Is The Mobile Phone Technology Feasible For Effective Monitoring Of Defecation Practices In Ghana? The Case Of A Peri-Urban District In Ghana

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Abstract: Background: The world leaders have decided to increase the sanitation coverage in areas of with poor access and monitor the progress. However, data collection via existing paper-based monitoring and evaluation (M & E) survey tools has limitations, including the approach used in Ghana. Therefore, there is the need to test new innovative M & E tools for monitoring sanitation practices. **Objective:** To compare a mobile phone short messaging service (SMS) M & E survey tool with a paper based format in a rapidly expanding peri-urban setting of Prampram, Ghana. **Methods:** Four hundred and fifty-eight adults with access to a mobile phone were purposely selected. Next, they were randomly assigned to the group using SMS or the group reporting on sanitation practices through a paper-based survey method. Respondents were asked to answer 5 questions on sanitation practices once every quarter over a one-year period. Non-responders were interviewed to ascertain reasons for non-response. A subset of 227 respondents were interviewed to obtain information on acceptability, ease of use and level of privacy of the two M & E survey tools. **Results:** Respondents from this study, found the mobile phone SMS M & E survey tool to be feasible although the tool was unacceptable, not user friendly and offered a low level of privacy as compared to the paper tool. **Conclusions:** The mobile phone SMS M & E tool cannot replace paper-based tool for sanitation M & E in Ghana. Further studies could examine alternative mobile phone applications, for example the use of pictorial mobile phone technology for data collection among low-literacy populations.

Index Terms: Mobile phone, data collection, feasibility, survey tool, sanitation, monitoring, defecation practices

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Introduction

To monitor progress towards achieving the Millennium Development Goals (MDG) relating to drinking water and sanitation, the United Nations established the Joint Monitoring Programme (JMP) for Water Supply and Sanitation. Under the JMP, sanitation information is collected by national agencies and ministries of health [1], [2], [3]. These country agency reports include the National Statistical Offices (NSO), complimented by dedicated surveys, as for example the Health and Demographic Surveillance Survey (DHS) and the Multiple Indicator Cluster Survey (MICS) [4], [1]. In most low and middle-income countries, these questionnaires are paper-based and are conducted as large field surveys. In Ghana, sanitation data are collected at the district level according to the Environmental Sanitation Policy [5], [6]. Through the Environmental Sanitation Units, the District Assemblies collate the sanitation data as part of the districts responsibilities in terms of general monitoring and evaluation [7]. Results of the surveys, at the household level are recorded using paper and pencil. This requires significant amount of time and money for respondents to answer and is coupled with the cumbersome process of compiling the large amount of data gathered [8], [9], [10]. In recent years, mobile phone technology has been used for diverse public health purposes particularly presenting opportunities in low-income settings [11], [12], [13], [14]. In the developing world, mobile phones are easily available and accessible such that real time observations and data collection is timely and reliable [15], [16], [17]. The mobile phone technology is presented as a low cost and easy to use means of communication compared to the paper-based approach [18], [19]. This is in addition to its extensive availability and accessibility across the world as compared to the landline telephones or standard Internet [11], [18], [19]. It is estimated that roughly 98% of Ghana's 24.5 million population own mobile telephones [20]; indicating that mobile phone technology may be a good data collection tool for use in the sanitation sector. The technology also offers a two-way communication system

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and includes text messaging, video messaging, voice calling, and internet connectivity among others [21], [22]. Several innovations have been developed to address issues such as improving the convenience, speed, and accuracy of communication in general as well as data collection [19], [23]. Although there have been many studies involving mobile phone technology in general and for different public health purposes, it has not been exploited for M & E in the sanitation sector. We therefore compared the mobile phone Short Messaging Service (SMS) with the existing paper-based tool for M & E of sanitation practices. Data collection using the mobile phone M & E survey tool at the district level could be informative in terms of its effectiveness and efficiency. However, response rates; acceptability, feasibility and challenges at both the district and community levels will have to be further assessed. The aim to use mobile phone technology in the area of sanitation will also provide timely, dependable, accurate and continuous data collection. The aim of this study was to ascertain the feasibility of using mobile technology in terms of acceptability, perceptions related to privacy and ease of use. The reasons for non-response to SMS text were also ascertained.

Methods

Study Area
The study was conducted in the Ningo-Prampram District (formerly the Dangme-West District) of the Greater Accra Region, Ghana. The district is mainly rural but rapidly urbanising. It lies between latitude 5◦45' south and 6◦05' north, and longitude 0◦05' east and 0◦20' west, and has a total land area of 1442 km2 with an estimated population of 73,386. The sanitation situation in the district reflects the rural peri–urban paradigm with the majority relying on public trench latrines or the Kumasi Ventilated Improved Pit Latrine and 26% of households having pit latrines or flush toilets [24].Study Design The study was a comparative, prospective cohort study. There were three paper based samples for the study. The first was across all four quarters of the study, the second was at the end of the first quarter whilst the third was at the completion of the fourth quarter. First paper-based survey: The household population with mobile phones in Prampram in the Ningo-Prampram District as at 2011 was 4195 [25]. The 2011 round update on defecation practices in 2011 showed that most respondents (61%) practiced open defecation whilst a few (11%) used public VIPs [26]. Assuming a 10% difference between the cohorts (61% and 71% open defecation) to be a real difference, which is not caused by random variation (chance): a sample size of 352 was calculated with a power of 80% and a significance level of 5% using Epi Info software. A 30% allowance was also made for non-response. This gave a rounded sample size of 458 household representatives, which were randomly selected and used as study units. The randomly selected 458 household representatives were randomly divided into two equal cohorts: 229 household representatives were assigned to the mobile phone SMS cohort and the other 229 to the paper based cohort. The same questions in the mobile phone SMS questionnaire were presented on this paper based questionnaire (Table 1). Second paper-based survey: For reasons of non-response, a second paper

survey was conducted. At end of the first quarter, a total of 190 non-responses in the mobile phone SMS cohort was obtained. Using this as a sampling frame and assuming an expected frequency of 50% and a worst expected frequency of 40%, a sample size of 128 was calculated with a power of 80% and a significance level of 5% using Epi Info software. A 10% allowance was also made for non-response, giving a rounded sample size of 140 household representatives. However, only household representatives were purposively sampled. Third paper-based survey: The third paper-based survey was to answer for reasons of non-response, acceptability, ease of use and challenges encountered with the two survey tools. This study was conducted after the fourth quarter. Out of the selected 458 household representatives, a total of 445 had used both survey tools. Assuming an expected frequency of 50% and a worst expected frequency of 40%, a sample size of 207 was calculated with a power of 80% and a significance level of 5% using Epi Info software. A 10% allowance was also made for non-response, giving a rounded sample size of 227. The household representatives were then randomly selected as shown in Fig. 1. The first quarter was for the mobile phone survey and was conducted from May 17th, 2013 to June 30th 2013. The second quarter was conducted from July 1st to September 30th, 2013, whilst the third run from October 1st to December 31st, 2013. Finally the fourth quarter was from January 1st to March 31st 2014. Concurrent with the mobile phone SMS survey, the first quarter for the first paper-based survey was conducted from May 17th 2013 through to June 30th 2013. The second quarter was conducted from July 1st to September 30th, whilst the third is to run from October 1st to December 31st, 2013. Finally, the fourth quarter run from January 1st to March 31st 2014. In addition, a second paper-based survey was conducted from July 1st 2013 to September 30th 2013. The third paper survey was run from April 15th 2014 to June 30th 2014. A stratified sub-sample household representatives were used for the 32 FGDs. Households were stratified into the four communities using the DHDSS 2011 round update as sampling frames. For each community, four different FGDs were held. The FGDs comprised of young males between 18-30 years, young females between 18-30 years, adult males 30 years or more and adult females 30 years or more. The selection of household respondents was randomly done by balloting with replacement. Semi-structured questionnaires were used for the FGDs. There were two sets of FGDs. The first set had questions on whether the household representatives were willing to use their personal mobile phones for the study. The second was for reasons of non-response, acceptability, ease of use and challenges encountered with the two survey tools. A digital recorder was used to capture all the discussions.

Sample Size
The non-response sample was a purposive selected sample of 40 non-respondents. They were grouped into (1) 10 adult men and women aged 30 years or more, and (2) 10 young adult men and women aged 18 - 30 years. For feasibility, a sub-sample was obtained from a total sample frame of 445 respondents who had used both SMS and paper-based survey tools. Using an expected frequency of 50% and a worst expected frequency of 40%, a sample size

of 207 was estimated with a power of 80% and a significance level of 5% using Epi Info software. A 10% allowance for non-response was added on to obtain a sample size of 227 for the study as shown in Fig. 2.

Sampling procedure
For both the non-response and in-depth studies, the respondents were purposively selected. However, in the feasibility study, the sample of 227 was obtained by random

selection of household representatives through balloting with replacement. The main study used the same questions for both the mobile phone SMS and paper-based survey tools (Table 1). The reasons for non-response to these questions was ascertained using qualitative in-depth interview guides and responses with consent were tape recorded. In the feasibility study, a structured paper-based questionnaires were administered to all consented participants.
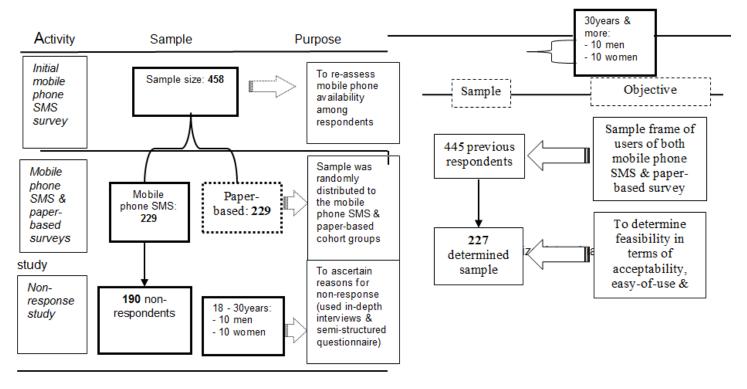

Fig. 1. Sample size determination of non-response of the study

Data and statistical analysis
Response rate: Response rates were estimated for mobile phone SMS and paper-based surveys as proportion of responses to all the five questions for both (Table 1). Data agreement: Data agreement was assessed using the Kappa value for categorical variable. The level of agreement for both M & E survey tools were determined using a range of 0.6 - 0.9 for both tools. Assessment of data agreement was done by determining if a respondent answered all five questions using both M & E tools. In-depth interviews: All interviews and quotations were transcribed and entered into Microsoft word. Files transcripts and notes were also typed and saved as word documents. Transcribed interviews were grouped in themes according to the study objectives: (1) feasibility of sanitation data collection using the mobile phone SMS technology, (2) reasons for non-response in the mobile phone SMS group, (3) level of acceptability of both M & E survey tool (4) ease of use of both survey tools and -5) level of privacy of both M & E survey tools. Feasibility assessment: The feasibility indicators were acceptability, ease of use and privacy of mobile phone SMS and paper-based M & E tools respectively. The following questions were asked respectively for acceptability (In your opinion, the mobile phone was more acceptable for collecting data on

defecation practices than the paper tool); ease of use (In your opinion, the mobile phone was easy to use for answering questions on defecation practices than the paper tool) and privacy (The mobile phone method of data collection provides privacy for discussions on issues of your defecation practices than the paper method). Levels of acceptability, ease of use and privacy of the M & E messages were estimated using rating of respondents' responses. A 5-point Likert Scale for both M & E survey tools was used (1= strongly disagree, 2= disagree, 3= Unsure, 4= agree, 5= strongly agree).

Ethical clearance
Ethical clearance was obtained from the Ethical Review Committee of the Ghana Health Service (Ethical Clearance - ID NO: GHS-ERC 01/11/2012) and Institutional Review Board for the Dodowa Health Research Centre (Ethical Clearance – DHRC – IRB CPN 14/09/12 revd.2012).

Study limitations
The study assumed the use of improved toilet facilities and hand-washing practices only as a measure good defecation practices. The use of unimproved toilet facilities and failure to wash hands were considered as poor defecation practices. In addition, the study could have had an

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unintended effect of change in sanitation practices among the participants under the assumption that alternative facilities were available and participants had a choice to use improved rather than unimproved facilities.

Results

Table 2 shows the characteristics of all 458 participants. The majority were younger adult females. Only 2.2% used improved sanitation facilities according to the JMP definition.

Table 2 Background characteristics of respondents for both M & E survey tools

Characteristics	Sex	
	Male (%)	Female (%)
Age (years):		
18-29	56 (12.2)	108 (23.6)
30-39	54 (11.8)	81 (17.7)
40-49	26 (5.7)	40 (8.7)
50 and above	38 (8.3)	55 (12.0)
Occupation:		
Unemployed	57 (12.4)	61 (13.3)
Employed	117 (25.6)	223 (48.7)
Defecation Practices:		
Improved Toilet Facilities Users	4 (0.9)	6 (1.3)
Unimproved Toilet Facilities Users	169 (36.9)	279 (60.9)
Total	174 (38.0)	284 (62.0)

The response rates for both M & E survey tools for all four quarters in terms of their sex were estimated as indicated in Table 3. The highest response rates for the paper-based tool was in the females (65.1%) whilst the lowest was in the males (34.1%) both in the fourth quarter. Mobile phone SMS M & E survey tool response rates were also highest in females (21.4%) during the third quarter and lowest in males (7.4%) in the first quarter. The lowest response rates for both sexes were for the mobile phone SMS M & E survey tool during the first quarter (8.7% for females and 7.4% for males).

Table 3 Response rates for both M & E survey tools

Quarters	Sex	Paper-based (%)	SMS (%)
First	Female	141(62.0)	20 (8.7)
	Male	80 (34.9)	17 (7.4)
Second	Female	130 (56.8)	35 (15.3)
	Male	89 (38.9)	24 (10.5)
Third	Female	144 (62.9)	49 (21.4)
	Male	84 (36.7)	42 (18.4)
Fourth	Female	149 (65.1)	40 (17.4)
	Male	78 (34.1)	43 (18.8)

Data agreement

There were a total of 5 questions answered by the respondents in both surveys. The various values for the weighted Kappa and their level of agreement for both M & E survey tools were determined as shown in Table 4. The results showed the highest level of agreement of 47.9% between the first and third quarter for the two tools with the least level of agreement of 38.0% between the second and fourth quarter. An independent t-test for the differences in means for Kappa values between the two M & E survey tools showed that there was no significant difference (p - value = 0.203) between the two tools. Thus both M & E survey tools showed no acceptable levels of agreement. There was also no significant correlation of defecation practices with the age of the respondent (OR = 1.256, p = 0.427), sex (OR = 2.471, p = 0.167) or occupation (OR = 0.595, p = 0.476) for both tools.

Table 4 Level of agreement for all four quarters for both tools using Kappa values

Quarters	Kappa values for both tools	P values	Levels of agreement between quarters (%)
First and Second	0.074	0.017	43.1
First and Third	0.161	0.000	47.9
First and Fourth	0.008	0.416	38.9
Second and Third	0.064	0.031	41.5
Second and Fourth	0.002	0.480	38.0
Third and Fourth	0.031	0.183	39.8

Reasons for non-response after the first quarter

Various reasons for non-response to the mobile phone SMS M & E tool were compiled from the paper-based responses given by the respondents. Findings from the study showed that the majority of female and male adults less than 30 years gave reasons of mobile phone credits challenges, poor network services, illiteracy and unavailability of electricity or power outages. The following responses provide further evidence: "As for issues of keeping this town clean, we all need to be involved. I have not been to school in my life. So I always have to ask someone else for help before I can read and write... So me, if you tell me to text something on the phone, someone has to show me what to do." (FGD, Young men, Kley) "We all dump rubbish into the sea and sometimes it washes back. As for this thing you are talking about, where are we going

to get the money for mobile phone credits? How am I going to buy credits? I cannot buy the phone credits." (FGD, Young women, Olowe) "Our rubbish is a problem and something should be done. For the mobile phone sometimes, too the network is a big problem. For several days it is on and off. Then we cannot make calls. It can come on for thirty minutes and then it goes off about two days. It is frustrating because it can spoil all your plans." (FGD, Young women, Lower West) "The power is not there for several days. Then we cannot charge our battery and you cannot charge your phone." (FGD, Young men, Lower East) The majority of respondents 30 years or more for both males and females also noted that: "There are mobile phone credits challenges so I may not buy units often. That is why I cannot load the phone credits I need and give out the answers when I am asked." (FGD, Adult women, Lower East). "As for me I have a phone but I sometimes cannot charge it because of dumsor. No electricity. There are mobile phone credits challenges so I may not buy units often. That is why I cannot reply with my phone." (FGD, Adult Men, Lower West). "The network is terrible. In fact it a big problem. I use the phone if I try and see that the network is working." (FGD, Adult Men, Kley). "I did not understand what we should do. You see what I know is that they come and ask the questions and they write the things themselves. But this one you say we should use our phone. How? So I was confused and I stopped." (FGD, Adult women, Olowe).

Feasibility

The estimated proportions of survey tool users in terms of preference to its acceptability, privacy and easy to use were compared as shown in Fig. 3. From the results respondents who answered that the mobile phone SMS M & E survey tool was acceptable, offered privacy and was easy to use as compared to the paper based tool were 6.3%, 0.5% and 0.5% respectively.
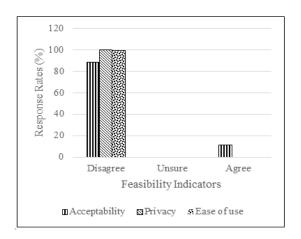

Fig. 3. *Feasibility indicators for 227 household respondents from Prampram, Ghana*

Acceptability

Findings from the study showed that, adults in the age group of 18-29 years (both males and females) preferred the paper-based M & E survey due to challenges of mobile phone credits (40.5%), poor network services (21.4%), illiteracy (9.5%) and unavailability of electricity or power

outages (9.5%) (Table4). For respondents between the ages of 30-39 years (both males and females), 26.3% attributed their preference of the paper-based tool to illiteracy, 13.2% to poor network services, another 13.2% to issues of mobile phone credits and 13.2% to the unavailability of electricity or power outages. From the results, preference for the paper-based tool in the 40-49 age group (both males and females) were due to poor network services (4.2%), illiteracy (29.2%), inadequate mobile phone credits (20.8%) and unavailability of electricity or power outages (8.3%), for both males and females. However, respondents 50years or more were of the opinion that illiteracy (52.6%), poor network services (4.2%) and issues of mobile phone credits (8.3%) were their reasons for preference for the mobile phone tool. Among the male respondents, their reasons for their preference of the paper-based M & E tool were poor network services (19.4%), illiteracy (27.4%), mobile phone credits (22.6%) and unavailability of electricity or power outages (14.5%). However, female respondents answered that poor network services (10.7%), illiteracy (28.6%), mobile phone credits (21.4%), poor communication from the field (1.4%) and unavailability of electricity or power outages (12.1%) were mainly their reasons for their preference for the paper-based M & E survey tool as against the mobile phone SMS M & E survey tool. Some of the challenges mainly related to difficulty in answering the text messages from the mobile phone SMS survey tool and included issues of literacy, the unavailability network services and electricity resulting in their inability to charge their mobile phones. Some respondents made the following observations:

> *"A lot of people have not been to school before, so we will need somebody to always help us to do it. We have not been to school before, so always, somebody has to help us. It will not be easy for those who have not been to school before. People will say give them money to buy credit to send the text messages." (FGD, Young men, Kley)*

> *"Sometimes, we need to charge our battery. For days, we go without power. It prevents you from charging your phone" (FGD, Young women, Lower West)*

> *"Sometimes the power, this "dumsor dumsor" problem makes the charging a problem." (FGD, Adult men, Kley)*

> *"The network is not good at all. Sometimes it is unavailable for three days. All the networks, Vodafone, MTN, TIGO, all." (FGD, Young men, Olowe)*

> *"The lights-off can worry me sometimes. Because if I don't charge it and the lights go off and the message comes at that time then I cannot do it, I have to wait until the lights come back." (FGD, Adult men, Kley)*

In contrast, the minority younger male and female respondents 18 years or more but less than 30 years were of the opinion that the mobile phone SMS M &E survey tool

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was more acceptable, easier to use and made the following comments:

"At any time you can reply to the questions if you are using the mobile phones. Even if you are busy you can do it later." (FGD, Young women, Lower East)

"The mobile phone is good. You can easily learn how to use it. With the paper someone always has to come to you. But with the mobile phone you can do it in your room, only you. " (FGD, Young women, Lower West

"Things are moving fast, and also things are changing. So for me, the mobile phone is good. No one knows what you want to say and it can be at any time." (FGD, Young men, Olowe)

"Everyone now has a mobile phone. We are all going forward. The phone questions are okay. Which place does not have people using the mobile phone? Tell me. We have to try." (FGD, Young men, Kley)

Ease of Use
From the results, adults between the ages of 18-29 years (both males and females) gave reasons of difficulty using the mobile phone SMS M & E survey tool (11.9%), and challenges with survey tool administration (18.6%) and also preferred the paper-based M & E tool to that of the mobile phone M & E survey tool. For respondents between the ages of 30-39 years (both males and females), 26.3% attributed their preference of the paper-based tool to that of the mobile phone to illiteracy and another 26.3% to difficulty in the use of the mobile phone SMS tool. Reasons for the preference of the paper-based tool to that of the mobile phone in the 40-49 age group were difficulty in the use of the mobile phone tool (20.8%) and issues of survey tool administration (16.7%). Respondents 50years or more answered that difficulty in the use of the mobile phone tool (25.0%) and issues of survey tool administration (11.1%) were their reasons for the preference of the paper-based tool to the mobile phone tool. Among the male respondents, their preference of the paper-based tool to that of the mobile phone was difficulty in the use of the mobile phone tool (14.5%). However, female respondents answered that difficulty in the use of the mobile phone tool (20.7%) and issues of survey tool administration (0.7%) were their main challenges leading to their preference of the paper-based tool to that of the mobile phone.

Privacy
Among the various age groups, adults between the ages of 18-29 years gave reasons of mobile phone sharing (4.8%) as the reasons for their preference of the paper-based tool as to that of the mobile phone. Respondents between the ages of 30-39 years, also attributed their preference of the paper-based tool to that of the mobile phone to the same reason of mobile phone sharing (2.6%). In the 40-49 age group there were no respondents on this reason, whilst respondents 50years or more (2.8%) answered that mobile phone sharing was a reason for their preference of the paper-based tool to that of the mobile phone. Among the male respondents, 4.3% answered that mobile phone

sharing was their reason for their preference of the paper-based tool to that of the mobile phone whilst no female respondent was in this category. In contrast, the minority younger male and female respondents 18 years or more but less than 30 years were of the opinion that the mobile phone SMS M &E survey tool was easier to use and offered a greater level of privacy:

"At any time you can reply to the questions if you are using the mobile phones. Even if you are busy you can do it later." (FGD, Young women, Lower East)

Discussion
From the results, the paper based M & E tool was comparatively more acceptable, easier to use and offered more privacy. In addition, although sanitation data collection with the mobile phone SMS M & E tool was feasible, there were several challenges such as issues of low literacy, the unavailability network services, and unavailability of electricity resulting in their inability to charge their mobile phones. The feasibility of mobile technology, in terms of data loss and uploading challenges, which offers mobile phones as a feasible method of data collection requires further exploration. The results from this study show that use of mobile phone text messaging for intervention purposes is feasible. Although household survey data collection is predominantly paper based, mobile phone text messaging may have advantages over paper, but little evidence exists on how they compare. Collectively, these findings suggest that consideration may be given to literacy levels as well as mobile phone sharing. More effort is needed to improve the poor electricity and network services and addressing the difficulty in the use of the mobile phone SMS M & E tool, which may negatively affect usage. Generally, the findings from the results show that levels of acceptability, privacy and ease for the mobile phone SMS M & E tool were very low although the tool is feasible for data collection.

Conclusions
Clearly, the study shows that in terms of feasibility, the paper-based tool was more acceptable, easier to use and offered more privacy as compared to the mobile phone SMS M & E survey tool at the moment. However, with the high usage of mobile phones and with its advancing social media technology such as whatsup, ChatON etc, mobile phones could become useful tools for data collection in the not too distant future. Furthermore, the challenges of mobile phone usage were low literacy levels, poor network services, issues of mobile phone credits, mobile phone sharing and unavailability of continuous electricity supplies.

Recommendations
The design of the mobile phone SMS M & E survey can be improved in terms of sanitation data collection to ensure higher levels acceptability and ease of use. The mobile phone SMS M & E survey tool with appropriate education and sensitization can be used as an advocacy tool in relation to sanitation data collection. The JMP could further examine the use of pictorial mobile phone technology for data collection as a guide for low-literacy populations.

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Acknowledgments

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