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Water treatment practices in rural Myanmar and residents' perceptions of technologies from donor countries

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ABSTRACT

Access to safe water is a significant issue in developing countries. Myanmar, a developing country in Southeast Asia, receives aid from many Organization for Economic Co-operation and Development (OECD) member countries. Installation of point-of-use water treatment devices is an example of a water aid project to update the water infrastructure of the recipient country. However, research has tended to ignore the circumstances of the recipient. Usually, they already conduct water treatment and provide water for daily use; therefore, comparison of newly installed technology with currently used technology is important to achieve sustained use of the new technology. In this study, 99 households in a village near Yangon City were asked to complete a questionnaire survey. The questionnaire included basic household information, currently used local technology, and residents' perception of newly installed technologies from donor countries. The outcome of the study showed that local people were interested in higher water quality from both current and newly installed technologies, and they had different expectations of different donor countries. They were concerned about costs with all countries, but had different expectations for quality and ease of use from different countries. Analysis of specific technologies suggested that local people recognized the similarity of donor countries A (Japan) and B (China), but they expected higher quality from donor A and lower cost from donor B. Further analysis regarding current technology implied that they preferred to receive, and were more willing to use, technology from donor country A than from donor country B due to perceived quality.

Keywords: Perception; SDGs; Donor; Japan; China; Myanmar, Treatment technologies

1. Introduction

Access to safe water is a significant issue in developing countries. About 780 million people globally do not have access to an adequate water supply, 2.5 billion do not have access to suitable sanitation facilities, and about 2 million die every year due to diarrheal diseases [1]. Myanmar is a developing country in Southeast Asia. The United Nations criteria place Myanmar in the category of least developed countries [2]. Water infrastructure needs to be developed for the country's further economic development. The country receives aid from many OECD member countries, such as Japan, the United Kingdom, and the United States. Japan plays a key role in aid projects in Myanmar, providing 64% of Myanmar's total aid [3]. It is important to ensure that such projects are effective. To the best of our knowledge,

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only a few water quality surveys having been conducted [4–8]. Several projects target the renovation and expansion of water infrastructure in urban areas; however, information about rural areas is scarce.

Water aid projects usually include the installation of point-of-use (POU) water treatment devices to update the water infrastructure of the recipient country. However, once installed, such devices are sometimes abandoned, leading to the failure of the project [9]. Failure of sustained use is often caused by a physical defect in the device. Brown et al. [10] reported that the use of filters declined at a rate of 2% per month, largely due to breakage. Although other aspects should be considered, few contributions have addressed the question of the user's experience in the post-implementation phase [9]. Sobsey et al. [11] summarized six key features of a sustainable POU technology: consistency, effectiveness, time, cost, reliability, and ease of maintenance. Meierhofer and Landolt [12] showed that important factors for sustained use of solar water disinfection (SODIS) were availability of devices, visibility of the method, tailored implementation, feeling of health improvement, and official backup. In Malawi, Wood et al. [13] confirmed the importance of interpersonal communication in prompting the adoption of household water treatment. Ngai and Fenner [14] presented a case study from rural India regarding the adoption of biosand water filters by an NGO to maximize the sustained use of filters. Several additional case studies for water and sanitation projects in developing countries have been published [15–20].

However, all such research tends to focus on the donor and disregard the circumstances of the recipient. Usually, recipients of such aid projects conduct their own water treatment, which provides water for daily use; therefore comparison of newly installed technology with currently used technology is important for the sustained use of the newly installed technology and the success of the aid project. This study also focused on participants preferences in terms of the donor country. Nowadays, local people usually have access to updated information on foreign countries, and they may have formed some impressions of donor countries and their water treatment products based on such information. Therefore, they may well have some expectations of the donor country's aid project. If the actual product fails to satisfy their expectations, the likely result is failure of sustained use of the newly installed technologies. Therefore, this study focused on residents' perception of new technologies compared with currently available local technology and of newly implemented technologies from donor countries.

2. Materials and methods

2.1. Questionnaire survey

The questionnaire survey was distributed in Htantabin village west of Yangon City. The village was selected because it is one of the target villages of the Myanmar National Community-driven Development Project [21]. Survey was conducted after approval of officer at the rural health center. The village, which is accessed by a 2 h drive from center of Yangon City, has no public water supply. The village has about 850 households and a population of around 4,000. The main water source is a drinking water pond, whose main water source is assumed to be rain water. The questionnaire survey was completed by representatives of 99 households in the village, which was selected by coordination by the head of village. The questionnaire included questions regarding (i) basic household information, (ii) currently used local technology, and (iii) impressions of newly installed technologies. Questions were asked about imaginary situations to receive new technologies from different donor countries, which are home country (Myanmar), donor country A (Japan), and donor country B (China). Questions were asked verbally by the surveyor and the response of the interviewee was confirmed.

2.2. Water quality survey

In addition to the questionnaire survey, this study surveyed the quality of water provided by the current local technology to find the relationships among technology, perceptions, and water quality. Physical, chemical, and biological parameters were used to examine water quality. Physical and biological parameters were measured without filtration, and chemical parameters were measured after filtration through a 0.45 μm PTFE membrane. Physical parameters, that is, pH, oxidation–reduction potential (ORP), electric conductivity (EC), and total dissolved solids (TDS), were measured using a portable meter (MP6, HACH, USA). Chemical parameters mainly consisted of organic matter, dissolved total nitrogen (DTN), and anions. Microbial parameters included *Escherichia coli*, total coliform, and heterotrophic plate count (HPC). Petrifilm was used to enumerate colonies.

3. Results and discussion

3.1. Water treatment practices in the village

For the water quality survey, water sampling were conducted in seven households in three villages in Htantabin Township. Interviews followed the sampling to reveal their household water treatment practice. Their treatment included two components: particulate removal and disinfection. Particulate removal was generally done by sedimentation, that is, particles settled out of the water due to gravity. In some households, alum was used to accelerate the process. After the sedimentation process was completed, the water was transferred to a drinking water pot through a filter, which removed large particles. Disinfection was done by boiling; sometimes, it was omitted. A chlorination tablet was used in some households when available. Microbial parameters were monitored through this treatment train. Water was measured at the drinking water pond, in sedimentation pots, and in the pots used for filtered water storage. Results are presented in Fig. 1. Closed circles, squares, and triangles represent total coliform, *E. coli*, and HPC, respectively. Open symbols represent measurements that were outside the detection limit. Coagulation by alum reduced the concentration of all microbial indicators, possibly due to sedimentation of bacteria with associated particles. However, water stored in the pot after filtration showed more bacteria than after coagulation; some indicators were even higher than the original water sample. One

possibility may be intrusion of bacteria during their daily use, because villagers directly put a cup in the pot to drink water. Another possibility may be due to the regrowth of bacteria in the water storage pot after filtration, which suggests that household water treatment is effective, but the water storage process is not.

3.2. Current water treatment practices and perceptions of foreign technology

For the main survey, 99 households in the village were visited, and members of each completed the questionnaire survey. Fig. 2 shows the water treatment practices employed in these households. In the village, people take water from the pond, treat it themselves, and store it in a pot until use. There are several variations of household treatment. The full treatment train consists of coagulation, sedimentation, filtration, and boiling. The questionnaire survey revealed villagers' water treatment practices. Of the 99 households, 29 used alum, 67 used sedimentation, 59 used filtration, 58 used boiling, and only 1 used chlorination. Sedimentation was the most widely used technology, followed by filtration, boiling, alum, and chlorination. For alum coagulation, a rock form of alum was used; the rock was scraped, and scrapings were mixed with the water for coagulation. Among those who used alum, the dominant reason for employing this technology was "higher water quality" (90%), which was considered reasonable (Fig. 3). The dominant reason for using sedimentation technology was also "higher water quality" (67%), followed by "easily available" (20%), "maintenance is easy" (3%), and "cheaper than others" (2%). During the sedimentation process, water is placed in a large pot and left until the particles have settled out. Therefore, the answers "easily available", "maintenance is easy", and "cheaper than others" were common rationales for this option. In addition, Fig. 1 shows that sedimentation was effective, resulting in a significantly reduced number of bacteria; therefore, the answer "higher water quality" is also reasonable. For filtration, the dominant answer was also "higher water quality" (73%), followed by "cheaper than others" (10%). This can be explained by comparing the sedimentation pot and the filter. The sedimentation pot, which can be obtained in the village, has a capacity of several 100 L and has a certain cost. However, the filtration device is a loose plastic mesh rather than a membrane. It cannot be obtained in the village and requires access to markets in the cities, although it is not expensive. Regarding water quality, the actual microbial number does not match with people's impression of "higher water quality". This issue is key for further improvement of water treatment in the village. Boiling was used for different reasons. Almost 30% of users chose it for "higher water quality", while 57% did so without providing a reason ("none of the above"). Only one person expressed a preference for chlorination, attributing the choice to "higher water quality".

3.3. Preferences for donor countries

The impression of the donor country that is conducting an aid project is important in terms of the people's expectations and perceptions of the new technology and its sustained use. Here, the preference for donor countries was examined, with Japan and China chosen as examples. Japan is the top donor country to Myanmar; China has recently assumed an important role in a large number of projects in developing countries in Asia and Africa [22] and is likely to play a larger role in Myanmar in the future. Therefore, characterization of these two important donors will provide useful insights into the sustained use of water devices and the success of water aid projects.

Fig. 4 shows participants' preferences for donor countries and for one's home country. The first question about preferences asked whether participants preferred the technology from each country and the reasons for this preference. Among three countries, Myanmar (home country), Japan

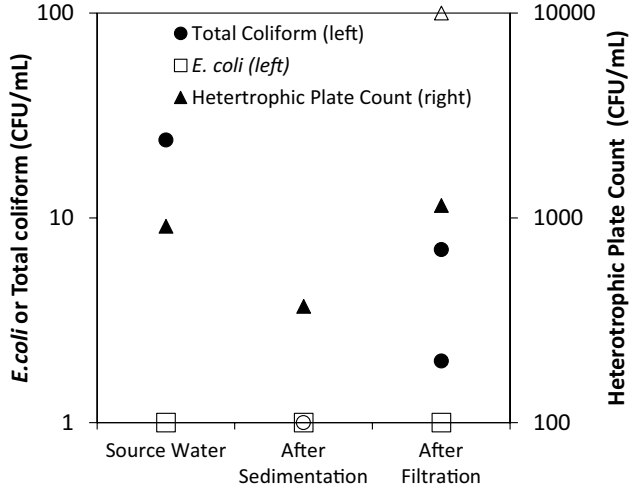

Fig. 1. Microbial parameters in the treatment train.

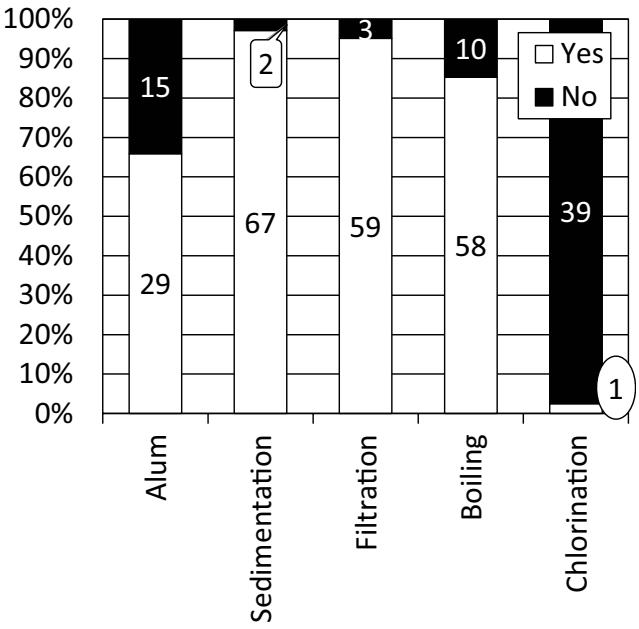

Fig. 2. Currently employed water treatment practices.

(donor country A), and China (donor country B), the home country's technology was most preferred (76%), followed by technologies from donor countries A (53%) and B (21%). Thus, preferences among countries differed.

The results shown in Fig. 4 were further analyzed using Table 1. Three sets of χ^2 tests were performed for different combinations of countries, namely (i) between donor country A and donor country B, (ii) between donor country A and home country, and (iii) between donor country B and home country. The χ^2 test results revealed a significant difference in preferences for (i) and (ii), whereas the differences in preference for (iii) were not significant. These comparisons suggested that local Myanmar people consider donor country B and their home country to be in the same category, whereas donor country A was seen as being in a different category. Thus, it makes sense that expectations of the two donor countries also differed.

3.4. Reasons for country preference

The reasons for participants' willingness or unwillingness to use technology from various countries were also surveyed and are shown in Figs. 5 and 6. The reasons for willingness to use technologies from the home country were diverse, with the dominant answer being "easily available" (35%), followed by "cheaper than others" (15%), "maintenance is easy" (11%), and "higher water quality" (10%). Summing "easily available" (35%), "cheaper than others" (15%), and "maintenance is easy" (11%) reveals that about 60% of participants were happy to use the home country's technology due to its cost and accessibility. With respect to respondents' willingness to use donor country A's technology, the most common answer was "higher water quality" (88%); in contrast, the dominant reason for willingness to use donor country B's technology was "cheaper than others" (74%). Thus, preferences for technologies from donor country A or B were attributed to quality and cost, respectively, which highlights the differential expectations displayed in Table 1. The Myanmar people clearly had very different impressions of different donor countries, even though the performance of their products was not clearly known.

The only reasons specified for unwillingness to use the home country's technology were "lower water quality" (35%) and "not easily available" (9%). For donor country A, the dominant reasons for unwillingness to use the technology were "more expensive than others" (29%) and "not easily available" (33%), indicating that these respondents had a negative impression of donor country A's products, particularly in terms of cost and ease of access. By contrast, for donor country B, 27% of respondents replied, "lower water quality". Meanwhile "not easily available" was a common reason given for products from both donor countries, accounting for 33% of replies regarding donor country A and 22% of those regarding donor country B, suggesting that products from such donor countries are not easily available to the local

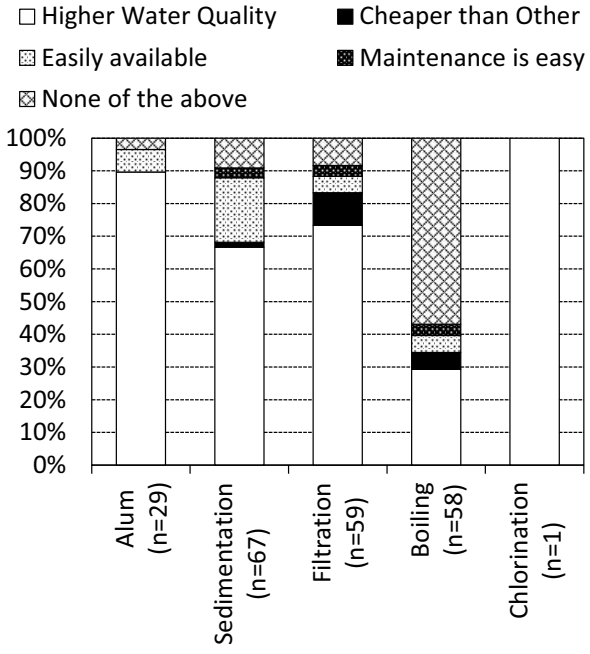

Fig. 3. Reasons for using current technology.

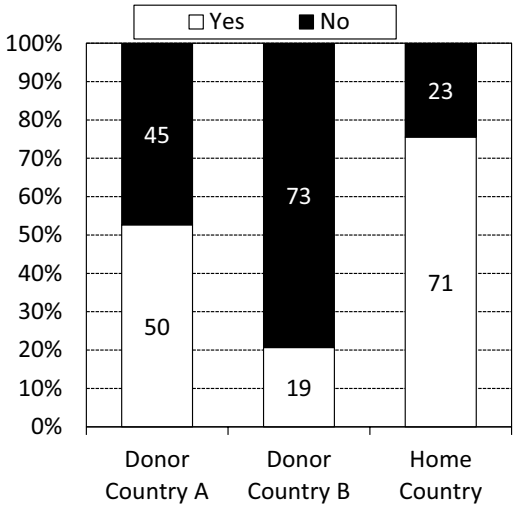

Fig. 4. Willingness to use technology from various countries.

Table 1
Preference among countries

		Donor country B				Home country				Home country	
		Yes	No			Yes	No			Yes	No
Donor Country A	Yes	17	31	Donor Country A	Yes	27	21	Donor Country B	Yes	12	6
	No	2	43		No	43	2		No	57	17

Myanmar people. A comparison of the reasons for being unwilling to use technologies reveals perceived differences in the quality and cost of products from the donor countries. The same conclusions were drawn from the reasons for willingness to use technologies from the donor countries, as discussed earlier. Overall, Myanmar local people prefer technologies from their home country due to lower cost and greater ease of access. They also offered reasons related to cost and quality with respect to both donor countries. Cost was a common concern with respect to all three countries, while people had different concerns about access and quality when evaluating technologies from the donor countries and the home country.

3.5. Relationships of currently used technology with country preferences

To further analyze the reasons for respondents' preferences, the relationship between participants' current technology, and their willingness to use technology from different countries was investigated (Table 2). In the analysis, missing responses were considered "No" answers. The data were analyzed by applying a χ^2 analysis to the intersection of Yes/No answers for the use of each technology and Yes/No answers for the willingness to use products from a specific country. Fisher's exact test was also applied to evaluate the results that were found to be significant by the χ^2 test.

The results for donor country A showed a significant relationship between the use of boiling ($p < 0.05$), alum ($p < 0.01$), or filtration ($p < 0.01$) as the current water treatment practice and willingness to use technology from donor country A. These results showed that people in households currently using water purification techniques such as boiling, alum, or filtration were significantly more willing to use water treatment technology from donor country A. It may be that such households were concerned with water quality, which led to greater interest in water purification devices

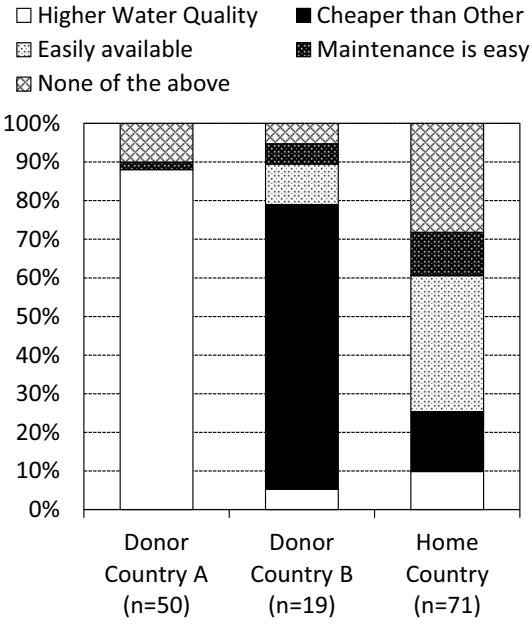

Fig. 5. Reasons for willingness to use technology from various countries.

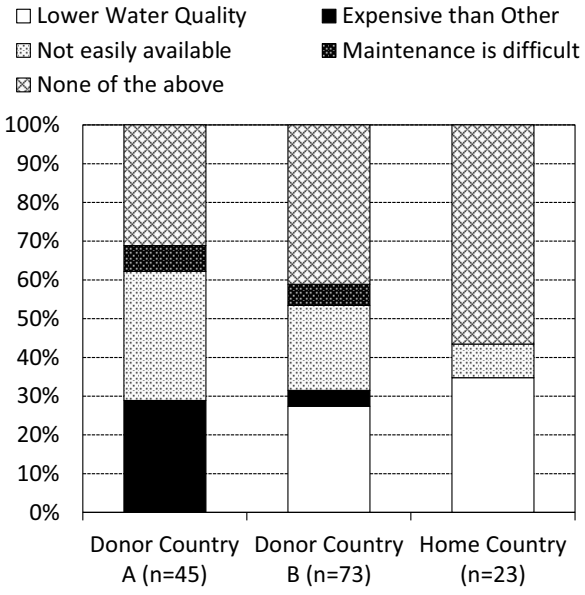

Fig. 6. Reasons for unwillingness to use technology from various countries.

Table 2
Relationship between current technology and willingness to use technology from various countries

		Currently employed technologies									
		Alum		Sedimentation		Filtration		Boiling		Chlorination	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Donor country A	Yes	23	27	35	15	40	9	35	15	1	49
	No	3	42	29	16	16	29	21	24	0	45
Donor country B	Yes	13	6	17	2	18	1	14	5	0	19
	No	11	63	45	29	36	37	40	34	1	73
Home country	Yes	20	52	54	18	44	28	42	30	1	71
	No	6	17	11	12	12	10	14	9	0	23

and therefore in water treatment technology from donor country A.

The same analysis was also applied to donor country B and to the home country. This analysis showed significant relationships between current use of sedimentation, alum, or filtration and willingness to use technology from donor country B ($p < 0.05$, 0.01, and 0.01, respectively). It appears that local people who used any kind of water treatment device were willing to use technology from donor country B. Thus, people were interested in low-cost technology regardless of the nature of that technology. There was also a significant relationship between sedimentation and willingness to use the home country's technology ($p < 0.05$), suggesting that people using sedimentation are satisfied with the current local technology due to its ease and low cost.

The following conclusions can be drawn from these comparisons. First, local people have some common impressions regarding technology from the home country and that from donor country B, as seen in the significant relationship between current use of sedimentation and willingness to use the technologies of these countries. In addition, considering the results for alum and filtration, local people also perceive some similarity between donor countries A and B. However, respondents' expectations of donor countries A and B may differ, considering the results noted in the previous section. For example, local people are interested in both alum and filtration, but their rationale differs depending on the country; for instance, they attribute high quality to donor A's products and low cost to donor B's products. Understanding these different impressions of the donor countries may contribute to the future success of aid projects, including the sustained use of technology.

3.6. Perceptions of current technology and of new technology from different countries

In addition to the question regarding which technology participants preferred, the questionnaire also asked about the reason for choosing a technology. Here, we examine the relationship between donor countries and the reasons for using the current technology. A χ^2 test between willingness to use technologies from donor country A and reasons for employing particular current technologies was performed; the results are shown in Table 3. The significance of the results was confirmed using Fisher's exact test, as noted previously (section 3.5 (Relationships of currently used technology with country preferences)). The analysis revealed a significant negative correlation between "sedimentation because it is easily available" and "willing to use technology from country A". Also, those who used "sedimentation because of higher water quality" were more willing to use technology from country A. A similar trend was also observed for filtration, with a significant negative relationship of willingness to use products from donor country A with "cheaper than others" and a significant positive relationship between such willingness and "higher water quality". This analysis suggests that households that had an interest in "higher water quality" were willing to use water treatment technology from donor country A. The same analysis was also applied to reasons for current technologies and preferences for donor country B (Table 4). The results showed significant positive relationships of a preference for products from donor country B with "higher water quality using sedimentation" and "higher water quality using filtration", indicating that households that had an interest in "higher water quality" were also willing to use water treatment technology from donor country B. Thus, people who placed importance on "higher water quality" were willing to use technologies from both donor countries. The difference between preferences for the two donor countries lies in the use filtration and sedimentation. The preference for donor country A was significantly negatively related to "cheaper than others" for filtration and "easily available" for sedimentation. No such relationship was found for donor country B. These negative relationships with reasons for being unwilling to use donor country B's products, such as they are "cheaper" or "easily accessible", may imply a stronger motivation and greater willingness to rely on donor country A than on donor country B, perhaps due to questions of quality.

In summary, the outcomes of the study with regard to respondents' perceptions of new technologies and the differences in their perceptions of the donor countries suggest that people in Myanmar were interested in higher water quality as a criterion for both current technologies and newly installed technologies, and they had different expectations for different donor countries. They were concerned about the cost of technologies from all countries, but their expectations regarding quality and ease of access differed between the donor countries. The analysis of attitudes toward specific technologies suggested that local people recognized a similarity between countries A and B as donors, but they expected better quality from donor A and lower cost from donor B. Further analysis of the reasons

Table 3
Reasons to use current technologies and willingness to use technology from donor country A

		Reason to use sedimentation				Reason to use filtration					
		Higher water quality**		Easily available**		Higher water quality**		Cheaper than other**		None of the above**	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Willingness	Yes	32	3	1	34	35	6	2	39	1	40
	No	9	19	12	16	6	10	4	12	4	12

Significant at 99% (**).

Table 4
Reasons to use sedimentation and willingness to use technology from donor country B

		Reason to use sedimentation		Reason to use filtration	
		Higher water quality**		Higher water quality**	
		Yes	No	Yes	No
Willingness	Yes	16	22	18	20
	No	1	21	0	16

Significant at 99% (**).

for using current technologies suggested that, in terms of quality, the participants preferred and were more willing to use technologies from donor country A compared with those from country B. This study also revealed differing expectations of the technologies from different donor countries on the part of the local Myanmar people. Uncovering these underlying expectations may contribute to greater satisfaction and sustained use of products by local people and will contribute to the success of future aid projects.

4. Conclusions

First, the local Myanmar people were interested in higher water quality, both from current technologies and from newly installed technologies. Second, they had different expectation of the technologies from different donor countries. They were concerned about the cost of technologies from all countries; however, they had different expectations with regard to the quality and ease of access of technologies from the different countries. Analysis focusing on specific technologies suggested that local people recognized the similarity between countries A and B as donors, but expected higher water quality from donor A and lower cost from donor B. Further analysis of participants' reasons for using current technologies suggested that water quality was the most salient reason for their preference for country A's technology, relative to that of country B, and for their willingness to use country A's products. This study revealed that the Myanmar people held different expectations for different donor countries. Elucidating this underlying expectation may contribute to people's greater satisfaction with and sustained use of products, as well as to the success of future aid projects, by applying different technologies to people who have different expectation to technologies.

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