Author’s response to reviews

Title: Piloting a low-cost hardware intervention to reduce improper disposal of solid waste in communal toilets in low-income settlements in Dhaka, Bangladesh

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Author’s response to reviews:

Response to Reviewer #1

Overall relevance:

The article describes an iterative approach of using qualitative investigation to address sanitation challenges in an urban centre in a developing country. It therefore provides a good learning example for other cities faced with similar challenges.
Materials and Methods:

Page 10 line 17: The authors report that collected data was used to design materials for a pilot intervention. It is not clear how this was achieved. What strategy was used to prioritise the specific materials and interventions for piloting?

- Response: Thank you for your valuable comments. We collected data and identified factors contributing to improper disposal of trash into communal toilets. We drafted signs and developed behavior change communication materials to discourage waste disposal in toilets and returned to the residents of the community to elicit their feedback on these materials. Then we hired a professional artist to draw the signs indicating appropriate waste disposal in waste bin and to draw the signs discouraging waste disposal in toilet. We examined four potential waste bin hardware models to facilitate adoption of appropriate waste disposal behaviours and selected the hardware (waste bin). We revised the manuscript according to your suggestion which you can find in 2nd paragraph of page 11 and 1st paragraph of page 12.

- Revision in manuscript: “In Phase 1, we characterized the problem. In Phase 2 we selected hardware (waste bins with lids), behavioral recommendations (disposal of items into bins that could block toilet outflow), and visual aids to communicate the behavioral recommendations: stickers (for waste bins and doors), signs (for walls of compounds) and cue cards (for interpersonal communication by promoters). The choice of visual aids to be developed was influenced by our desire to place the information as close as possible to where the behavior would be practiced, i.e. near the toilet. We assessed the acceptability and preferences for four candidate waste bin models to facilitate adoption of appropriate waste disposal behaviors. We then conducted six focus group discussions—three with female residents and landlords, two with male residents and landlords, and one with children—to select the preferred waste bin design and elicit feedback on the stickers, posters and cue cards these materials before selecting and finalizing intervention hardware and print materials for the pilot intervention.”

Page 10 line 26: The authors developed BCC materials to discourage waste disposal in toilets. It would be helpful to give more details on what type of materials were developed (audio messages, posters, videos, etc) and what could have influenced this choice?

- Response: Thank you for your interest. We developed posters with appropriate signs and cue cards. We selected the materials according to the choice of the residents of the community. We installed the signs inside the toilets and hanged the cue cards in a suitable place after discussing with the compound members. We revised the manuscript according to your suggestion which you can find in 2nd paragraph of page 11 and 1st paragraph of page 12.

Revision in manuscript: “In Phase 1, we identified the problem. In Phase 2 we selected
hardware/technology (waste bins with lids), behavioural recommendations (disposal of items into bins that could block toilet outflow), and stickers (for waste bins and doors), signs (for walls of compounds) and cue cards (for interpersonal communication by promoters) to communicate the behavioural recommendations. The choice of visual materials to be developed was influenced by our desire to place the information as close as possible to where the behavior would be practiced, i.e. near the toilet. We assessed the acceptability and preferences for four candidate waste bin models to facilitate adoption of appropriate waste disposal behaviors. We then conducted six focus group discussions—three with female residents and landlords, two with male residents and landlords, and one with children—to select the preferred waste bin design and elicit feedback on the stickers, posters and cue cards these materials before selecting and finalizing intervention hardware and print materials for the pilot intervention.”

Page 10, line 33: focus group discussions were conducted separately for both males and females. However, they were both mixed with landlords. Could this have influenced the discussions? This choice should be justified. Also, a focus group discussion was conducted with “children”. It’s not clear how many these were and how they were selected. More importantly, the authors should clarify whether and how the consent process for the participating children was handled.

- Response: In these community there are two kinds of landlords. One kind lives elsewhere in the city. They were not part of the focus group discussions. Another kind of landlord lives in the same compounds. They use the same toilets. In this slum context, this second type of landlord has similar socioeconomic status to the tenants. It is common in this context that tenants are at liberty to give their own opinion in front of landlord and often they discuss with landlords regarding their problems with using the latrines. We encouraged the landlords to be present in the focus group, because their participation would facilitate eventual decisions over assignment of roles and responsibilities among compound members, such as emptying of waste bins. As maintenance is a big issue for this intervention and landlord can play a big role for maintenance so it was important for us to ensure their presence in focus group discussions.

- We did one FGD with children. We used an assent form and obtained consent from parents to conduct the FGD. The total number of participants for FGD with children were 12. Their age limit were 8-15.

- Revision in manuscript: In 1st paragraph of page 12 you can find the revised sentences. “In these community there are two kinds of landlords. One kind lives elsewhere in the city. They were not part of the focus group discussions. Another kind of landlord lives in the same compounds. They use the same toilets. In this slum context, this second type of landlord has similar socio-economic status to the tenants. It is common in this context that tenants are at liberty to share their own opinions in the presence of landlords and often they discuss with
landlords their problems with use and maintenance of the latrines. We encouraged the landlords to be present in the focus group, because their participation would facilitate eventual decisions over assignment of roles and responsibilities among compound members, such as emptying of waste bins. Landlords can play a pivotal role for maintenance so it was important for us to ensure their presence in FGDs."

- In 2nd paragraph of page 15 you can find the revised sentences. "We secured assent from children and obtained consent from parents to conduct the focus group discussions with children."

Data Analysis

Page 11, line 31: It is not clear what the authors mean by “manually analysed”. How do the results presented relate to the collected data? Was there identification of themes in the study? How well did the collected data fit within the IBM-WASH model used in the study?

- Response: Thank you for this valuable comment. Audio data from in-depth interviews and focus group discussions were transcribed verbatim in Bengali and then translated into English transcripts in Microsoft Word. The final English transcripts contained numerous transliterations so as to retain the original tone of the interviews. Based on themes we created codes which were chosen prior to data collection according to the study objectives. The research team met regularly during data transcription and translation to aid data familiarization. We generated additional inductive codes from the data. Individual and group interview transcripts were then manually coded and categorized according to these major codes.

- The three broad dimensions in the IBM-WASH model – contextual, psychosocial and technological – captured well the different considerations that we needed to address in developing the intervention model: 1) The physical, economic and social context of low-income communities in Dhaka, and how this context affects the feasibility and effectiveness of interventions; 2) psychosocial factors at the individual, household and compound levels, including disgust in response to disposal of certain items into waste bins; and 3) technology factors including design of waste bins and the functioning of Vacutug machines. On the other hand, a simplified model of issues warranting consideration might be designed for groups hoping to adapt or replicate this intervention model in different settings.

- Revision in manuscript: In 1st and 2nd paragraph of page 14 you can find the revised sentences. " All data were collected by native Bengali speakers with extensive qualitative research experience. Audio recorded data from in-depth interviews and focus group discussions were transcribed verbatim in Bengali and then translated into English transcripts
in Microsoft Word. The final English transcripts contained numerous transliterations so as to retain the original tone of the interviews. The translators were instructed to transliterate great portions of the interviews which contained local terms and expressions. Based on themes we created codes which were chosen prior to data collection according to the study objectives. The research team met regularly during data transcription and translation to aid data familiarization. We generated additional inductive codes from the data. Individual and group interview transcripts were then manually coded and categorized according to these major codes.

- Although the interviews were coded and categorized individually, the research team drew inferences from the findings collectively. The research team also took additional open ended field notes even when they were not officially observing or interviewing. These included informal discussions and observations. The team noted the tone and attitudes of the respondents during data collection and met regularly during data transcription to generate additional relevant codes and themes.

How well did the collected data fit within the IBM-WASH model used in the study?

Was the analysis process validated?

General comment on data management and analysis: The authors could highlight on how their relationship with the studied community, their own professional and personal experiences, or cultural differences could have affected their interpretation and design of the intervention. For instance, who coded the data, who analysed the data? And what experiences do these bring to the entire process?

- Response: Thank you for raising this important question. The field team had 4-5 years experience in qualitative data collection. All data were collected by native Bengali speakers with extensive qualitative research experience. Their academic background is Anthropology. The translators were instructed to transliterate great portions of the interviews which contained local terms and expressions. Although the interviews were coded and categorized individually, the research team drew inferences from the findings collectively. The research team also took additional open ended field notes even when they were not officially observing or interviewing. These included informal discussions and observations. The team noted the tone and attitudes of the respondents during data collection and met regularly during data transcription to generate additional relevant codes and themes. we drew inferences from the findings collectively.

- In 1st and 2nd paragraph of page 14 you can find the revised sentences. All data were collected by native Bengali speakers with extensive qualitative research experience. Audio
recorded data from in-depth interviews and focus group discussions were transcribed verbatim in Bengali and then translated into English transcripts in Microsoft Word. The final English transcripts contained numerous transliterations so as to retain the original tone of the interviews. The translators were strictly instructed to transliterate great portions of the interviews which contained local terms and expressions. Based on themes we created codes which were chosen prior to data collection according to the study objectives. The research team met regularly during data transcription and translation to aid data familiarization. We generated additional inductive codes from the data. Individual and group interview transcripts were then manually coded and categorized according to these major codes.

- "Although the interviews were coded and categorized individually, the research team drew inferences from the findings collectively. The research team also took additional open ended field notes even when they were not officially observing or interviewing. These included informal discussions and observations. The team noted the tone and attitudes of the respondents during data collection and met regularly during data transcription to generate additional relevant codes and themes."

Ethical considerations.

Line 52. The second sentence does not read well. Please check

- Response: We have revised the manuscript according to your suggestion. Please find in the 2nd paragraph of page 15.

- Revision in manuscript: “We obtained written informed consent from the adult study participants as well as verbal permission to conduct intervention activities from the landlords in the pilot communities. The study protocol was reviewed and approved by the ethical review committee of icddr,b and institutional review board of Stanford University.”

Conclusions

General comment: The conclusions should be summarised further highlighting the most important messages from the article in at most 2 paragraphs. The study limitations could be included and discussed under the discussion section.

- Response: Thank you for your valuable comment. We have revised. Please find in the last paragraph of page 25 and 2nd paragraph of page 26.
Revision in manuscript: "This intervention to improve waste disposal in communal toilets in this settings demonstrated that a lidded waste bin inside the toilet with a removable plastic bag, behavioral recommendations for what items to place in the waste bin, visual aids and interpersonal communication to promote the behavioural recommendations and assignment of responsibility for regular emptying of the waste bins reduced the improper disposal of waste in the toilet pit that can impede the safe removal of fecal sludge and impair toilet functionality. Residents reported positive changes in toilet cleanliness and usability resulting from this intervention. Residents liked the waste bins because they were used and the toilet cubicle remained clean and orderly. We observed a strong shared interest in maintaining the waste bins, encouraging their continued maintenance.

Designation of a site or a collection service for disposal of materials placed in the waste bins remains challenging and we still have not identified a satisfactory solution to it. People dump waste in lakes, ponds, ditches etc. in areas where there is no system in place for regular solid waste collection."

Recommendation:

The manuscript should be published after addressing these minor changes.

Response to Reviewer #2

Firstly, it is great to see more research focused on urban sanitation. This is a growing challenge worldwide and we need to find solutions for the many, highly-complex issues regarding sanitation and health in urban slums. Your study has shown that a focused, iterative method can help find custom-fit solutions for specific communities. I have a few queries regarding the manuscript.

Materials & Methods

In terms of materials and methods, how were the two communities selected? Were these two the only communities where WSUP funded Vacutug pumps were being used (and getting blocked) or where there others, thus needing to make the decision to go for Bauniabad and Kolyanpur based on other factors?

Response: The two communities were selected on the basis of current report from WSUP's vacutug emptiers that they faced problem of blockages during emptying. Please find at the 1st paragraph of page 10.
Revision in manuscript: "To better understand waste disposal practices and fecal sludge management in low-income, urban communities in Dhaka, we selected two communities, Bauniabad and Kolyanpur, where Vacutug pumps supplied by WSUP become blocked at that time because of obstructive solid waste disposed directly into toilets."

When conducting in-depth interviews with residents regarding toilet use, did you encounter any individuals who refused or were not eligible for the interview (page 10, lines 7-19)? Are the toilets in the two communities only accessible to residents, or can people from outside the community use them? (ie from a nearby trading centre).

Response: We did not encounter any individuals who refused or were not eligible for the interview. Toilets in the two communities only accessible to residents.

It was not clear to me that one type of bin model with foot pedal and one type without foot pedal was tested (only clear once I saw Figure 1). Was it randomly decided to trial one particular one in one setting or the other? Page 10, line 47 onwards.

Response: Yes it was randomly decided to trial one particular one in one setting. Please find the revised sentences at the 1st paragraph of page 13.

Revision in manuscript: "We promoted the pilot intervention including hardware and behavior change messages at two communal toilet sites in Bauniabad and Kolyanpur. The pilot intervention tested one particular one waste bin model in one site and another particular model at the other site (Figure 1)."

Was there a cost difference between the two different bin models? Page 11, line 7, were the daily spot checks at random times, or could the residents 'expect' them at a specific time of day.

Response: The cost difference between two waste bins was very minimal. It was .43$/35 BDT. Daily spot checks were in random times.

Page 11, line 21/22. Perhaps 'achieved' or 'reached' data saturation sounds better than 'got', but this may be a personal preference.

Response: Thanks for your valuable comments. We have revised the sentence. Please find at the 1st paragraph of page 14.

Revision in manuscript: We reached thematic saturation after completion of these 24 interviews.
Data analysis, page 11, line 40. How many people (and who?) were involved in the manual analysis of the English codes, and how was consensus reached if there were any disagreements?

- Response: Thanks for your valuable comments. We have revised the manuscripts. Please find at the last paragraph of page 13.

- Revision of manuscript: " All data were collected by native Bengali speakers with extensive qualitative research experience. Audio recorded data from in-depth interviews and focus group discussions were transcribed verbatim in Bengali and then translated into English transcripts in Microsoft Word. The final English transcripts contained numerous transliterations so as to retain the original tone of the interviews. The translators were instructed to transliterate great portions of the interviews which contained local terms and expressions. Based on themes we created codes which were chosen prior to data collection according to the study objectives. The research team met regularly during data transcription and translation to aid data familiarization. We generated additional inductive codes from the data. Individual and group interview transcripts were then manually coded and categorized according to these major codes.

- Although the interviews were coded and categorized individually, the research team drew inferences from the findings collectively. The research team also took additional open ended field notes even when they were not officially observing or interviewing. These included informal discussions and observations. The team noted the tone and attitudes of the respondents during data collection and met regularly during data transcription to generate additional relevant codes and themes.”

Results. Page 12, line 54. Do the communities pay for the emptying of the dumpsters by the city's Solid Waste Management System? Is this a communal pay or a household payment? Did you explore why do the residents throw some waste in the dumpsters (food waste) but other waste in the lakes/bushes/toilets (ie. Children's feces). Page 13, line 9. I assume cost is a major factor, and this gets mentioned later in line 42. Perhaps a small table showing the differences between the two communities and the intervention they received - basic info could be added to Table 1. For example, it is not immediately clear to me whether both areas are served by the city's Solid waste management system, as clearly Bauniabad has other options (lake) for waste disposal (page 13, line 50). If residents were encouraged to dispose of their sanitary waste in the bins (menstrual rags etc) as well as their household waste, were there any issues surrounding vermin/flies with the bins in the toilets (in addition to any flies possibly present in a communal toilet)? Especially if the waste was occasionally left up to 3 days.

- Response: Thanks for your valuable comments. Yes, the communities pay for the emptying of the dumpsters. This was not communal pay. It was household payment. At night time the caregivers did not want to take the child to the toilet because children were afraid to enter the dark latrines and because it was inconvenient to bring the child to the latrine at night. They
reported at night children's feces are contained in plastic and paper bags or collected in potties and subsequently disposed in nearby lakes, bushes or in toilet pits. This is why the caregivers throw some waste in the dumpsters (food waste) but other waste in the lakes/bushes/toilets.

- Though both the areas are served by the city's solid waste management system cost is a major factor in Bauniabad for choosing other options (lake) for waste disposal as lake was adjunct to the community.

- In Bauniabad the waste bin had the lid. So, it was not a problem regarding vermin/flies. In Kolyanpur there was paid cleaner of the waste bin who cleaned the bin everyday. So, in Kolyanpur waste was not left up to 3 days even occasionally.

In terms of issues reported on the disposal of menstrual waste products in the bins, were any of the communal toilets separated for men/women? Or were all facilities used by both? Did any of the communities charge for the use/maintenance/cleaning of the communal toilets? (if so, people have an interest in keeping them functional, and thus will be potentially be more concerned if the emptying cost increases due to solid waste in the pits).

- Response: Thanks for your valuable comments. No, there was not any communal toilets separated for men/women. All facilities were used by both. Use/maintenance/cleaning charge were included with the house rent for the users.

It would also encourage the 'paid bin emptying' model, rather than the volunteer emptying, if residents are already used to paying for a service. Overall, the sustainability of a service where bins are provided/emptied will depend on many factors, including cost and potential cost recovery. As this study conducted a thorough analysis of the waste disposal in two specific settings, could you provide some insight into the potential for rolling it out/scaling it up?

- Response: Thank you for raising this important issue. We have revised the manuscript. Please find at the last paragraph of page 25.

- Revision of manuscript: "This intervention to improve waste disposal in communal toilets in this settings demonstrated that a lidded waste bin inside the toilet with removable plastic bag, behavioral recommendations for what items are to be placed in the waste bin, visual aids and interpersonal communication to promote the behavioural recommendations and assignment of responsibility for regular emptying of the waste bins reduced the improper disposal of waste in the toilet pit that can impede the safe removal of fecal sludge and impair toilet functionality. Residents reported positive changes in toilet cleanliness and usability resulting from this intervention. Residents liked the waste bins because they were used and the toilet
cubicle remained clean and orderly. We observed a strong shared interest in maintaining the waste bins, encouraging their continued maintenance.

- Designation of a site or a collection service for disposal of materials placed in the waste bins remains challenging and we still have not identified a satisfactory solution to it. People dump waste in lakes, ponds, ditches etc. in areas where there is no system in place for regular solid waste collection."

Response to Reviewer #3

This is an important topic, but the manuscript is deficient in a number of ways, described below. I did not find the article to be very novel in terms of its findings. I believe the authors could do more to improve this, such as including more information about the complexity of working in the urban slum context and what makes it a unique context.

- Response: Thank you for your comments. We have revised the manuscript and tried to address your comments according to your suggestions.

Abstract

The steps of the study need to be more carefully explained. It is difficult to understand the flow of the study. The authors could break the methods into sections, such as: Pre-intervention in-depth interviews with five FSM operators and five community members; six intervention design focus groups; and post-intervention in-depth interviews with ten community members and two waste bin collectors.

- Response: Thank you for this suggestion. We have revised the method section. Please find at the 2nd, 3rd and 4th paragraph of page 6.

- Revision in manuscript: "Pre-intervention: We conducted in-depth interviews with five operators of fecal sludge emptying equipment and five adult residents who were also caregivers of children. We identified factors contributing to improper disposal of trash into communal toilets, a barrier to operation of the equipment, in low-income communities of Dhaka, Bangladesh.

- Intervention design: We developed behavior change communication materials to discourage waste disposal in toilets, and promote use of waste bins. We conducted six focus group
discussions with adult male, female, landlord and children to select the preferred design for waste bins to be placed inside toilets, and finalize communication materials.

- Post intervention: We then pilot-tested an intervention package to promote appropriate trash disposal practices and thus facilitate periodic removal of fecal sludge when the latrine pits become full. We conducted 20 in-depth interviews and four focus group discussions with community residents, landlords and cleaners of communal toilets.

The results do not seem very novel.

- Response: The novelty of this study is that the research team was not working as a stand-alone group to bring about change in a one-time, isolated fashion. The project was part of a larger effort to improve fecal sludge management in low-income communities in Dhaka. The project sought to address practical problems faced by Vacutug operators in their work. WSUP is setting up the Vacutug operators as entrepreneurs. The potential for sustainability comes from linkage to this for-profit model, and the interest of the Vacutug operators and other stakeholders in promoting long-term adoption of the behavioral recommendations.

I did not find the conclusion in the abstract related to the study. Consider re-writing this to pull out key lessons from the study.

- Response: Thank you for your valuable comments. We have revised the conclusion. Please find at the 2nd paragraph of page 7.

- Revision in manuscript: "The current practice on the part of local residents of disposing of waste into toilets impedes the safe removal of fecal sludge and impair toilet functionality. Residents reported positive changes in toilet cleanliness and usability resulting from this intervention, and this both improves the user experience with toilets, but also promotes the sustainability of the entrepreneurial model of Vacutug operators supported by WSUP."

Introduction

The authors are missing a lot of relevant literature. For example, there is no discussion of how the IBM-WASH model has been used previously, yet this is the model that the authors used for their study. We don’t hear about this model until the methods section. Further, several qualitative studies have been conducted to characterize cleaning of shared toilets. The authors need to highlight more of those studies.
Response: We have revised the manuscript. We have added discussion of how the IBM-WASH model has been used previously. The three broad dimensions in the IBM-WASH model – contextual, psychosocial and technological – captured well the different considerations that we needed to address in developing the intervention model: 1) The physical, economic and social context of low-income communities in Dhaka, and how this context affects the feasibility and effectiveness of interventions; 2) psychosocial factors at the individual, household and compound levels, including disgust in response to disposal of certain items into waste bins; and 3) technology factors including design of waste bins and the functioning of Vacutug machines. On the other hand, a simplified model of issues warranting consideration might be designed for groups hoping to adapt or replicate this intervention model in different settings. Please find at the 1st paragraph of page 10.

Revision in manuscript: "IBM-WASH had been used for data analysis previously in many literatures. In a study conducted in Bangladesh where authors were guided by IBM-WASH to design codes, conduct thematic analysis, and organize emerging themes according to levels and dimensions in the framework. They analyzed the results according to the contextual, psychosocial, and technological dimensions, at the habitual, individual, household, and community levels, related to behavior in infrastructure-restricted settings [13]. In another study the authors mentioned that they developed Cholera-Hospital-Based-Intervention-for-7-Days and the design of intervention was informed by factors from the Integrated Behavioral Model for Water, Sanitation and Hygiene interventions and constructs from the Health Belief Model [14]. In another study the authors mentioned that the study team used both a priori codes, drawing from IBM-WASH model and the types of user groups, and emergent codes [15]."

We have highlighted more qualitative studies which have been conducted to characterize cleaning of shared toilets. Please find at the 1st paragraph of page 8 and the 1st paragraph of page 8 and 1st paragraph of page 21.

Revision in manuscript: "There is evidence of a potential increased risk of undesirable health outcomes in shared toilet facilities compared with individual household toilets [3]. Shared facilities were less likely to be functional, less clean, and more likely to have feces compared with individual household toilet [3]. Users of shared facilities often reported feeling both satisfied and safe when sanitation facilities were clean and shared by a limited number of households [4]. Over half of the users of the communal latrine facilities were unaware when the tank was last emptied [5]. A study conducted in Kampala, Uganda has revealed that group discussions are effective in improving the cleaning behaviour of shared sanitation users [19]."
The authors should consider discussing the topic more broadly and highlight the existing gaps in the research, prior to discussing their study (Page 7, line 16-29). They may want to move the part about why they are doing their study just before the methods.

- Response: Thank you for this valuable comment. We have revised the manuscript. Please find the 1st paragraph of page 8 and the 1st and 2nd paragraph of page 9.

- Revision in manuscript: "A major barrier to the functionality of latrines in urban slums in Dhaka is lack of fecal sludge management [6]. Currently when latrines fill up, they are either abandoned, or emptied manually [6-8]. Manual emptying is common in many settings: destroying the squatting slab and digging the sludge out with hand tools such as speeds, shovels and buckets [7, 8]. However this practice/method contaminates the surrounding environment, as well as exposing the emptiers to high concentrations of pathogens. Another way of emptying is vacuum-based method which includes utilizing high rates of air flow to suck pit contents through a hose into a container under a partial vacuum [6].

- In Dhaka, installation of sanitary sewer systems is not a viable solution in the short term. The non-governmental organization Water and Sanitation for the Urban Poor (WSUP) is recruiting, training and equipping operators to perform emptying of fecal sludge in low-income communities with one type of vacuum-based equipment, Vacutugs [9, 10]. The vision is that these Vacutug operators will charge for their services, and that this fee for service model will represent a financially sustainable solution for fecal sludge management.

- The entire Vacutug entrepreneur model is put at risk when slum residents dispose of trash in latrines. It blocks the Vacutug machines, making them inoperable [9,10]. The Vacutug operator incurs costs to repair the machine, putting at risk the financial model of working as a Vacutug operator. An assessment of fecal sludge removal in WSUP’s intervention area found that only 10% of fecal sludge in low-income communities in Dhaka was removed by operators using Vacutug or an alternative device for emptying fecal sludge such as a diaphragm or Gulper (Rahman et al, Unpublished data). Fifty-seven percent was removed by manual operators and 33% of latrines remained un-emptied [11]."

Materials and Methods

Similar to the comment in the abstract, there needs to be more work to explain the sequencing of events.

- Response: Please find the revised method section at the last paragraph of page 11, the 1st paragraph of page 12 and 1st paragraph of page 13.
Phase 2 (Intervention design): Developing and pretesting behavior change materials

We developed behavior change communication materials to discourage waste disposal in toilets, and examined four potential waste bin hardware models to facilitate adoption of appropriate waste disposal behaviors. In Phase 1, we characterized the problem. In Phase 2 we selected hardware (waste bins with lids), behavioral recommendations (disposal of items into bins that could block toilet outflow), and visual aids to communicate the behavioral recommendations: stickers (for waste bins and doors), signs (for walls of compounds) and cue cards (for interpersonal communication by promoters). The choice of visual aids to be developed was influenced by our desire to place the information as close as possible to where the behavior would be practiced, i.e. near the toilet. We assessed the acceptability and preferences for four candidate waste bin models to facilitate adoption of appropriate waste disposal behaviors. We then conducted six focus group discussions—three with female residents and landlords, two with male residents and landlords, and one with children—to select the preferred waste bin design and elicit feedback on the stickers, posters and cue cards these materials before selecting and finalizing intervention hardware and print materials for the pilot intervention. The focus group discussions lasted 60-130 minutes. In these communities there are two kinds of landlords. One kind lives elsewhere in the city. They were not part of the focus group discussions. Another kind of landlord lives in the same compounds. They use the same toilets. In this slum context, this second type of landlord has similar socio-economic status to the tenants. It is common in this context that tenants are at liberty to share their own opinions in the presence of landlords and often they discuss with landlords their problems with use and maintenance of the latrines. We encouraged the landlords to be present in the focus group, because their participation would facilitate eventual decisions over assignment of roles and responsibilities among compound members, such as emptying of waste bins. Landlords can play a pivotal role for maintenance so it was important for us to ensure their presence in FGDs.

Phase 3 (Post intervention): Conducting and assessing waste disposal pilot intervention

We promoted the pilot intervention including hardware and behavior change messages at two communal toilet sites in Bauniabad and Kolyanpur. The pilot intervention tested one waste bin model at each of the two sites (Figure 1). Signs indicating appropriate and inappropriate waste disposal behaviors were posted inside communal toilets as a cue to action (Figure 2). We conducted courtyard sessions to introduce hardware, present behavior change messages, demonstrate how to use the hardware to encourage target behaviors, and to recommend that the communities organize a system for emptying and maintaining bins. Weekly, household interpersonal communication sessions reinforcing the behavior change messages and daily spot checks of the bins were conducted for a 2-week period. To explore the acceptability and
feasibility of the pilot intervention, we conducted two follow-up qualitative assessments which included 24 in-depth interviews at four weeks and ten weeks after the pilot commenced. Each assessments included 12 in-depth interviews five with male, five with female communal toilet users and two with waste bin emptiers. One site (Bauniabad) had toilet which contained three cubicles and the other site (Kalyanpur) included two toilet cubicles. We selected one adult male and one adult female toilet users from each toilet cubical users according to their availability and willingness to participate for each assessment. We selected the waste bin emptier based on their current involvement on keeping the waste bin clean as well as responsible for maintenance and availability to participate. Assessments also included an additional focus group discussion with the female toilet users at each site (see Table 1 for a summary of data collection). We reached thematic saturation after completion of these 24 interviews.

How long did the in-depth interviews and focus groups last?
- Response: The in-depth interviews lasted 30-60 minutes. The focus group discussion lasted 60-130 minutes. You can find the revised sentences at the 1st paragraph of page 11 and the 1st paragraph of page 12.
- Revision in manuscript: "The in-depth interviews lasted 30-60 minutes."
- Revision in manuscript: "The focus group discussions lasted 60-130 minutes."

It’s not clear how the authors picked the people for some of the in-depth interviews. Some of the numbers seem
- Response: Thank you for asking this clarification. We tried to clarify this. Please find the revised sentences at the 1st paragraph of page 13.
- Revision in manuscript: "To explore the acceptability and feasibility of the pilot intervention, we conducted two follow-up qualitative assessments which included 24 in-depth interviews at four weeks and ten weeks after the pilot commenced. Each assessments included 12 in-depth interviews five with male, five with female communal toilet users and two with waste bin emptiers. One site (Bauniabad) had toilet which contained three cubicles and the other site (Kalyanpur) included two toilet cubicles. We selected one adult male and one adult female toilet users from each toilet cubical users according to their availability and willingness to participate for each assessment. We selected the waste bin emptier based on their current involvement on keeping the waste bin clean as well as responsible for maintenance and availability to participate. Assessments also included an additional focus
group discussion with the female toilet users at each site (see Table 1 for a summary of data collection). We reached thematic saturation after completion of these 24 interviews."

Some of the research design choices need to be better characterized. Why focus groups for parts of the study and in-depth interviews for other parts? How were focus groups conducted (e.g., # of participants, etc.)? Why did you have residents and landlords together? It seems like landlords could affect the openness of other participants.

- Response: Thank you for your valuable comments. We did both focus group discussions and in-depth interviews for data triangulation. We did focus group discussions to select and pre-test behavior change communications and materials for waste disposal for pilot intervention. There were 6-12 participants in each focus group discussion. We seek collective suggestions from FGD participants to know how to improve the messages and the materials. We tried to refine and select final behavior change communications and hardware for pilot intervention.

- We conducted in-depth interviews to explore knowledge, perceptions, reported practices and barriers to fecal sludge management and waste disposal practices. We also tried to explore the acceptability and feasibility of behavior change communications and materials for waste disposal. Our objective were to know the barriers to keep toilet clean, and to identify problems in using behavior change communications and materials for waste disposal and practices for emptying and maintaining the bin.

- We have revised the manuscript. You can find the revised sentences at the 1st paragraph of page 12.

- Revision in manuscript: "In these community there are two kinds of landlords. One kind lives elsewhere in the city. They were not part of the focus group discussions. Another kind of landlord lives in the same compounds. They use the same toilets. In this slum context, this second type of landlord has similar socio-economic status to the tenants. It is common in this context that tenants are at liberty to share their own opinions in the presence of landlords and often they discuss with landlords their problems with use and maintenance of the latrines. We encouraged the landlords to be present in the focus group, because their participation would facilitate eventual decisions over assignment of roles and responsibilities among compound members, such as emptying of waste bins. Landlords can play a pivotal role for maintenance so it was important for us to ensure their presence in FGDs."
Results

I’m not sure there’s anything novel about what was found. I recommend that the authors think about how their study results build on the greater body of evidence and what can be gleaned from this study that is different than other studies.

- Response: Thank you for this important comment. Please find revised sentences at the 1st paragraph of page 8 and 1st paragraph of page no 9.

- Revision in manuscript: A major barrier to the functionality of latrines in urban slums in Dhaka is lack of fecal sludge management [6]. Currently when latrines fill up, they are either abandoned, or emptied manually [6-8]. Manual emptying is common in many settings: destroying the squatting slab and digging the sludge out with hand tools such as speeds, shovels and buckets [7, 8]. However this practice/method contaminates the surrounding environment, as well as exposing the emptiers to high concentrations of pathogens. Another way of emptying is vacuum-based method which includes utilizing high rates of air flow to suck pit contents through a hose into a container under a partial vacuum [6].

- In Dhaka, installation of sanitary sewer systems is not a viable solution in the short term. The non-governmental organization Water and Sanitation for the Urban Poor (WSUP) is recruiting, training and equipping operators to perform emptying of fecal sludge in low-income communities with one type of vacuum-based equipment, Vacutugs [9, 10]. The vision is that these Vacutug operators will charge for their services, and that this fee for service model will represent a financially sustainable solution for fecal sludge management.

- The entire Vacutug entrepreneur model is put at risk when slum residents dispose of trash in latrines. It blocks the Vacutug machines, making them inoperable [9, 10]. The Vacutug operator incurs costs to repair the machine, putting at risk the financial model of working as a Vacutug operator.

After reading the results, it’s very difficult to know whether the intervention has the potential to be sustained any length of time. What steps were taken to ensure that the effects would be lasting? How might you measure the potential of this intervention to endure past the short-term follow-up of the interviews?

- Response: Thanks for raising this important question. There is little hope of better governance in the near term. That is why we are linking this intervention to a Vacutug operator-entrepreneur model supported by WSUP. This will provide a platform for the long-term sustainability of the intervention. We have revised the manuscript. Please find the revised sentences at the 1st paragraph of page 21.
Revision in manuscript: "The common features of a slum include poor-quality housing, limited educational and social services, and lacking or limited of water, sanitation, electrical grid and street network. Again most of the slums are located near polluted water bodies, swamps, ditch or putrid drains ([18]. Various non-state actors such as landowners and non-governmental organization (NGOs) fill some but far from all of the gaps in regulation and service provision [17]. There is little hope of better governance in the near term [17]. Linking the interest of entrepreneurial Vacutug operators who want to keep their machines from clogging with users of shared toilets who want clean facilities provides an opportunity for sustainable improvement."

Discussion

It seems like the lack of focus on local governance is a barrier to the intervention that will significantly affect the project’s long-term success. If the authors disagree with this point, then they should make a more compelling argument for how to effectively work around the government rather than with them. I realize that NGOs often cover for the lack of good governance, but at some point the transition to better governance should happen.

Response: There is little hope of better governance in the near term. That is why we are linking this intervention to a Vacutug operator-entrepreneur model supported by WSUP. This will provide a platform for the long-term sustainability of the intervention. Please find the revised sentences at the 1st paragraph of page 21.

Revision in manuscript: "Various non-state actors such as landowners and non-governmental organization (NGOs) fill some but far from all of the gaps in regulation and service provision [17]. There is little hope of better governance in the near term [17]. Linking the interest of entrepreneurial Vacutug operators who want to keep their machines from clogging with users of shared toilets who want clean facilities provides an opportunity for sustainable improvement."

The authors should expand on how the urban slum context is a complex social system. What do they mean by this and how did it affect their intervention more specifically?

Response: Thanks for your valuable comments. The common features of a slum include predominantly poor housing, poor quality or no sewerage and drainage, inadequate drinking water supplies, insufficient or no street. There is no electricity in street and there is no paved street or path. Again most of the slums are located near polluted water bodies, swamps, ditch or putrid drain. Alongside this features there is lack of good governance in the slum areas.
There is little hope of better governance in the near term. That is why we are linking this intervention to a Vacutug operator-entrepreneur model supported by WSUP. This will provide a platform for the long-term sustainability of the intervention. We have revised the manuscript and you can find the revised sentences at the 1st paragraph of page 21.

Revision in manuscript: "The common features of a slum include poor-quality housing, limited educational and social services, and lacking or limited of water, sanitation, electrical grid and street network [18]. Again most of the slums are located near polluted water bodies, swamps, ditches or putrid drains ([18]. Various non-state actors such as landowners and non-governmental organization (NGOs) fill some but far from all of the gaps in regulation and service provision [17]. There is little hope of better governance in the near term. That is why we were linking this intervention to a Vacutug operator-entrepreneur model supported by WSUP as a platform for sustainability of the intervention.

Can the authors help the reader understand what was novel about their study? I realize waste bins could be a barrier to successful FSM services, but the findings all seem very intuitive. Was there anything that was surprising and might help others overcome implementations challenges?

Response: Thanks for your comments. This intervention to improve waste disposal in communal toilets in this settings demonstrated that a lidded waste bin inside the toilet with removal plastic bag, behavioral recommendations for what items are to be placed in the waste bin, visual aids and interpersonal communication to promote the behavioural recommendations and assignment of responsibility for regular emptying of the waste bins reduced the improper disposal of waste in the toilet pit that can impede the safe removal of fecal sludge and impair toilet functionality. Residents reported positive changes in toilet cleanliness and usability resulting from this intervention. Residents liked the waste bins because they were used and the toilet cubicle remained clean and orderly. We observed a strong shared interest in maintaining the waste bins, encouraging their continued maintenance. This is a new approach for the low-income urban communities which proved that if the residents of the low income communities get this facilities they might change their behavior which will prevent latrine blockages. The project was part of a larger effort to improve fecal sludge management in low-income communities in Dhaka. The project sought to address practical problems faced by Vacutug operators in their work. WSUP is setting up the Vacutug operators as entrepreneurs. The potential for sustainability comes from linkage to this for-profit model, and the interest of the Vacutug operators and other stakeholders in promoting long-term adoption of the behavioral recommendations. Please find the revised sentences at the last paragraph of page 25 and 1st paragraph of page no 26.

Revision in manuscript: "This intervention to improve waste disposal in communal toilets in this settings demonstrated that a lidded waste bin inside the toilet with removal plastic bag,
behavioral recommendations for what items are to be placed in the waste bin, visual aids and interpersonal communication to promote the behavioural recommendations and assignment of responsibility for regular emptying of the waste bins reduced the improper disposal of waste in the toilet pit that can impede the safe removal of fecal sludge and impair toilet functionality. Residents reported positive changes in toilet cleanliness and usability resulting from this intervention. Residents liked the waste bins because they were used and the toilet cubicle remained clean and orderly. We observed a strong shared interest in maintaining the waste bins, encouraging their continued maintenance.

- Designation of a site or a collection service for disposal of materials placed in the waste bins remains challenging and we still have not identified a satisfactory solution to it. People dump waste in lakes, ponds, ditches etc. in areas where there is no system in place for regular solid waste collection.”