Report of Focus Group Discussions and Scenario Experiment of WASH Suppliers' Adaptation Financing

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This report was compiled from the field scenario experiment and focus groups conducted in the research project *Climate change impacts, adaptation measures, and inclusive resilience system in WASH: A case study of marginalised communities in rural Cambodia*, funded by Australian Department of Foreign Affairs and Trade, under the Women for Water Fund, Innovation and Impact Grant.

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Cover photograph by: Lien Pham

Disclaimer: There are inherent limitations of the methods used in data collection and analysis. Thus, the authors cannot guarantee the accuracy, completeness or reliability of findings and their generalisation to the wider population in Cambodia. Readers are encouraged to read the report with caution and undertake additional research in support of their activities.

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1. Introduction

Building on WOBA Cambodia's achieved targets of 4,349 poor plus GESI households, the project entitled Climate change impacts, adaptation measures, and inclusive resilience system in WASH: A case study of marginalized communities in rural Cambodia is established to further assesses the impacts of climate change on the access and use of WASH services among the poor and GESI households in rural Cambodia as well as to explore the role of private sector in collective adaptation for the said communities. The study addresses three questions:

1. Sustainability: How can we better accommodate the climate vulnerabilities and resources of marginalized households and providers and enhance their adaptive capacities?
2. Resilience and Innovation: Which conditions enable private sector providers to deliver resilient WASH services for marginalized communities?
3. Inclusion: How can policy makers ensure that inequality is not worsened by climate change through equitable adaptation measures in WASH?

The study provides insights into resilient thinking and adaptive capacities and how they could be enhanced in inclusive ways within the contexts and characteristics of Cambodia's marginalised communities and provides evidence for policies and practices in building WASH resilience for such a developing country.

The study has two phases. Phase 1 addresses RQ 1 and 3. It investigates households' climate-related experiences and associated impacts on their access and use of WASH services through surveys with households and local authorities. Interviews were conducted with policy makers, climate experts and WASH suppliers to gain more in-depth information about issues relating to climate change impacts, adaptive capacity and current policies on climate change adaptation in Cambodia.

Phase 2 addresses RQ 2 and 3. It employs scenario-based field experiments and focus group discussion with the private sector WASH suppliers to understand the internal and external conditions which influence their decisions to provide resilient WASH services in the community. This report presents the findings from the Phase 2 focus group discussion and field experiments.

2. Methodology

Three workshops were held in June – July 2022 to conduct the focus group discussions and field experiments. 18 sanitation suppliers and 9 water operators from 7 provinces including Kampong Chhnang, Kampong Speu, Kratie, Prey Veng, Pursat, Takeo, and Tbong Khmum participated in the workshops. The aim of the focus group discussion is to solicit information on 1) current business operations; 2) observation of climate change and impact on their WASH businesses; adaptation measures that they currently employ or have seen; financing options that they are aware or using

and would like to take up to finance adaptation measures; government actions to support WASH businesses generally and adaptation specifically. The focus group discussions also aim to provide the scenarios and context setting to help the suppliers prepared for the field experiments that follow. The field experiment aims to find out (1) the preference for WASH-resilient products that the service providers would likely to choose, and (2) the preference for financing options that they would like to get in order to operate their resilient business.

2.1 Supplier participants

The suppliers are involved in the current WOBA project. The list of suppliers (9 water operators and 17 for sanitation suppliers) was obtained from the WOBA project team. The total number of 26 suppliers from this list (23 % are female) come from 7 provinces, as shown in Figure 1. They were separated into 3 groups for convenience of the workshop organisation, and were invited to take part in the workshops through formal invitation by the research team. Table 1 below shows the arrangement of the workshops including venue, date and participants from different provinces.

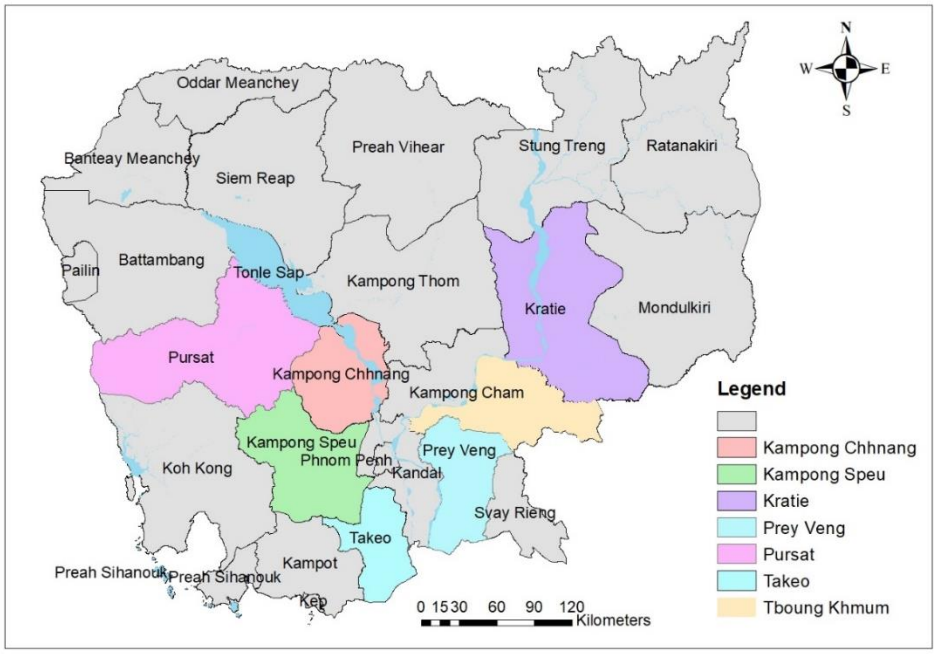

Figure 1: Location where all the participants come from

Table 1: Sampling for the workshops

Date	Origin of participants	Venue	Number of participants
28 June 2022	Prey Veng	Prey Veng	2 Water operators 3 Sanitation suppliers
	Tbong Khmum		1 Water operator 1 Sanitation supplier
05 July 2022	Takeo	Phnom Penh	1 Water operator
	Kampong Speu		1 Water operator 1 Sanitation supplier
	Pursat		8 Sanitation suppliers 1 Water operator
	Kampong Chhnang		1 Water operator
07 July 2022	Kratie	Kratie	1 Water operators 5 Sanitation suppliers

2.2 Background information of the suppliers

2.2.1 Water operators

Education and Experience in water business

While 44% have been in the business less than 6 years, 22% of them have more than 10 years 'experience (Figure 2). However, only 22 % of water operators had university or professional college education. The majority (78%) had primary school or lower secondary school education (Figure 3).

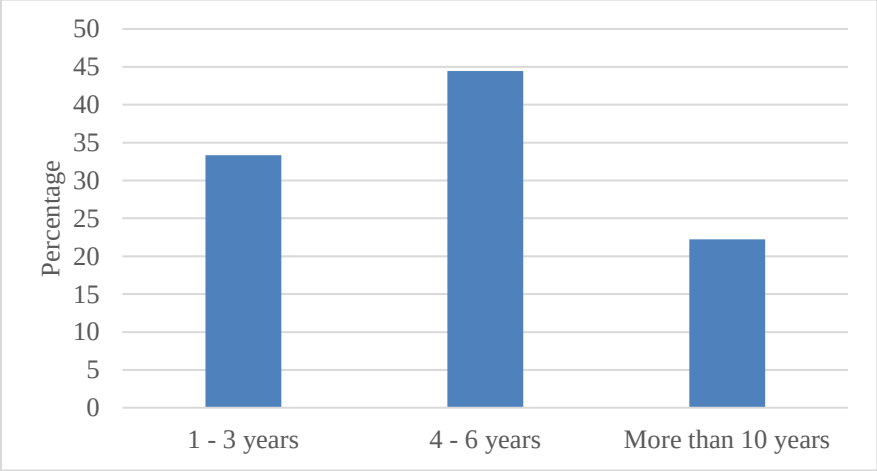

Figure 2. Number of years being in the water business

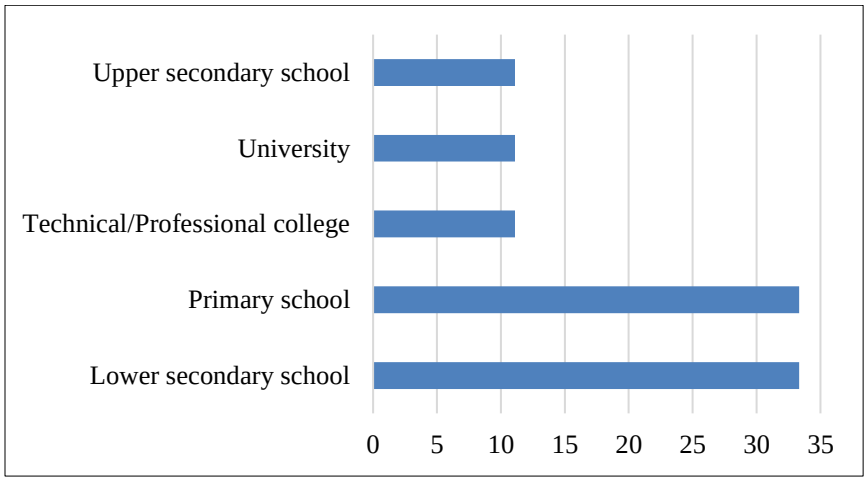

Figure 3: Education level of the water suppliers

Climate change exposure

As shown in Figure 4, 89 % of the water operators are based in the rural areas whereas an operator from Takeo province has the services cover both urban and rural area. In terms of climate change, participants from different regions experience climate hazard differently.

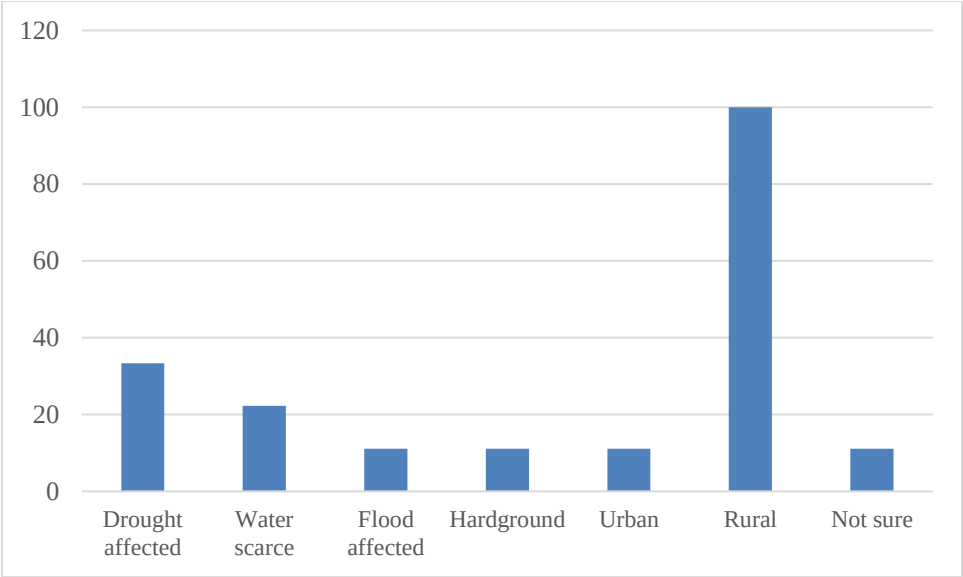

Figure 4: Regions where the water operators are from

Nature of business and core income

Among the 9 water operators, 7 people (78%) are working on the pipe water supply while 2 (22%) is working separately on water filter or bottled water distribution. The tariff price for pipe water is set by the government. In this study, in the rural area, 1 cubic meter of water costs between 2,000 to 2,400 Riels (about US$0.50) whereas in the city, the cost varies by consumption volume. For example, from 0 to 3 cubic meters, the cost is 1500 Riels (US$0.38) per m^3, from 4 to 10 cubic meters the cost is 1750 Riels (US$0.44) per m^3, and from the usage of more than 11 m^3, the cost is 1850 Riels (US$0.46) per m^3. Table 2 shows the monthly revenue of the survey water operators.

Table 2: Monthly revenue of the water operators

Revenue in USD	Frequency	Percent
765	1	11.1
3000	1	11.1
6250	2	22.2
8000	1	11.1
Prefer not to say	4	44.4
Total	9	100.0

2.2.2 Sanitation suppliers

Education and Experience in sanitation business

As shown in Figure 5, similar to the water operators, majority of the sanitation suppliers (77%) didn't go to university. 41% and 36% of them only attended primary school and high school, respectively.

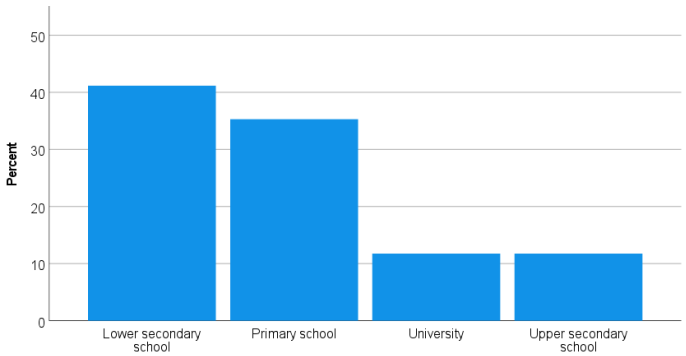

Figure 5: Education level of the sanitation suppliers

The sanitation suppliers in this context are not the SME. They own the family-scale business at the village and commune level. Majority of them work in teams of around 3 to 6 people, including the owner and labourers. 18% of them have laborers working for them between 14 to 30 people and there was one case of a supplier having around 61 labourers. According to Figure 6, 35% of them have only been involved in the sanitation business for around 1 to 6 years, 41 % have more than 7 years' experience, and the other 24% have more than 10 years of experience. Among them, 29% are the suppliers for both materials and service whereas the rest do not own a shop, but provide the installation service and produce the pit ring, and toilet platforms by themselves.

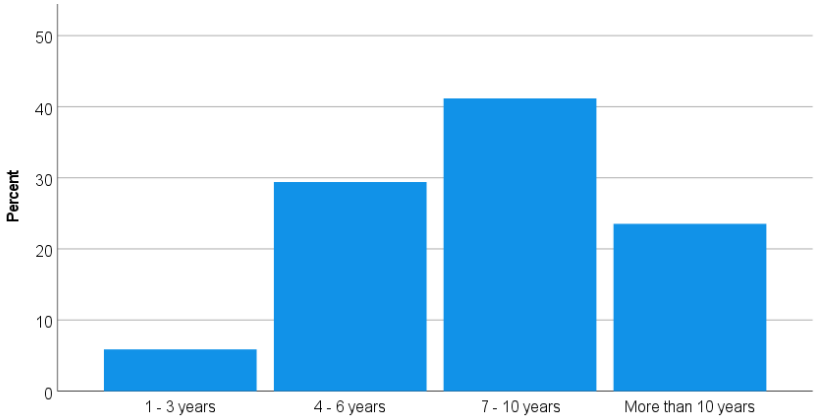

Figure 6: Number of years being in the sanitation business

Climate change exposure

As shown in Figure 7, more than 82 % of them are having their services cover the rural area while the rest extend their service to urban or commune border. Hard ground seems to be a common problem facing by all the sanitation suppliers (71%), followed by flood (41%), drought (35%), and water scarcity (29%).

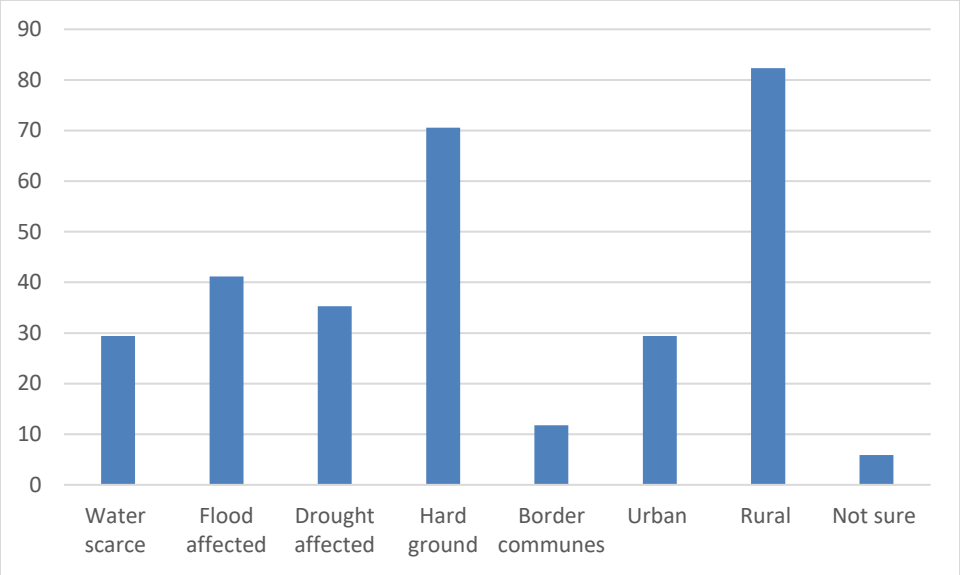

Figure 7: Regions where the water operators are from

Nature of business and core income

Figure 8 and 9 show the services/products that the sanitation suppliers sell. Building latrine, selling toilet, latrine material/equipment supplies and delivery are the common jobs beside construction work, pit emptying, importing, and producing construction material. Out of these four jobs, building latrine is the main source of income for the sanitation suppliers.

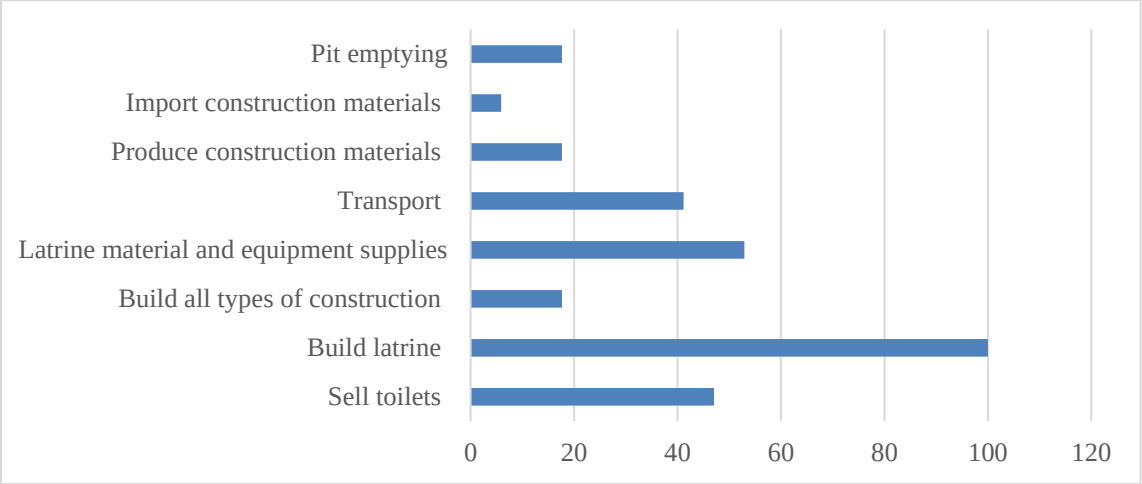

Figure 8: services/products that the sanitation suppliers sell

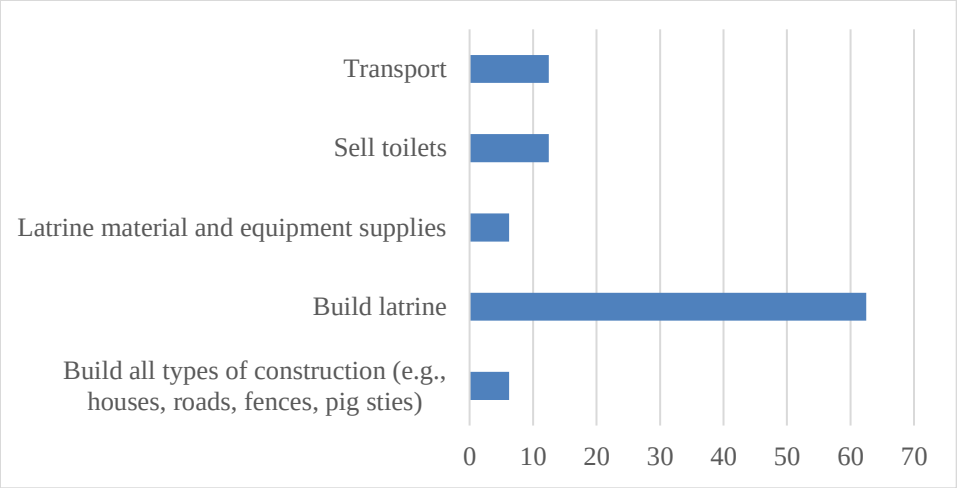

Figure 9: Main sources of income for the sanitation suppliers

Table 3,4 and 5 show the numbers of toilets being sold per month, the total revenue and the profit margin of the suppliers' CORE products. In a month, 35% of sanitation suppliers could sell around 20 sets of latrine, 35% could sell between 30 to 50 sets and 29% could sell between 100 to 300 sets. Depend on the demand, 48% earn between US$200 to US$500 per month, 12% between US$500 to US$1,000, 18% between US$2,000 to US$3,000 and 6% up to US$10,000 per month. The profit margin can vary between 10% to more than 50%, but the majority of them (76%) earn between 10% to 30%.

Table 3: Number of toilets being sold per month

Number of toilets	**Frequency**	**Percent**
Less than 10 sets	5	29
10 to 20 sets	1	6
20 to 30 sets	0	0
30 to 50 sets	6	35
Between 100 to 300 sets	5	29

Table 4: Total income per month of the sanitation suppliers

Revenue in USD	Frequency	Percent
200 $ to 300 $	4	24
301$ to 500$	2	24
501$ to 1000$	4	12
2000$ to 3000$	3	18
Up to 10,000$	1	6
Prefer not to say	3	18

Table 5: Profit margin in percentage

Margin	Frequency	Percentage
10% to 20%	6	35
20 to 30%	7	41
30 % to 40%	1	6
more than 50%	1	6
Prefer not to say	2	12

2.3 Scenario experiment design

Scenario-based field experiment is used to test a set of carefully constructed and realistic but still hypothetical adaptation scenarios. The scenarios comprise 8 WASH adaptation measures of which 4 are for the water operators, 4 are for sanitation suppliers, and eight different constellations of financing for both. Selection of adaptation measures is guided by the results of the survey with households and local authorities and interviews with WASH suppliers, climate experts, policy makers on climate change risks, and adaptation measures conducted in Phase 1 and relevant studies. The 32 scenarios (4 measures X 8 constellations) are shown to the suppliers and they are asked to rank them in terms of investment preferences. The detail of different adaptation measures and financing options is in Annex 1, and the simulated experiment could be found in Annex 2. The experiment divided into 3 parts.

The four possible adaptation measures are:

For water operators:

1. bottled water distribution system to provide drinking water for all
2. community rainwater harvesting to collect and store for productive use
3. pump water to ensure supply of water for all
4. water filter

For Sanitation Suppliers:

1. Resilient latrine built on the house
2. Handy pod system
3. Pump water or water pumping services to ensure supply of water for all
4. Water filter

The eight possible financing constellations for both water operators and sanitation suppliers are:

1. Government loan
2. Commercial loan guaranteed by government
3. Commercial loan
4. Credit enhancement
5. Government subsidies
6. Grants or technical assistance from donors
7. Green bonds
8. Social impact bond

By the end of the ranking sections, suppliers were also asked for their opinion about the provision of adaptative measures such as WASH product/service for free to the poor and socially disadvantaged people (Yes/No/Not sure) and their financing preference for providing the adaptative WASH product/service to those vulnerable groups. The options for financing sources are:

1. Sanitation businesses co-contribute,
2. Sanitation businesses and government co-contribute,
3. Sanitation businesses, community organisations and government co-contribute, and
4. Donors or philanthropic organisations contribute.

2.3 Data Analysis

The data collect from the experiment was keyed-in into the Qualtrics system which was then extracted as separated excel spreadsheet for statistical analysis at later stage. Prior to the analysis both data set was verified to ensure proper coding and that missing or incomplete data set is not present. All in all, 1 data was removed because it was incomplete leaving 25 samples for the analysis.

Due to the small sample size, bootstrapping was used. The accuracy of the bootstrap approximations for small sample sizes was proved to be good by many studies such as those of Steland (1998), Fernández & Gamero (2009), and Rochowicz, (2010). According to Rochowicz, (2010), bootstrapping is a numerical sampling technique for generating the uncertainties (confidence limits and probabilities) in the true value of a statistic from a study of a sample. Bootstrapping statistics is useful when the assumptions about sampling distributions are untrustworthy or unavailable, especially for small sample size. In bootstrapping, the data sampled are resampled with replacement, meaning sampled data becomes the population and the resampled data are the samples. For each of a hundred or thousand bootstrapped data, each of them has the same size as the original sample and were drawn randomly from the original sample. These values are then analyzed as if they came from repetitions of the study.

In this study, per each question, R software was used to generate bootstrapped sample sets of 1000 from 25 responses, which 8 for water operators and 17 for sanitation suppliers. The ranks of the preference for WASH products and financing sources were based on the mean score of each sample set. The one which has the lowest mean score will be ranked at the top (reflecting the ranking ordinal scale in the experiment). Data were analyzed following analysis of Friedman test and means were compared based on the least significant difference (LSD) test at the 0.01 probability level.
Focus group discussions were recorded and transcribed and translated into English by a member of the research team. The transcripts were analyzed thematically by the project lead. The focus group discussion responses are used in this report to discuss and explain the results of the field experiment.

2.4 Limitations

The results of this study may not be completely generalized to the context of WASH enterprises in Cambodia because the samples were restricted to WOBA water and sanitation suppliers only. This is partly because there is very little information about sanitation SMEs working in Cambodia and those SMEs whom we reached out were not available to participate in the research experiment. The sample comprises mostly family-own sanitation suppliers, which were found to have similarity in terms of cash flow issues, perception of financial risks, and financial management capability. In addition, the aim of trying to get numerous water SMEs beside those in WOBA project to participate in our experiment was not feasible. Our invitations were rejected because there were sections that inquire the sensitive information regarding the cash flow and profit. The small sample is countered by using bootstrapping and Friedman tests.

3. Experiment results

3.1 Preference for Adaptation measures and Financing Option for Water Operators

The results of Friedman test applied to bootstrapped sample of 1000 (Table 2) indicate that the means of the answers for each question that were generated from bootstrapping are significantly different with p value <0.01. The Friedman test was run on SPSS involving ranking each row (or block) together, then considering the values of ranks by columns.

Table 2: Friedman statistics test results for water operators 'responses

Variables	Chi-square	Asymp. Sig
Q9.1-9.4	1995.21	0.000
Q10.1-10.8	5691.68	0.000
Q11.1-11.8	6090.88	0.000
Q13.1-13.4	2807.67	0.000
Q14.1-14.8	6231.181	0.000
Q15.1-15.8	5799.187	0.000

As shown in Table 3, the bottled water distribution system is the most preferred option by the water operators with the lowest mean score of 1.63, followed by the water filter (2.63), community rainwater harvesting (2.75), and water pump or pumping service (3.00), respectively. The standard deviation between each measure varied from 0.25 to 0.39.

Table 3: Adaptation measures preferred by the water operators

Adaptation measure	Mean Score	SD
Q9_1. Bottled water distribution system	**1.63**	0.39
Q9_4. Water filter	2.63	0.39
Q9_2. Community rainwater harvesting	2.75	0.34
Q9_3. Water pump or water pumping service	3.00	0.25

From Table 4, we observed that the most preferred financing option for all four water adaptation measures is grants or technical assistance from donors followed by government loans as the second preferred option. Everyone chose government subsidy, and commercial loan guaranteed by the government as their third and fourth options, respectively, except for the rainwater harvesting system that the credit enhancement is the third option and government subsidy is the fourth option. The standard deviations between the means of each financing options vary between 0.4 to 0.81. This result indicates the preference for grants and technical assistance from the third parties and government supports in terms of financing such as the provision of loan or subsidy. This would enable them to take part in the WASH resilient business.

Furthermore, to encourage investment to water operation business, credit enhancement and government guarantee would allow the operator to get loan easier from bank.

Table 4: Financing options preferred by the water operators

Financing Options	Bottle water distribution system		Water Filter		Community rainwater harvesting		Water pump or Water pump service	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Government loan	3.24	0.81	2.73	0.74	3.61	0.80	2.75	0.75
Commercial loan guaranteed by government	4.77	0.69	4.87	0.60	4.78	0.61	4.72	0.58
Commercial loan	5.87	0.59	6.23	0.60	5.49	0.63	6.51	0.57
Credit enhancement (e.g. use exiting revenue stream) as collateral to finance the investment	4.13	0.50	5.51	0.57	3.86	0.57	4.74	0.44
Government subsidies	3.62	0.73	3.61	0.46	4.48	0.56	3.74	0.45
Grants or technical assistance from donors	**2.53**	0.63	**1.62**	0.46	1.51	0.46	**1.64**	0.48
Green bonds to raise finance for the investment	6.40	0.79	5.75	0.79	6.47	0.72	5.51	0.78
Social impact bond	5.51	0.60	5.60	0.40	5.74	0.57	6.33	0.47

All participants believed that the adaptive water product/ service should be provided to the poor for free to the poor. Similar to financing preferences to produce WASH adaptation measures, as shown is Table 5, they also preferred that such provision to the poor be funded by donors or philanthropic organizations, followed by the co-contribution between water operators, NGOs, and the government. The option of funding by co-contribution from water businesses is least preferred by all water suppliers.

Table 5: Financing Options for providing adaptive water product/ service to the poor for free

Adaptation measure	Mean	SD
Q13_1 - Water businesses co-contribute	3.50	0.37
Q13_2 - Water businesses and government co-contribute	2.88	0.28
Q13_3- Water businesses, community organisations and government co-contribute	2.12	0.11
Q13_4 - Donors or philanthropic organisations contribute	**1.51**	0.36

3.2 Preference for Adaptation measures and Financing Option for Sanitation Supplier

According to Table 6, we are confident to confirm that means of the answers for each question that were generated from bootstrapping are significantly different with p value <0.01.

Table 6: Friedman statistics test results of sanitation suppliers' responses

Variables	Chi-square	Asymp. Sig
Q2.1-2.4	2726.72	0.000
Q3.1-3.8	6416.305	0.000
Q4.1-4.8	6258.22	0.000
Q5.1-5.8	6096.33	0.000
Q6.1-6.8	6121.22	0.000
Q8.1-8.4	2193.54	0.000

As shown in Table 7, resilient latrine on the house is the most preferred option by the sanitation suppliers with the lowest mean score of 1.53, followed by the Handy pod system (2.24), water pump or pumping service (3.06), and water filter (3.18), respectively. The standard deviation between each measure varied from 0.17 to 0.27.

Table 7: Adaptation measures preferred by the sanitation suppliers

Adaptation Measure	Mean	SD
Q2_1.Resilient latrine (on the house)	**1.53**	0.17
Q2_2.Handy pod system	2.24	0.27
Q2_3. Water pump or water pumping service	3.06	0.20
Q2_4. Water filter	3.18	0.22

Table 8: Financing options preferred by the sanitation operators

Financing options	Resilient latrine (on the house)		Handy pod system		Water pump or water pumping service		Water filter	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Government loan	**2.18**	0.27	**2.70**	0.35	**2.77**	0.38	**2.81**	0.42
Commercial loan guaranteed by government	2.93	0.35	3.05	0.40	3.53	0.41	3.30	0.38
Commercial loan	4.29	0.53	4.52	0.42	4.83	0.56	4.42	0.60
Credit enhancement	4.46	0.44	4.87	0.34	4.49	0.42	4.79	0.44
Government subsidies	5.06	0.29	3.39	0.58	4.53	0.42	4.59	0.41
Grants or technical assistance from donors	4.02	0.61	6.40	0.37	3.43	0.67	3.45	0.65
Green bond	6.41	0.36	6.30	0.50	6.13	0.37	6.07	0.36
Social impact bond	6.66	0.48	4.70	0.59	6.34	0.49	6.58	0.46

From Table 8, we observed that the most preferred financing option for all the sanitation adaptation measures is government loan. No consistent clustering of preferences for the second, third and fourth option was observed. However, other popular options are commercial loan guaranteed by government, government subsidies, grants or technical assistance from donors, and credit enhancement. The standard deviations between the means of each financing options vary between 0.40 to 0.81. Compared with the ordinary procedure for loan requests, credit enhancement would be easier and more convenience for sanitation suppliers to get loans from the bank.

As with water operators, all sanitation suppliers believed that the adaptive sanitation product/ service should be provided to the poor for free. They too preferred that such provision to the poor is funded by donors or philanthropic organizations, followed by co-contribution between sanitation suppliers, NGOs, and government. They least preferred to co-contribute with other sanitation suppliers.

Table 9: Financing Options for providing adaptive sanitation product/ service to the poor for free

	Mean	**SD**
Q8_1. Sanitation businesses co-contribute	2.81	0.31
Q8_2.Sanitation businesses and government co-contribute	2.82	0.15
Q8_3.Sanitation businesses, community organisations and government co-contribute	2.30	0.16
Q8_4. Donors or philanthropic organisations contribute	**2.07**	0.34

4. Focus group discussions

The results of the focus group discussions that took place prior to the experiment are discussed here to provide some explanations for the results of the scenario experiment presented in Section 2.

4.1 Water operators

4..1.1 High operational costs

The most significant effects of climate related hazards encountered by the water operators were additional costs and labour for the water operators. Most water operators observed are pollutants in the stream water which they draw from, due to the water runoff during rainy season, especially from the rice fields as farmers start their planting, ploughing and sowing. The extra costs of water treatment and treatment chemicals increase their treatment costs.

Some talked about increased mud in the stream water which damage the filter and thus leads to additional time to separate the mud from the water and money due to increased electricity

costs in pumping large volume of water. Other adaptation to ensure water quality from rain or flood include monitoring daily our electricity and controlling system, using sandbags to block the water from entering the storage tanks, raising pump and electrical devices, all of which means additional costs.

Flood also result in strong water current which could break the pipes, and if so, they have to dig and connect it from underground again, which is more costs and time.

Similarly, in the dry seasons, for those that draw water from tube wells, they face the pollutants of manganese and little lime, but haven't yet found a solution for this problem and are still consulting with NGOs and other water operators. Others cope with drought, by treating water in the nighttime to reduce the turbidities caused by the hot weather and to save chemicals.

Water quantity is not an issue for most operators in Prey Veng because they often have more than one tube wells that are more than 100 metres deep. Some may experience difficulty in getting the right balance of water from tube wells and pond water and need some training, which could explain the preference for technical assistance from donors.

Other areas like Kampong Chhang encounter shortage of water during drought, which they cope by buying already treated water from another water operator. Although this reduces their profit, the reduction is less than the costs for purchasing untreated water and treating the water themselves. Some talked about high water to mud ratio of 40:60, which means the treatment costs would be too high compared to the clean water extracted, as well as additional labour spent on the treatment such as pumping, electricity, tank washing. Purchasing treated water is more expensive and they still have to deal with the water loss through low-quality pipe, pipe breaking, water stealing or losing pipes.

The problem of water shortage during dry season is prevalent in Kampong Speu. For those with limited capacity such as small reservoir, they struggle to meet the demand of people who consume more water. The option of purchasing plots of land to drill well to cope with water shortage is not feasible because they are not able to drill many wells in the same plot, and the cost of pipe layout, pumping test, drilling, and pumps is too much of the investment compared with the output of the drilled well. In addition, drilled well water contain a lot of iron, which they have to treat using iron treatment tank which cost more money, although they have received support from NGOs. The treatment is simple by letting the water drop down about 2 meters so it can be exposed to sunlight and air.

Digging pond or transfer water from the lake is additional services that water operators provide during dry seasons.

> "We helped transfer water from the stream to sell to them. One tank of 2000 liters costs from 10 to 12.5 $, and for places where we can drill a well, we requested to our partnered NGO to drill one or two wells or dig a pond." Water operator, Pursat.

However, some felt that some NGOs offer ponds digging services, so villagers don't use piped water connection. The uncoordinated approach can create conflict between the operators and the villagers.

Some water operators cooperate with the local authority to close the water gate in dry season to reserve water for domestic uses and emergencies. Although this is a good practice of water governance, it is not always the most effective solution because some villagers open the gate for fisheries purpose, and there is not sufficient action by the government to stop these behaviours or quick enough to mitigate the effect of water exploitation. For those operators that have access to underground storage tank under the stream, they can better cope with the problem of water shortage.

> "We just close the gate because the government allows the farmers to cultivate only once per year and they'd already gotten that allocation. They wanted to open the gate because they want to cultivate more. Thus, what the government can do for drought adaptation is good water governance. However, illegal opening the gate still occurs by the fishermen opening the gate to catch the fish. Even when they complain, it still takes a month or so to get the water back.

In Takeo, the water operators told stories about thrown waste by factories and traders in the Takeo Lake despite having waste treatment system in those factories.

> "That trash is seen to be rotten in the lake and caused a bad odor. The lake has lotus, water lilies, and mud. We tried to use alum, PAC and wood charcoal to neutralize the bad odor. We did not use the active carbon but the wood charcoal though it helps to reduce a little bit of the smell and we've been doing this for 5 to 6 years. The problem is the cost of the treatment of the bad odor, and the fee paid to the authority which can be up to 5000- 6250$ per year. We just recently spent $500 for them to remove the water lettuce from the lake.

Although the government has implemented the lake restoration project, the results are not sustainable because only plants from the top of the lake rather than the roots, so the plants keep growing from time to time. To ensure water quality for their operation, the water operators opted to pay voluntary out of their own pockets to have the top level plants removed every year.

The poor-quality pipes in many areas can lead to water leaks, especially when the operators use very strong pressure, which can be a significant cost for poor families not just the operators. Pipe breakage also occur due to the repeated road or drainage construction in the city. The leakage of underground pipe is difficult to search for and the water leaks continue for a long period of time. The operators often don't receive financial compensation from the government. Pipe breaks occur when people construct houses, and they seldom inform the operators. As a result, they lost water for days until they realise and for those that don't monitor their water loss regularly, this can add up to significant amount of non-revenue water. In this regard, NGOs have helped to work with the operators to solve conflict between villagers and water operators and to educate the villagers about these impacts of pipe breaks. This is probably another reason why water operators preferred NGOs as a source of technical assistance.

4.1.2 Low revenue

On the revenue side, for the water bottle distribution businesses, there is less revenue in rainy seasons because villagers are able to use rainwater because they can save on buying bottled

water. On the other hand, during drought season they sell more bottled water. Similarly, water businesses also lose revenue in rainy seasons because they cannot connect as many connections, and that villagers tend to use rainwater rather than piped water. Some villagers perceived rainwater to be cleaner than piped water or it could just be habitual and lack of understanding about clean water.

> "Some people felt that pipe water is less clean than rainwater, so they use pipe water for washing clothes, and animals, and collect rainwater for drinking." Water operator, Prey Veng

Tube wells seem to present adequate water supply in Prey Veng, and many villagers use tube wells as their main source of drinking water as found in the Phase 1 household survey. In fact, many households and suppliers have tube wells for backup and all of them have pumps to pump water. Furthermore, the cultural norm of the Cambodian people is to continue pumping their tube wells until they are completely dry before they would consider connecting to piped water network. This would explain why pumping service or water pump was the least preferred option by all suppliers. On the other hand, bottled water is already commonly bought and sold and even seen as safely managed water in Cambodia, which is why it is the preferred option for water businesses.

There is a general perception among the water operators that the villagers lack knowledge about WASH and thus are not motivated to take up water connection. Another problem is that they often resist any form of improvement at a community level like improved roads because the road expansion reduces their land. This kind of resistance could be due to political conflicts like land grabbing in Cambodia or that they distrust the government. From the perspective of the suppliers, the cultural norm, lack of knowledge, and lack of trust in the government are contributing factors to discouraging people from taking up basic WASH and therefore adaptation actions.

Overall, the water operators face many financial risks due to high operational costs, non-revenue water which are compounded by flood and drought impacts. Except for one supplier who is an established company, the majority of the water operators felt the business environment for water operators is really discouraging.

4.2 Sanitation suppliers

Most sanitation suppliers did not observe too many climate related impacts on their business except for the hotter conditions which make working more difficult, or lack of transport during flooding seasons. In Kratie, the masons changed their location of work to cope with the weather. During the flooding period, they work on the hilly areas, and in dry season, they work on flat ground. The more intense rainy period with thunderstorm compared to the last 10 years, has led to many suppliers unwilling to deliver the materials in the rain because they are afraid of being hit by the thunder.

A supplier describes the difficulty of working in Kampong Speu's challenging environment when it rains heavily,

> "It takes us about 3 days to dig to the deep of 1 meter or a little bit more for 3 pit rings. The above soil layer is sand and the below is stone. Another problem is the heat. The soil level there is shallow so the heat can cause disease to both human and animals. The soil there is naturally hard, everywhere! During the flood period, we cannot do anything. The water won't infiltrate at all. In my area, the flood level can be up to 70 to 80 cm, so we need to raise the toilet quite high, which, sometime, has a higher risk of collapse during flood." Sanitation supplier, Kampong Speu

This could explain why resilient latrine (latrine on the house) is most preferred as an adaptative measure by sanitation suppliers.

Another impact of flood mentioned in Kampong Speu is land erosion which can make the rings fall when the water current is strong especially in mountainous area. Transportation on these areas is difficult and become more problematic during heavy rain.

Most suppliers felt that there is sufficient water supply all the time and most toilets function properly during floods. This is because in many areas, the latrine pits, platforms, or property ground have already been raised. The most popular form of adaptation among most of the masons in all provinces was adding more rings, moving up the draining pipe to convert the latrines into twin pit latrine. The cost of constructing twin pits vary from $100 to $175.

Those that work in flood zone in Kampong Speu talked about sky latrine which the villagers are really interested, which could explain why that option is most preferred. However, there are those, in Pursat for example, who have introduced sky latrine but no take up so far because the educational messages are not getting through the community and open defecation still happens. Sky latrine is seen as usable in both areas of flooded and non-flooded areas.

Mobile toilet, one that can be moved to higher ground during flood and moved back when flood recedes, is another option but more expensive which villagers cannot afford. Moreover, most suppliers do not know how to build this type of latrine.

To adapt to drought, especially in hard ground areas, the masons must dig quite hard. But as the RSCC manager explained, through trial and error, they have learnt that it is still effective to dig only 80 cm deep, and use only 2 pit rings, so they can bury the rings in the first soil layer, and then connect the rings. It takes about 3 days to dig 1 meter or more into the hard ground and bury 3 pit rings, and they could dig several holes and cannot find an appropriate place for the rings because of the stony and graveled soil especially in mountainous areas. The problem for these masons is that they have to bear the costs of additional digging in the case of hard ground because the price is already fixed. In the case of the RSCC head supplier, he sometimes has to bear from his own pocket because the households cannot pay the branch masons. As a result of this problem of working in hardground areas, many suppliers gave up and not too many people wanted to enter the business because of lack of financial revenue and high costs. Consequently, the lack of latrines in these areas present open defecation and therefore a hygiene problem in the water sources that either feed directly into the rice fields or drawn by those that use surface water sources.

4.3 WASH financing

4.3.1 Financing needs

WASH suppliers required additional financing for different reasons although most financing needs relate to increased investment for different product types rather than adaptation measures. The discussion of the financing options among the suppliers suggests limited capacity of the suppliers for financing and awareness or availability of different financing options.

Water operators needed about 20-30% increase in cash flow to expand pipe network to service their customers or to provide connections where there is demand by users but no existing pipe networks. Other water businesses want to give customers loan to encourage them to connect. Others want to build additional storage tanks to service more users.

> "I hope NGO could help us with financing. We spent a lot on the network, so we couldn't have enough money for another upgrade such as a pump, and treatment tank."

> "My station could not make use of its full capacity for 1000 connections; thus, I need to spend a lot on electricity."

Some wanted finance to start bottled water business as a backup to their piped water service business to increase revenue because of decreased revenue and increased costs associated with drought and flood, and financial risks they encounter generally in the water sector. As noted above, this could be because bottled water is a product that is already sold and accepted as good quality water in the communities, and which explain why this option is seen as most preferred.

Financing needs are much less for sanitation suppliers. Most agree that sanitation suppliers don't need much cash to start up and payment cycle is short. As a supplier explained:

> "In one week, after constructing a toilet, we will receive payment I have taught those under my branch about financial management, so they won't face similar problems like me in the past."

Sanitation suppliers' requirement of finance tend to be customer affordability rather than invest into their business. For example, some talked about more cash to participate subsidy program like WOBA so they can lend to the poor and let them pay back via installments. Others want additional cash to meet the shortfall of payment from poor families. This is also a problem of water suppliers who talked about having had to provide up to 50% subsidy for the poor to connect water.

There are some who wanted to build short type pit latrines in advance so they can supply customers on demand. It is interesting that in Kratie, almost no supplier was aware of any financing option in their business because they operate on a cash business. When they talked about loans, they referred to interest rate of about 6%, which is a lot higher than in other areas where the interest rate was cited as about 1%. It is likely that they were referring to microfinancing loans.

4.3.2 Financing options

Grants and technical assistance from donors and third parties was the most preferred financing option by water suppliers. As noted above, they also require technical support in maintaining water quality and water usage in terms of the size of treatment tanks, pipe size for various geographical locations and number of users, which they feel donors or NGOs can provide. They also look towards NGOs as financing providers. The most common financing option that suppliers were aware of or using was commercial banks loans with mortgage security or micro financing for increased cash flow. High interest rate is the main concern and they felt that NGOs could lend them money with a lower interest rate than the banks.

Sanitation suppliers also mentioned international NGOs who have provided technical training.

Most haven't received government support for financing, and would like this, which may explain why government loan is most preferred by sanitation businesses. It appears that although national policies encourage private sector investment in WASH, there is a lack of financing strategy at the policy and institutional level to help private sector financing or mechanisms to support to increase revenue, meeting operational or investment costs, increase demand of customers to these WASH products, or building capacity of the suppliers.

> "They [the government] have no direction. Just go as far as they can, not being fair. For example, in the agricultural sector, if there are NGOs or private sectors doing something, they will promote their demonstration on the Facebook, but our government, never show their results or demonstration to the public so that people can follow and earn more income. Moreover, in their study area, they invested a lot, but never teach people how to do the crop hybrid, so after they left, people still do not know what to do. For WASH program, without NGOs support, seem like they never make it to reach to the grass root demand.

In fact, many felt that the gap between policies and the practical situations is stigma associated with sanitation business which often result in discriminating behaviours by the authorities and households towards sanitation suppliers. As the leader of the RSCC, a large sanitation company in Pursat said:

> "I hope the government will work with the private sector as a team. They should not judge us as small people. Some at the national or district level are okay, but some at the commune or village level, discriminate against us. They never think that we are their important messengers. Without us, how could they implement their project?

The sanitation businesses also felt that the government has a role in mobilising households by raising their awareness to increase demand for latrines. The problem, and related financing needs is not on the supply side. Many are already well equipped to construct double pit latrines.

> "We have everything in stock, be ready for the adjustment from the normal to twin pit latrine and to raise the pipe. We just need someone who can convince people to do so." Sanitation supplier, Prey Veng

It is not surprising that they also view NGOs as a source of financing, which comes from accumulation of experiences in working with NGOs and receiving both financial and technical support. They also see the role of NGOs in educating the communities:

> "For poor people, if they understand about WASH, they would spend money on the connection. NGO's role in this is very important."

Some felt that the community would value WASH more and could support the suppliers more in the community if the local authorities and village chiefs have better knowledge of WASH. Kampong Speu sanitation suppliers felt that building capacity of subnational authorities is important because the PDRDs tend to let the commune or village chef do the work in the community.

> "Even if they go, it is only because they have support from the NGOs or their development partners."

Suggestions for the government to support WASH businesses include the Commune Councils developing concrete plans in WASH for the people, appointing a delegated person in the Commune Council to promote WASH and work with the private sector businesses. The Commune Council has the authority to intervene in the villages to ensure protection of the pipe networks, or resolve issues relating to building new pipes along the road. Another suggestion is for the government to involve citizen representatives and the private sector in public consultation before they decide on the commune investment plan to ensure WASH investment is allocated in the commune budget and that all stakeholders are considered in the WASH plans.

4.3.3 Financing to support the poor

As found in the MTR relating to basic WASH, all suppliers felt that poor families should be fully supported in adaptation measures. For them, supporting the poor is "a good deed" although their revenue was lost.

> "We rather lose money in the hope to see all of them [the poor] can have the latrine. Those people are really poor, they almost have nothing, and some are even handicapped and could not earn money." Sanitation supplier, Kompong Speu.

> "We did not receive the full payment from the villagers. Projects like WOBA do pay something to us but it is very little money. We did not make profit, and lose a lot as well." Sanitation supplier, Kampong Speu.

> "In order to help our people, we agreed to supply water without any profits. With our subsidy to the poor of about $30-39 for each water connection, the overall amount can be a lot if multiplied by number of families. Because I wanted to help the poor, I wrote the proposal, proposed budget plan and communicated with the authority to be part of WOBA. In the end, my boss blamed me for the financial loss of our business." Water operator, Takeo

For this reason, although all indicated that provision of adaptation measures to the poor should be free, their first preference is that this funding is provided by donors or philanthropic organisations, and their last preference is co-contribution by WASH suppliers. As seen in the comment below and although it is about basic latrine, the supplier's preference for donors in pro-poor adaption funding is based on the same premise of business financial viability.

> "If the next project can support them [poor families] financially, it's our success. Otherwise, it's hard for us to supply it because some areas are far and difficult to access. Therefore, we really hope that there will be donors to support them and to get the latrine for use."

Alongside the desire to supporting the poor, the suppliers emphasise the need for a better mechanism to identify the poor because the current system of ID poor card is not robust and fair, pointing to many non-poor people who have ID poor cards.

> "I hope EMW will still continue your project to support the poor people. I hope you have a better mechanism that would actually help the real poor people" Sanitation supplier, Pursat

> "I think the government should go to meet them directly to see how poor they actually are. Some real poor families did not receive the subsidy." Sanitation supplier, Takeo

> "As identification officer, I have difficulty to classify the financial status of each family too. We sent the information of the interviewee to the government through the commune chief and when the list was out, it was different from what we sent. A village chief and his other family members were classified as poor while I am also poor. Since I am the officer, I'd rather not accept the support but to let the people who are really poor to get it. If the officer only think about themselves, how can we help other people?" Sanitation supplier, Kampong Chhang

To improve this situation, some suggested that non-government agency or transparent government officer should undertake the evaluation of the family personally. This issue and lack of trust in the government system has been noted in several studies by scholars inside and outside Cambodia and also in the MTR. It explains why NGOs are seen as a preferred source of financing.

5. Conclusion

The Friedman test indicated that the answers or sample set for each question that were generated from bootstrapping are significant different with p value <0.001. The most preferred water adaptation measure is water bottled distribution system and the most preferred sanitation adaption measure is resilient latrine. The reasons for these preferences are mainly due to community awareness of products therefore improved chance of selling. Water pump and pumping service is least preferred because most households already have this facility and that buying bottled water is the norm in these communities and bottled water is considered safely managed in Cambodia widely. Resilient latrine is most preferred by sanitation suppliers

because of suppliers' existing knowledge and experience in building sky latrine and double pit latrine. Double pit latrine is not expensive and therefore the most common adaptation measure for these suppliers. There seems to be limited knowledge among the suppliers about safely managed sanitation and distinction between those and adaptive sanitation measures in WASH.

The water operators' first preference for financing adaptation is grants or technical assistance from donors. This is because most are only aware of or currently have loans from commercial banks and micro finance institutions, and thus high interest rate is their concern. Their experience with NGOs or donors includes receiving technical assistance and financial support, and they have limited exposure to other financing options. They also see NGOs as potential funding source with lower interest rates compared to the banks and micro financing institutions. Their preference for NGOs also stems from the lack of trust in the current local authorities, lack of concrete action plans at sub national and local authorities to support water operators in working with the community to protect the water ways and pipe networks.

Sanitation suppliers prefer government loans the most, although there are more diverse preferences in 2nd and 3rd choices. Their financing needs are much less than water operators due to lower costs except for those who work in challenging environment and face high costs of digging in hard ground and/or lack of transport during flood or intense hot periods. Their cash flow requirement is mostly to fill the shortfall from nonpayment of poor households. It could also be that the sanitation suppliers see the government as having a critical role in raising awareness of WASH to increase demand for latrine, and reduce stigma against the sanitation workers, or that none of the suppliers have had support from the government for their sanitation businesses.

All water and sanitation suppliers believe that the adaptive sanitation product/ service should be provided to the poor for free, and that they should be funded by donors or philanthropic organisations. The reason is mainly because of the significant financial viability risks that they currently encounter, which has increased due to climate related impacts, and the WASH business environment which is generally low profit, risky revenue stream, and high operational costs especially for water operators.

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