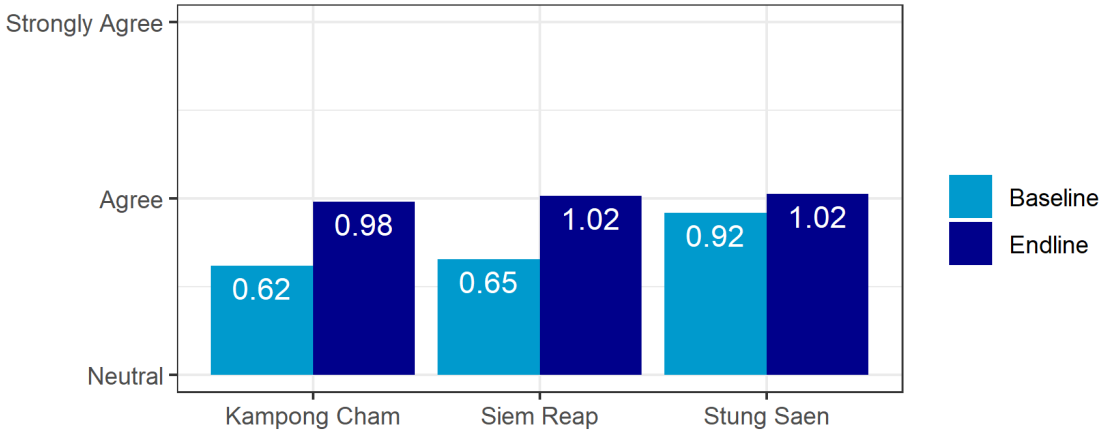


Figure 7.2 similarly shows improvements in agreement with the view that burning waste is disrespectful to neighbors. Overall agreement increased 57% from 0.47 to 0.74 on the –2 to 2 scale. Here, we observe some differentiation across municipalities. Agreement growth was remarkably higher in Siem Reap (64%) and Stueng Saen (56.2%), than Kampong Cham (38.3%), where growth was positive but more modest.

Figure 7.2: Agree that burning waste is disrespectful

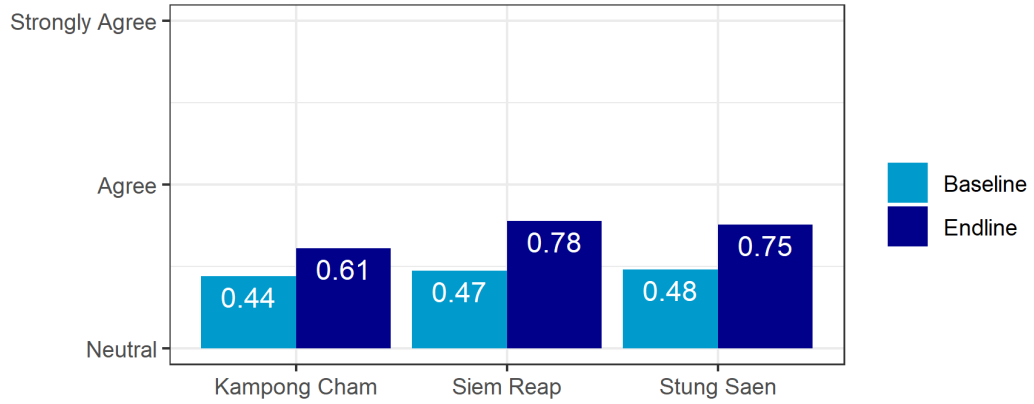
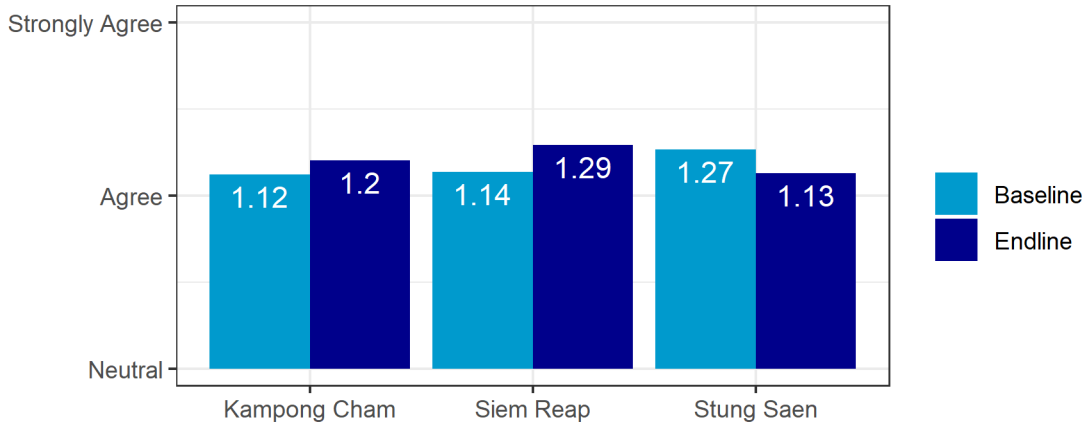


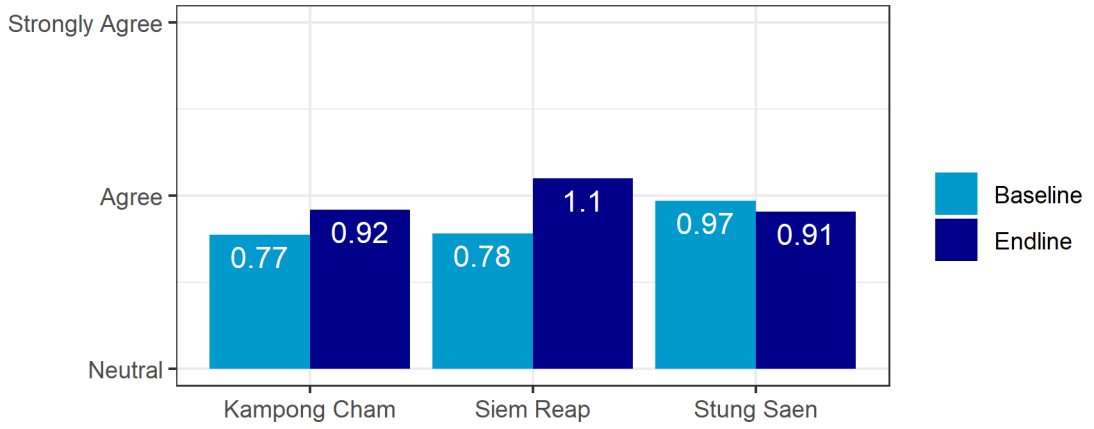
Figure 7.3 illustrates a similar trend with respect agreement on not littering. Between baseline and endline, all respondents increased their agreement that littering was unreasonable behavior. Overall agreement increased 5% from 1.17 to 1.23 on the –2 to 2 scale. Increases were highest in Kampong Cham (13.5%) and Siem Reap (7.3%), with a modest decline in Stueng Saen (-10.8%).

Figure 7.3: Agree that one should not litter



Finally, in **Figure 7.4** we observe much smaller growth over time in agreement with the notion that waste disposal is an important issue for respondents. The increase in agreement was only 22%, moving from an average at 0.83 at baseline to 1.01. **Figure 7.4** demonstrates that agreement increased modestly in Kampong Cham (19.5%) and substantially in Siem Reap (40.8%) but declined in Stueng Saen (-6.7%).

Figure 7.4: Agree that waste disposal an important issue



Primary Results

Table 7.1 presents the endline difference-in-means for the primary indicators in the Opinions on Waste Issues outcome family. Recall that results with stars reach standard levels of statistical significance, where * indicates p < 0.10, ** indicates p < 0.05, and *** indicates p < 0.01.

Table 7.1: Endline Difference in Means for Outcome Family 2

	Obs	App Treatment	Report Treatment
Agree that dumping on road is disrespectful (-2 to 2)	3731	-0.060*	0.000
Agree that burning trash is disrespectful (-2 to 2)	3725	-0.074**	0.006
Agree that waste disposal an important issue (-2 to 2)	3715	-0.063**	-0.009
Agree that one shouldn't litter (-2 to 2)	3739	-0.057**	-0.074***

Most surprisingly, we find that across the board, the App Treatment had a modest *negative* effect on respondents' opinions on waste issues. On average, households in the App Treatment group are significantly less likely to think that dumping or burning trash is disrespectful, that waste disposal is an important issue, or that one should not litter when compared to households in the App control group.

This finding appears to indicate that exposure to the *WasteTracker* app may have heightened respondents' awareness to poor waste disposal behavior of their neighbors, leading them to be more tolerant of it than unexposed respondents in the control group. Among the small subset

of respondents who took the time to report issues, it may also be a sign of frustration that waste issues were not addressed by responsible parties.

8. OUTCOME FAMILY 3: ACCOUNTABILITY AND RESPONSIVENESS

Summary of Key Findings

- We find little evidence of across-the-board improvements in satisfaction with waste provision (except in Siem Reap) or in beliefs about the efficacy of contacting service providers as a means to improve service quality.
- Neither the App nor Report Treatments have any measurable impact on citizen perceptions of service satisfaction or the responsiveness of service providers.

Trends over time

Figure 8.1 demonstrates that satisfaction with villages services improved over time across all respondents, from an average score of 0.82 on the baseline to 0.87 on endline. Importantly, however, these improvements with satisfaction are attributable primarily to respondents in Siem Reap, where we observe a 20% improvement from .77 to .92. Satisfaction dropped marginally in both Kampong Cham and Stueng Saen.

It is possible that *WasteTracker* App promotion played an indirect role in generating this result. Although we don't see specific effects in the treatment group, municipal government and waste service providers, aware of the project, may have improved waste collection generally in response to the increased attention to service delivery. Our interaction with Siem Reap local officials and representatives at GAEA led us to believe that they were particularly aware and interested in the outcomes of the project.

Figure 8.1: Satisfaction with Village Waste Provision

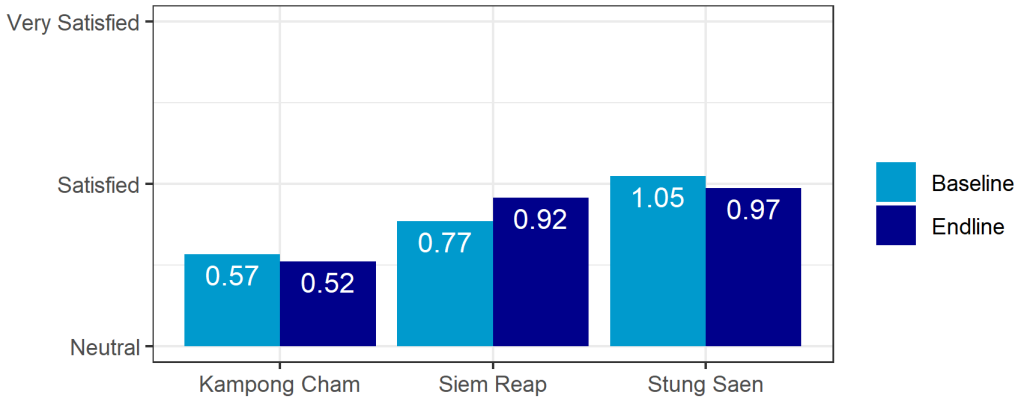
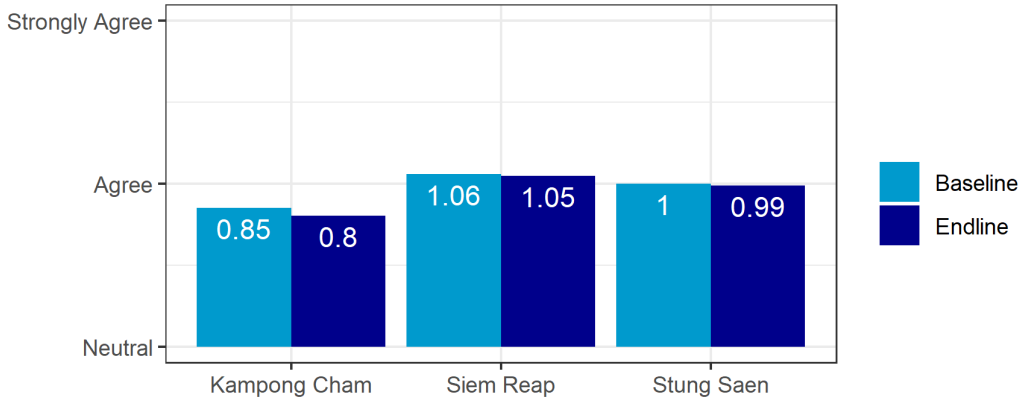


Figure 8.2, however, illustrates that improved perception of service delivery did not result from increased responsiveness to particular issues raised by constituents. We do not see any improvement over time in the belief that contacting service providers was effective overall for any municipality. Pulling the two findings together, we can conclude that waste providers may have improved overall service provision over time by increasing the scope and frequency of collections; however, they did not alter their behavior in response to individual customer complaints.

Figure 8.2: Contacting the Service Provider is Effective



Primary Results

Table 7.1 presents the endline difference-in-means for the two primary indicators in the Accountability and Responsiveness outcome family. Recall that * indicates $p < 0.10$, ** indicates $p < 0.05$, and *** indicates $p < 0.01$. As with results on the first two outcome families above, general improvements in overall satisfaction over time cannot be attributed to the *WasteTracker* App or Report Treatments. We find no evidence of significant differences in satisfaction with village waste services or beliefs in the efficacy of contacting SWSPs between treated and control respondents at endline.

Table 7.1: Endline Difference in Means for Outcome Family 3

	Obs	App Treatment	Report Treatment
Satisfaction with Village Waste Provision (-2 to 2)	3615	-0.020	0.002
Agree that contacting provider is effective (-2 to 2)	1638	-0.053	-0.017

9. OUTCOME FAMILY 4: WILLINGNESS TO PAY

Summary of Key Findings

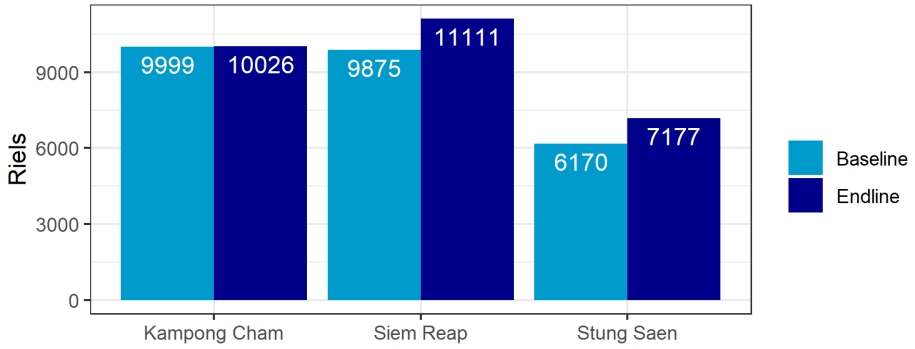
- Between baseline and endline, there is a noteworthy increase in citizens' willingness to pay for both home and neighborhood collection of waste. These increases are particularly large in Siem Reap and Stueng Saen.
- Neither the App nor Report Treatments contributed to these positive trends. The App Treatment actually has a statistically significant *negative* effect on the willingness of households to pay for neighborhood collection.

Trends over time

At both baseline and endline, we asked respondents a series of questions that aimed to determine the precise amount respondents were willing to pay per month for two different collection services: a.) guaranteed, punctual collection of waste directly from their home twice a week, and b.) a community fund that leads to the entire neighborhood being cleaned once a week. We began by proposing a modest starting price for each service: 12,000 Riels ($3.00) for home waste collection, and 10,000 Riels ($2.50) for neighborhood waste collection. Depending on the respondent's willingness to pay the first amount, we then asked them if they would be willing to pay a second amount – a higher amount if they said yes to the first offer or a lower amount if they rejected the first offer. For each collection service, we repeat this process two more times, arriving at a final amount that indicates the *most* respondents would be willing to pay for each service.

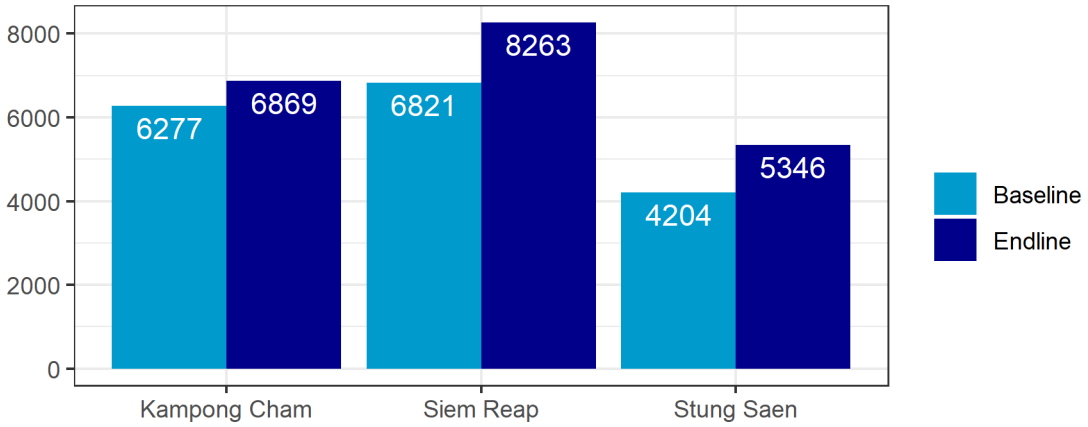
We observe a remarkable increase over time in respondents' willingness to pay for monthly waste collection. This could reflect greater need for the service, but also may reflect greater satisfaction with the quality of service they receive and improvements in the reliability and frequency of collection. Overall, the average amount respondents were willing to pay for collection of waste at home increased 11%, rising from 8,822 Riels ($2.15) at baseline to 9,807 Riels ($2.39) at endline. As seen in **Figure 9.1**, willingness to pay at endline was highest in Siem Reap, where the average amount respondents were willing to pay for home collection grew by 12.5% over time to 11,111 Riels ($2.71). Willingness to pay also increased in Stueng Sean by 16%, to a substantially lower monthly fee of 7,177 Riels ($1.75). Interestingly, both of these municipalities are serviced by GAEA, the waste management company that enthusiastically incorporated the *WasteTracker* app into their daily operations. By contrast, we saw no significant increases in willingness to pay overtime in CINTRI-serviced Kampong Cham.

Figure 9.1: Willingness to Pay for Home Collection



Turning to the willingness to pay for neighborhood services, as is to be expected, the average amount respondents are willing to pay is lower for this less personalized service. However, we do observe higher growth rates in willingness to pay overtime in all three municipalities. Across all municipalities, willingness to pay grew 20.6% from 5,974 Riels ($1.45) to 7,208 Riels ($1.76). Growth ranges in GAEA-serviced areas from 27% in Stueng Sean to 21% in Siem Reap, while respondents in CINTRI-serviced Kampong Cham recorded a 9.4% increase in willingness to pay for neighborhood collection.

Figure 9.2: Willingness to Pay for Neighborhood Collection



Primary Results

Table 9.1 presents the endline difference-in-means for the indicators in the Willingness to Pay outcome family. Recall that * indicates $p < 0.10$, ** indicates $p < 0.05$, and *** indicates $p < 0.01$.

We did not observe significant treatment effects for household services for either the App or Report Treatment. Remarkably, however, we see a sizeable and significant negative effect on the amount willing to pay for neighborhood waste collection in areas that received the phone promotion of the *WasteTracker* App. Recipients of the phone call were willing to pay 727 Riel (about ten cents) less per month for neighborhood services than respondents who did not receive the phone call.

This result is consistent with effects observed within the first three outcome families, where we showed that respondents were more negative about personal responsibility for formal disposal and marginally (but not significantly) more negative in their assessments of service delivery. Here, we see that those negative effects manifest in less willingness to pay for community collection.

Table 9.1: Endline Difference in Means for Outcome Family 4

	Obs	App Treatment	Report Treatment
Amount willing to pay for household collection (Riels)	3687	-138.014	-5.861
Amount willing to pay for neighborhood collection (Riels)	3692	-427.299**	-145.924

10. OUTCOME FAMILY 5: VILLAGE CLEANLINESS

Summary of Key Findings

- Household reported cleanliness increased in Siem Reap but declined in other municipalities.
- Village chief reported cleanliness showed no significant improvement over time.
- We find that neither the App nor the Information treatments have a statistically significant impact on respondent perceptions of village cleanliness.
- Likewise, the App Treatment had no impact on village cleanliness as reported by either the observational survey or the survey of village officials.

Trends over time

Figure 10.1 demonstrates very mixed results in household reports of village cleanliness over time. At baseline, Stueng Saen had the highest agreement score on the four-point scale (-2 to 2) with the idea that the village was clean (0.81), followed by Kampong Cham (0.65), and last Siem Reap (0.57). However, by endline, this situation had entirely reversed. Siem Reap was the only locality to show improvement over time, finishing with a cleanliness score of 0.66, compared to Kampong Cham, which declined to 0.52, and Stueng Sean, where self-reported cleanliness dropped by nearly half to 0.41.

Figure 10.1: Household Agreement that Village is Clean

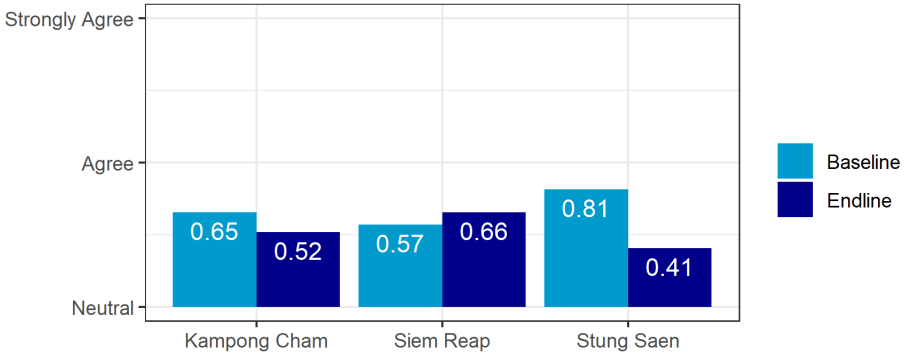
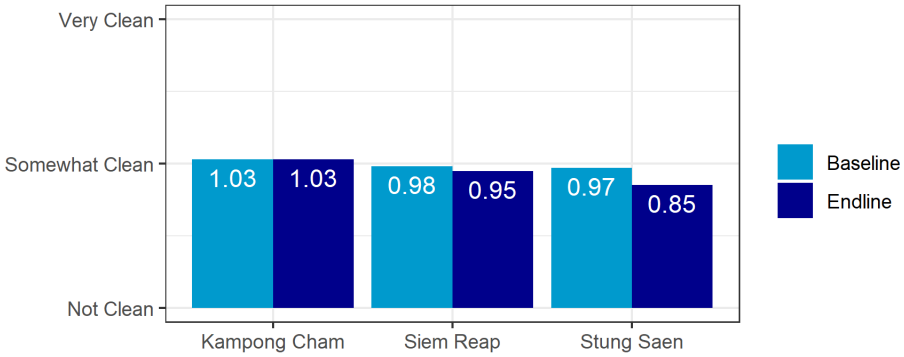


Figure 10.2 provides alternative data from village chiefs in the respective municipalities. Here, we observe very little change in village chief assessments over time with very small declines in Siem Reap and Stueng Saen.

Figure 10.2: Village Cleanliness, from Village Chiefs



Primary Results

Table 10.1 presents the endline difference-in-means for the three primary indicators in the Village Cleanliness outcome family. The first indicator is drawn from the household panel dataset. The second indicator is a measure of village cleanliness as appraised by the village chief or deputy chief, and thus is drawn from the village chief panel dataset. The third indicator is from the observational dataset, which tracks the largest waste pile in 246 blocks over the course of the study period. Because these last two indicators are measured at the village and block level, respectively, we can only estimate the effect of the App Treatment, as the Report Treatment was administered at the level of the household. The App Treatment was administered at the level of the block, however, one third of villages in the sample were set aside as "pure control villages," with no blocks in those villages receiving the treatment. For the second indicator, we therefore compare villages in which some or all blocks received the App Treatment to villages in which no blocks received treatment.

Overall, we find no effect of the App Treatment on village cleanliness, whether measuring cleanliness using household data on perception of cleanliness, village officials' perception of cleanliness, or objective observational data. Similarly, the Report Treatment had no effect on village cleanliness as perceived by households.

Table 10.1: Endline Difference in Means for Outcome Family 5

	Obs	App Treatment	Report Treatment
Agree that village is clean (-2 to 2)	3667	0.047	0.01
Village cleanliness according to village officials	122	0.043	-
Largest waste issue in block was resolved	246	-0.021	-

11. ADDITIONAL ANALYSIS OF SURVEY EXPERIMENTS

Survey experiments offer the potential for insight into how citizens assess sensitive issues that might be difficult to discuss and the tradeoffs involved in complex choices. We embedded three survey experiments in the SWAP endline survey to gauge: a) citizens' willingness to use elections to sanction poor performing local incumbents; b) the incidence of non-payment of sanitation bills; and c) the factors that impact how Cambodians decide which local leaders to seek help from with local problems. The results of these experiments do not speak directly to SWAP's main outcomes. Nevertheless, the survey experiments do provide original insight into how accountability for local services works in Cambodia and, thus, we present the results here.

List Experiment on Elections

Elections are a sensitive topic in Cambodia. As the government has become more restrictive in recent years, citizens have become less and less willing to openly discuss electoral politics. This kind of "sensitive" topic is important, but asking direct questions about it are unlikely to work because respondent might either not respond or provide a socially desirable response that does not reflect their true preferences. "List experiments" are a standard tool for assessing the incidence of sensitive opinions in a survey sample while protecting respondents from having to explicitly state that opinion. It does so by asking respondents to respond to a list of options and choosing the number of options that apply to them; because respondents do not respond to each individual item (including any potentially sensitive items), their privacy is protected. The experiment occurs when a randomly chosen sample of the survey respondents (the control group) are shown a list that does not include the sensitive item and the treatment group is shown a longer list that does include the sensitive item. By comparing the average number of responses between the two groups, researchers are able to identify the incidence of the sensitive behavior in the overall sample.

Our list experiment prompted respondents with the following: "Occasionally, subnational officials may perform below our expectations. The quality-of-service delivery may be less than we hoped, or they make policy decisions that we believe are not in our interest. We are interested in the sets of activities that you may take when you find the performance of your subnational officials to be disappointed. I am going to read 4 statements that describe activities. Please tell me how many of these activities you took in the past 3 years. *I don't want to know about any specific item. I only want to know the total number of activities that you did*." The control group was provided the three un-bolded, non-sensitive options below along with a "placebo" option, "Moved to Europe," which we expect no households to select, while the treatment group received the full list of options below, including the bolded sensitive item.

1) Complained to family, friends, or neighbors.
2) Organized neighbors to provide substitute services yourselves.

3) Considered changing my vote in the next election.
4) Moved to a different municipality or province.

Figure 11.1 demonstrates how the list experiment works. Starting with the left two bars in the Kampong Cham panel, we can see that at baseline respondents in the placebo group selected 0.31 items, while respondents in the treatment group (with the election prompt) selected 0.49 items. The difference between these two figures is .18, which allows us to conclude that at baseline, 18% of respondents in Kampong Cham reported a willingness to change their vote in an election to deal with poor service. Because the list experiment provides plausible deniability of which particular items the respondent may have selected, it is a very useful shield for answering such a sensitive question. However, at endline respondents in Kampong Cham were much less sanguine about elections as a tool of accountability. Less than 1% of respondents reported a willingness to change their vote in the shielded experiment.

Table 11.1 calculated the revealed behaviors for all three municipalities over time. By sharp contrast, willingness to use elections in Siem Reap actually increased over three percentage points to 15.5%. In Stueng Saen willingness to use elections increased by two percentage points to 8.7%. Overall, we see the percentage of the population that use elections as a sanctioning tool to remain at around 11% from baseline to endline.

The table reveals two important findings. First, only a small sliver of the population view elections as a viable tool for improving service delivery under the current government. However, secondly, the interest in elections is not uniform. Whereas Kampong Cham residents appear to have become particularly disenchanted over time, Siem Reap residents see increasing utility in electoral forms of engendering responsiveness.

Figure 11.1: Items Selected in Election List Experiment

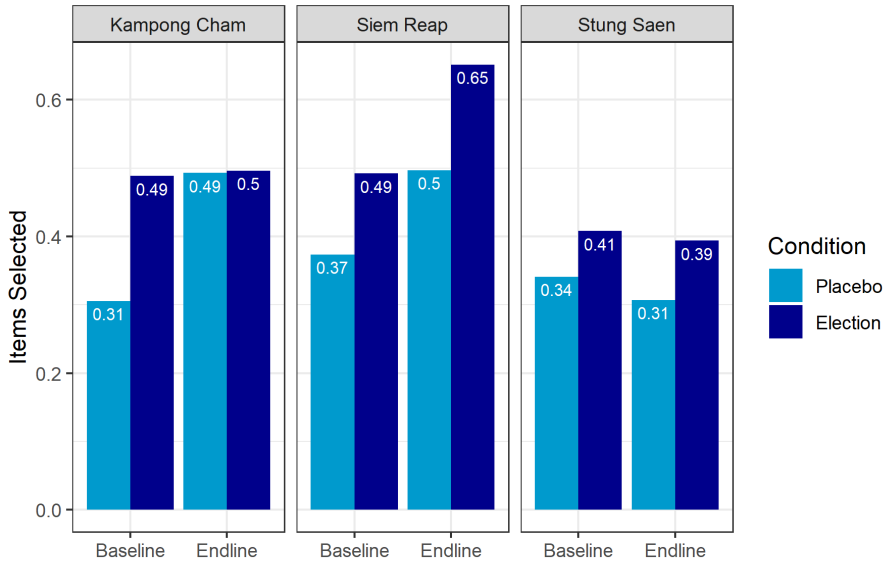


Table 11.1: Willingness to Change Vote in Election, by Municipality

	Kampong Cham	Siem Reap	Stueng Saen	**Overall**
Baseline	18.3%	11.9%	6.7%	**11.4%**
Endline	0.3%	15.5%	8.7%	**11.3%**

While there are increases in the willingness to use elections as a form of accountability over time in two of the three municipalities, with particularly large increases in Siem Reap, the results reported in **Table 11.2** indicate that we cannot attribute these changes to the App or Report Treatments. The control group experiences the largest increase in the willingness to use elections from baseline to endline. Statistical tests confirm that those receiving treatments were statistically no more (or less) likely than those in the control group to report a willingness to use elections to hold incumbents accountable for poor service delivery, indicating that neither treatment had a significant impact on use of elections as a tool for accountability.

Table 11.2: Willingness to Change Vote in Election, by Treatment

	App Only	Report Only	Both App and Report	Pure Control
Baseline	14.0%	18.7%	7.3%	5.6%
Endline	9.1%	9.9%	13.7%	12.6%

List Experiment on Payment for Waste Collection Services

One widely cited reason for poor waste collection services in Cambodia is a lack of a consistent payment for services by households.[15] Perplexingly, the baseline survey provided no such evidence of non-payment. Of 1,797 households that reported being charged for waste collection services at baseline, 92.5% stated that they "always" pay their waste collection fees.[16]

However, there are many reasons we might expect the 92.5% payment rate we observe to be overstated. Although respondents are assured that their responses are anonymous, respondents at baseline might fear that by admitting to non-payment to survey enumerators, they might face consequences from service providers. Furthermore, it is likely that social desirability bias, or the desire of respondents to appear as upstanding citizens to enumerators, pressured respondents to overstate the regularity with which they pay their waste service fees.

[15] See for example: Niem Chheng. September 16, 2016. "Cintri says it is owed up to $20M by Phnom Penh residents." *Phnom Penh Post.* https://www.phnompenhpost.com/national/cintri-says-it-owed-20m-phnom-penh-residents; Robin Spiess. October 27, 2017. "Cintri chided by former exec." *Phnom Penh Post.* https://www.phnompenhpost.com/business/cintri-chided-former-exec ; Kong Meta. September 18, 2017. "New firm takes over for Cintri to tackle trash in Sihanoukville." *Phnom Penh Post.* https://www.phnompenhpost.com/national/new-firm-takes-over-cintri-tackle-trash-sihanoukville

[16] Note that 250 households, or 12.2% of formally-serviced respondents, reported that they were not charged a waste collection fee.

At endline, we employ a list experiment to evade the potential of social desirability biasing our estimates of fee payment. As described in the previous section, list experiments are commonly employed to estimate the prevalence of sensitive behaviors in a population. Because the design of the question ensures respondents are "shielded" from admitting to any undesirable or sensitive behaviors outright, a list experiment is better poised to uncover the true prevalence of non-payment for the households in our study.

The endline asks the following question: "I'm going to read you a list of expenses that households like yours might pay on a regular basis. Please listen to the list and tell me how many of these expenses your household pays for in a typical month. I do not want to know which expenses you pay for, only how many." The control group was provided the three un-bolded, non-sensitive options below along with a "placebo" option "Magazine Subscription" which we expect no households to select, while the treatment group received the full list of options below, including the bolded sensitive item.

1. Rent
2. Property Tax
3. Waste Collection
4. Phone Service

The question was administered to all endline respondents in the final survey module about household assets, so as to reduce its association with the core modules about waste behaviors. Subtracting the mean number of items selected by those in the placebo group (the group of households that received a list of three non-sensitive options and one placebo option) from the mean number of items selected by those in the treatment group (the group of households that received a list of three non-sensitive options and the treatment option, "waste collection") provides us with the incidence of payment of waste collection fees in our survey's sample.

At endline, 2,398 of 5,012 households (47.8%) report receiving formal collection services at endline, of which 2,091 (87.2% of serviced households) report being charged a fee for waste services. In order to ascertain the rate of payment among households that should be paying for waste services, we compare the mean number of items selected by households that are charged a waste fee and receive the placebo question to the mean number of items selected by households that are charged a waste fee and receive the treatment question. **Table 11.3** below reports the results. Overall, we find that among households that are charged a fee, 90.1% pay their fee in a typical month. Surprisingly, this result is very close to the 92.5% of respondents who indicated at baseline that they always paid their waste service fee in response to the non-shielded question "How often does your household pay your waste service collection fee?"

Table 11.3: Waste Fee Payment, by Municipality

	Kampong Cham	Siem Reap	Stueng Saen	**Overall**
Share of HHs that pay waste fee (among HHs that are charged a waste fee)	94.9%	92.3%	72.1%	**90.1%**

Our results suggest that in general, concerns about non-payment of waste fees are likely overstated. However, we do see drastically different rates of payment across municipalities. Non-payment seems to be a significant issue in Stueng Saen, where the share of households that pay their waste fee stands at a little over 72%. Of the 256 households in Stueng Saen that are charged a waste fee for formal services, this amounts to 72 households that regularly do not pay, or approximately $2,592 in forgone waste fees each year just from those in our Stueng Saen survey sample.[17]

Conjoint Experiment on Public Services

The third survey experiment speaks to the factors that impact how Cambodians decide who to seek help from in negotiating their day-to-day interactions with government. The choice of who to seek help from is complex; citizens might consider several different parameters, including whether a potential helper shares their attitudes about government, their status in local government, and how much the leader will charge them for their help. "Conjoint" or "forced choice" experiments are designed to measure how much different considerations impact these kinds of complex choices. They do so by randomly assigning different values along key choice dimensions.

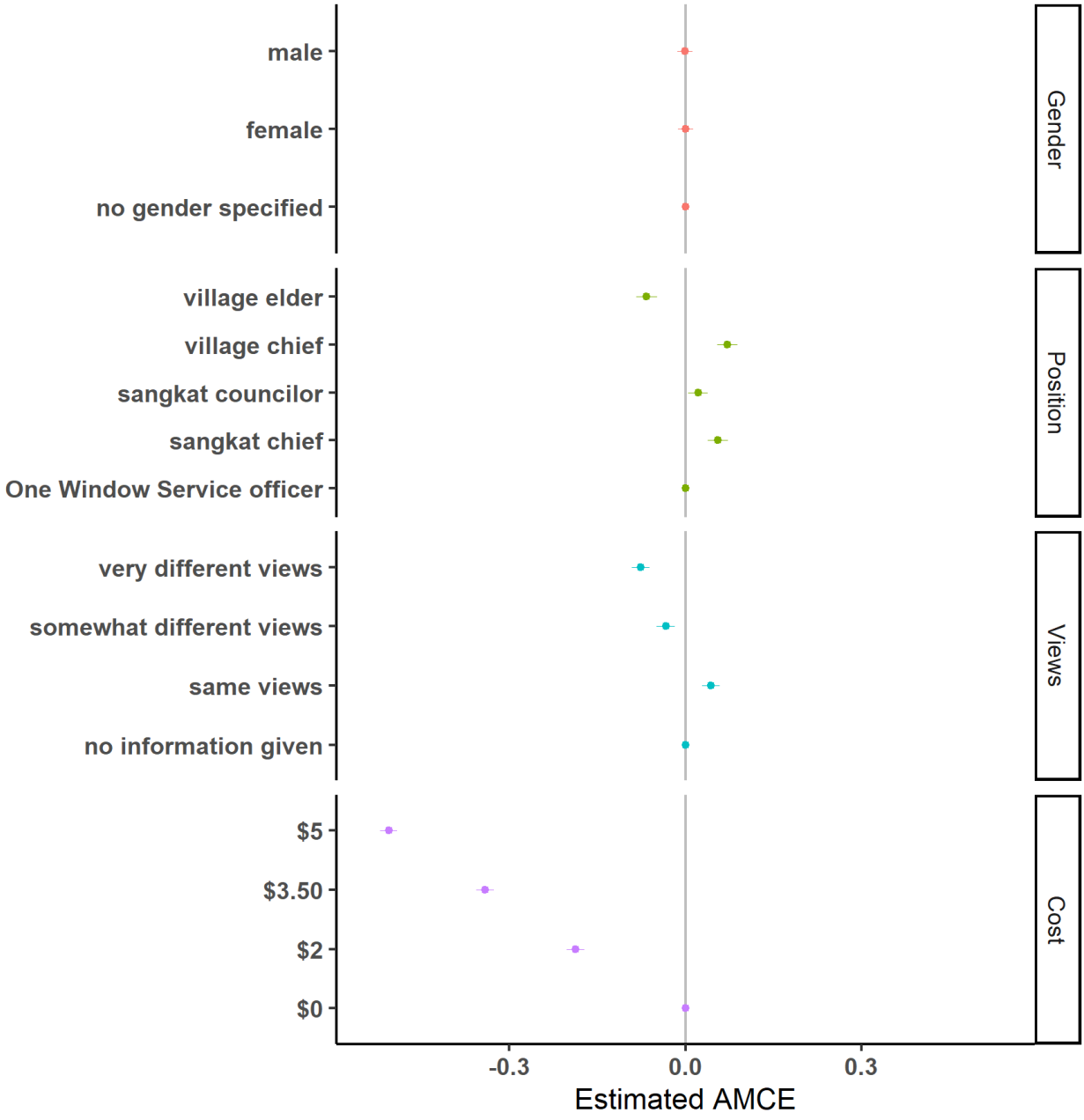
Our conjoint isolates the impact of four key dimensions: the gender of leaders, the position they hold in the local community, the extent to which they share views with the respondent, and how much they charge for help. We prompted respondents with: "I am going to ask you to make a choice between two imaginary leaders in your community to ask for help. Please note, the leaders we will describe are not real people. We simply want you to imagine who, between the two made-up leaders, you would choose to help you if they were real. Please imagine that someone in your household needed to obtain a birth certificate for their child. Some people in your community told you about two different people that can help you attain this document, and you have to decide which person to ask for the certificate."

Figure 11.2 reports the results. Readers can interpret the point estimates in the figure as the percent that the appearance of each dimension increases or decreases the probability that a respondent chooses one or the other leader. The findings on gender indicate that respondents are indifferent whether a hypothetical leader is a man or a woman. On the other hand, respondents prefer leaders who have political, rather than administrative, positions: village chiefs, sangkat councilors, or sangkat chiefs are 5-10% more likely to be chosen than a one-window service officer. Informal leaders are the least likely to be approached for help attaining a birth certificate, with respondents roughly 10% less likely to prefer village elders than one-window service officers. Likewise, respondents are also sensitive to the preferences of potential local leaders. They are about 10% less likely to choose a leader who has very different views than themselves and about 5% more likely to choose one who has their same views. Finally,

[17] This figure is derived by multiplying the mean waste fee respondents report being charged monthly - $4 – by twelve months, then multiplying by 72 non-paying households.

respondents are very price sensitive. Leaders who charge $5 for their help are about 60% less likely to be chosen, those who charge $3.50 are 45% less likely to be chosen, and those who charge $2 are 20% less likely to be chosen. Whether such payments are formal or informal, local citizens are very sensitive to their cost.

Figure 11.2: Factors Impact Respondent Choices of Which Leader to Ask for Help



12. RECOMMENDATIONS AND LESSONS LEARNED

1. For technically complex interventions, encouragement designs administered remotely are likely insufficient to ensure reasonable levels of treatment uptake. The onset of the COVID-19 pandemic required significant changes to the nature of the SWAP intervention, including the removal of most in-person components of treatment. While the *WasteTracker* app was in some ways well-suited for the pandemic context in that it could be operated by users independently and without in-person interaction, the inability to guide treated users through downloading and using the app in real-time undoubtedly limited the number of households in the treatment group that ultimately ended up installing and employing the app. The most commonly cited reason for not downloading *WasteTracker,* among households that had heard of the app, was not knowing how to do so.

2. Unfortunately, designing an app from scratch proved to be technically difficult in the narrow time period covered by the program. Technical glitches heavily impeded the *WasteTracker* app's functionality, especially in the earlier days of app rollout (when the App Treatment was administered). While many technical issues with the app were eventually resolved, for some users it was likely too late as they had already disengaged with the app. A follow-up project is recommended to evaluate the impact of the app after software improvements have facilitated ease of use.

   Key informant interviews indicated several existing ways in which citizens regularly communicate issues about waste collection services to SWSPs and government officials, including the use of WhatsApp groups, Facebook pages, Telegram channels, and phone hotlines. The ease of usability of these platforms, paired with their familiarity among citizens as well as service providers and officials, mean that new digital technologies should be programmed in a way that is compatible with pre-existing usage.

3. Sensitizing citizens to a new technology for addressing service quality when that new tech itself performs erratically may have negative effects on citizens' attitudes and openness to citizen tech. This may be especially true for uneducated or low-skilled citizens, who are not facile with digital technology.

4. Improving government accountability and oversight is challenging when the government cannot be directly engaged. Municipal and sangkat officials indicated enthusiasm and interest in the *WasteTracker* app; however, a lack of knowledge about the app's functionality hindered officials' ability to incorporate the app into their daily operations. At endline, it was evident that officials did not view the app as a tool for overseeing SWSPs and showed little evidence of understanding how or whether the app was being used by citizens in their constituencies. Investing more time and resources on training government officials in the functionality of the app, as well as the potential benefits of the intervention

not just for their constituents but also for making their own jobs easier, is important for ensuring buy-in from government stakeholders. Obviously, this policy lesson conflicts with USG policy in Cambodia, which precludes direct engagement with government.

5. IEs are a smart investment to ensure taxpayer dollars are spent on maximizing program impacts. In this IE, as in any applied research endeavor, even null results are helpful for providing concrete feedback on program successes and failures, potential unexpected consequences, and the need to adapt or redesign activities. Without the rigorous design of an RCT, it would have been easy to rely only on qualitative feedback from a small number of stakeholders that reported overall satisfaction with the program and decide that the SWAP model should be scaled.

   The data collected in this IE will provide many opportunities for additional learning about civil society and accountability in Cambodia. The research team is exploring future publications and conference presentations to widely share the results with the academic and practitioner communities. More broadly, the findings from this IE will help USAID/Cambodia and USAID to adapt existing programming, design new programs, and understand the development challenges facing civil society and service delivery in Cambodia.

6. Citizen tech interventions like SWAP may need a longer runway for a successful IE. It can take time to successfully develop, test, and promote an app to a new population. And it can take even longer for new technology to be accepted and frequently used by the target audience. It is possible that a longer evaluation period is needed to observe significant effects.

ANNEX I: TELEPHONE PROMOTION SCRIPT

Below is the script that VAs read to treated respondents over the phone after they indicated they were willing to learn more about the *WasteTracker* app.

> *Thank you very much for your time! This application will not only help you and your household, but your entire community. As I mentioned, WasteTracker is designed to fix waste problems by putting you directly into contact with your waste service provider, local government, and fellow citizens! This application allows you to photograph and report on any waste issue in your community, whether it be uncollected waste, a large pile of waste on a street corner, or an overflowing dumpster in the market. You can upload your photo\report anonymously or by making an account. Your report will have its location saved, and the exact location of the issue will be uploaded to a map of the city, so app users can see where large waste issues are in real time. Some customers of service providers will have extra features, like a calendar of when their waste will be collected.*
>
> *Your local service provider also has access to this map. Once an issue has been reported on, will be sent directly to the waste service provider and a clock will begin. The application tracks whether the service provider solves the issue and how long it takes them to solve it. This allows you, the user, to see whether your garbage company is doing its job well and directly give them feedback if they are not. Keep in mind there will be no way to connect the report to the sender. If you choose to post anonymously there is NO POSSIBLE WAY that the waste service provider or any other party will ever be able to know you sent that report.*
>
> *Your local government will have access to a report that collects all of the anonymous notifications into a single presentation and map. Using this report, the government can track both how the waste service provider is doing and what the citizens think of the service provider. This amplifies your voice, allowing the community to ensure that their waste is being collected. Keep in mind that all notifications can be anonymous, and the local government will only receive an aggregate report of status in the community. You have the control over if the report can be connected to you. If you do not create an account, no individual report can be connected to the sender.*
>
> *In order to make this application as great as possible, we need many people to use it! The power of any one post can be amplified by the community and working together as a community allows us to have the best solid waste service possible. Most importantly, this app connects you with your community and allows you to see all waste issues in your community and how they've been responded to. The more people in the community who are using the app, the more power the community has to make sure that all of these waste issues are being addressed in a proper and timely matter.*
>
> *Using the app will lead to a cleaner community with a more responsive and thorough solid waste service provider. A cleaner community is a healthier community, a community better for business and travelers, a more beautiful community, and one to be even more proud of! Working together, we can create a cleaner and healthier city!*

Prior to concluding the call, VAs read from the following script directing treated respondents to resources which could assist them in downloading and using the app.

> *Do you have any questions to me? {wait for response} If you do not have any questions for me, I would like to thank you for taking the time to learn about SWAP and the WasteTracker app. If you have any issues/questions about WasteTracker in the future, please do not hesitate to contact me via this number via call, or on SMS or Telegram and I will call back to save your cost on phone credit.*

13. ANNEX II: BASELINE DIFFERENCE-IN-MEANS TABLES

Table 14.1: Baseline Difference in Means for Outcome Family 1

	Obs	App Treatment	Report Treatment
HH receives formal collection services	3748	-0.008	-0.032**
HH burns waste	3748	-0.014	0.037**
HH buries waste	3748	0.000	0.000
HH dumps waste	3748	0.009	0.002
HH uses current disposal method because it is clean	3747	0.009	0.019
HH uses current disposal method because of the environment	3747	-0.017	-0.005
HH has no access to formal collection services	3748	0.011	0.000
Frequency of formal collection (1 = least frequent, 6 = most frequent)	1630	0.095	-0.001

Table 14.2: Baseline Difference in Means for Outcome Family 2

	Obs	App Treatment	Report Treatment
Agree that dumping on road is disrespectful (-2 to 2)	3706	0.001	-0.009
Agree that burning trash is disrespectful (-2 to 2)	3663	0.013	-0.064
Agree that waste disposal an important issue (-2 to 2)	3675	-0.024	-0.055
Agree that one shouldn't litter (-2 to 2)	3722	-0.002	0.004

Table 14.3: Baseline Difference in Means for Outcome Family 3

	Obs	App Treatment	Report Treatment
Satisfaction with Village Waste Provision (-2 to 2)	3354	0.079**	-0.019
Agree that contacting provider is effective (-2 to 2)	1386	-0.009	0.046

Table 14.4: Baseline Difference in Means for Outcome Family 4

	Obs	App Treatment	Report Treatment
Amount willing to pay for household collection (Riels)	3657	-234.633	-77.223
Amount willing to pay for neighborhood collection (Riels)	3673	-234.578	51.059

Table 14.5: Baseline Difference in Means for Outcome Family 5

	Obs	App Treatment	Report Treatment
Agree that village is clean (-2 to 2)	3667	0.047	0.010
Village cleanliness according to village officials	122	-0.014	-
Largest waste issue in block was resolved	-	-	-

14. ANNEX III: DIFFERENCE-IN-DIFFERENCES PLOTS

Figure 15.1 through **Figure 15.5** below plot the coefficients on the interaction term, with 95% confidence intervals, from the difference-in-difference models for each primary household indicator. If a coefficient's confidence interval crosses the zero line, it is indicative of a null result, such that the treatment is found to not have a statistically significant effect on that outcome.

Figure 14.1: Treatment Effects for Outcome Family 1

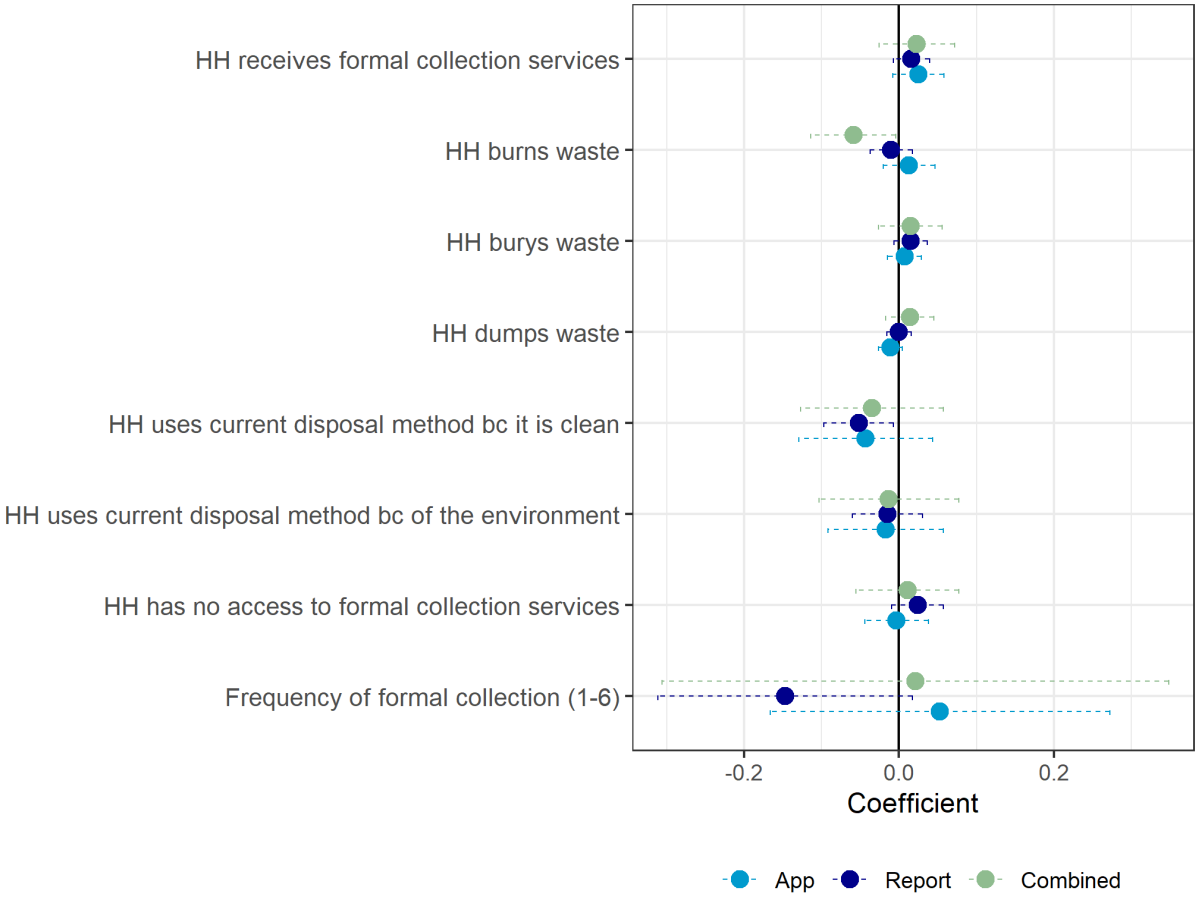


Figure 14.2: Treatment Effects for Outcome Family 2

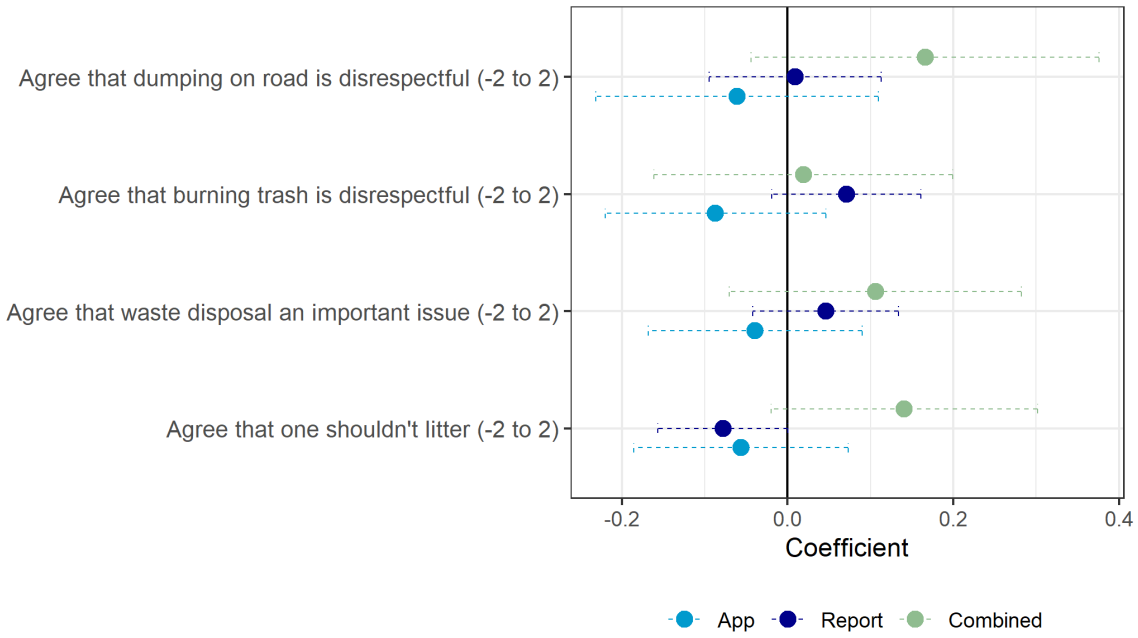


Figure 14.3: Treatment Effects for Outcome Family 3

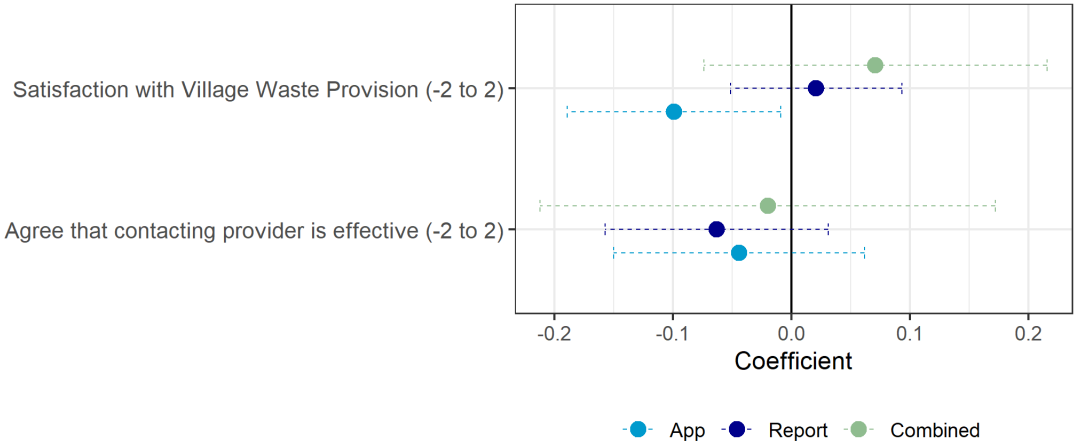


Figure 14.4: Treatment Effects for Outcome Family 4

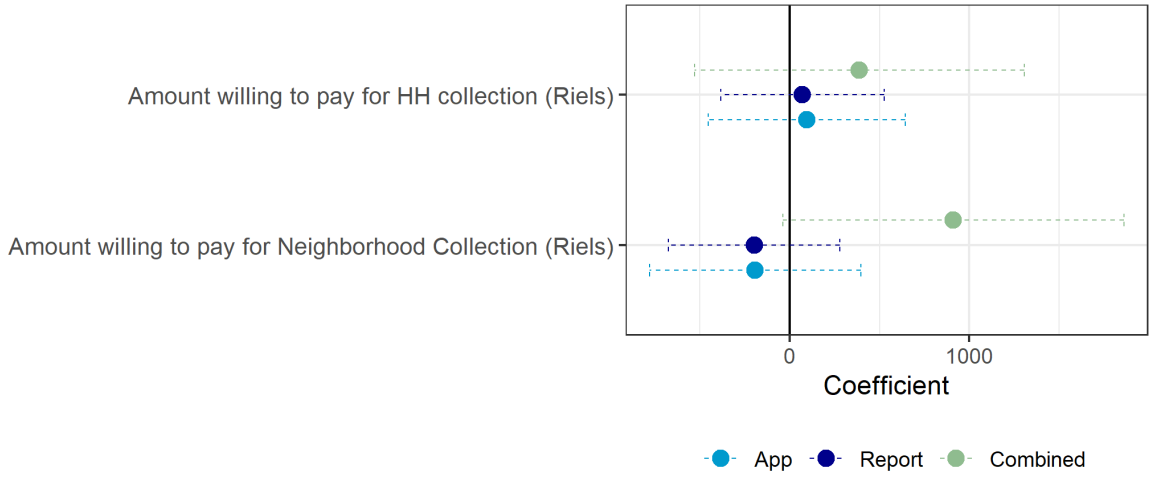


Figure 14.5: Treatment Effects for Outcome Family 5