Users' perspectives as a guide in the design of a new portable water purification system in Puerto Rico

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RESEARCH PROBLEM

This study focuses on exploring design parameters that help guiding vendors develop a best-fit water purification system that meet the needs and desires of residents in Puerto Rico. Many communities in this region suffer from water quality challenges due to limited basic water infrastructure and water quality monitoring, issues with contamination, or frequent shortages or interruptions caused by climate change or natural disasters. One of the pathways to address water insecurity in Puerto Rico is to establish a decentralized fit-for-purpose water purification system with in-line monitoring. The proposed research focuses on Puerto Rico as a model because the complexity of the ecosystem surrounding water insecurity there will aid in the delineation of distinct use cases (natural disasters, contaminated tap water, underserved areas) and the creation of a solution that is sufficiently accessible for these challenging circumstances (Roque, 2021).

There are several causes of ongoing water insecurity in Puerto Rico. First, there is worsening depletion and contamination of limited groundwater supplies driven by expansion of manufacturing industries – especially the pharmaceutical industry (Bruno, 2022; Jones et al., 2023). Second, issues with existing public water supply, such as filter clogs and pipe leaks, lead to an estimated 50% loss of treated water end route to residential homes. Third, while 97% of Puerto Rico's population receives drinking water from the Puerto Rico Aqueducts and Sewer Authority (PRASA), still 3% rely on household or decentralized water treatment systems. Finally, as an added intermittent threat to water security, the territory experiences hurricanes, which are increasing in intensity and frequency because of climate change. Hurricanes lead to interruption in centralized water services due to increases in turbidity and salinity driven by flooding and ocean surge. Turbidity is particularly problematic because it interferes with disinfection processes, thereby increasing the risk of waterborne illness from bacteria, viruses, and parasites. These challenges are exacerbated by the inadequacy of tools available to monitor water quality.

Resulting water shortages disproportionately impact poor and elderly populations on the island. According to the Health Resources and Services Administration (HRSA), the rate of poverty in Puerto Rico is 43.5% (in 2019). Additionally, roughly a quarter of the island's population is over the age of 65, due in large part to migration of younger individuals to the mainland U.S. in search of employment opportunities. Further, a decades long history of Safe Drinking Water Act (SDWA) violations by PRASA has led to a pervasive distrust of government agencies regarding water quality.

This study aims to examines users' challenges and cultural preferences with a new water purification system in Puerto Rico. The research methodology included a qualitative approach where 8 semi-structured interviews were conducted in March 2024. The interview focused on five themes: current drinking water sources, quality, and concerns; drinking water supply challenges; contaminants in the drinking water source and any filtration or purification system you know or use to purify the water;

end-users' preferences on water purification system; and end-users' interest in learning about the new technology and the filtered water quality. The findings of this study brings a comprehensive perspective of what a good purification system could serve compacted and vulnerable communities in Puerto Rico.

BRIEF RESEARCH METHODOLOGY AND APPROACH

A sample of 8 participants was recruited in March 2024 using snowball sampling in-person. Table 1 presents the sample demographics. Majority of the participants were males, middle aged adults with bachelor's degree. Interviews were conducted in English or Spanish and digitally recorded. The average duration was an hour. Respondents were compensated with $99 gift cards. The interviews were transcribed using Otter.ai software and REV.com, and transcripts were checked for errors by the first author, proofreading the transcripts.

TABLE 1. SAMPLE DEMOGRAPHICS

Demographics	Total	Percentage
Age	8	
Young adulthood	2	25%
Middle adulthood	5	63%
Old adulthood	1	13%
Education	8	
High-school degree	1	13%
Some collage	1	13%
Bachelor's degree	4	50%
PhD student or degree	2	25%
Gender	8	
Female	2	25%
Male	6	75%

KEY FINDINGS AND IMPLICATIONS

A systemic coding framework was followed based on the five themes of the designed interviews. 50% of the participants responded that they use bottled water as their main source of hydration even if they are connected to the PRASA utility water service.

"My mom buys water bottles."

"To drink I use bottled water, which I buy."

The others rely on well water or on-site water purification plant in their community.

"The water we drink every day is purchased we have a water planet purification water plant."

Their consumption rate ranges from 7 gal up to 30 gal per month which controls their drinking water cost to be $4 up to $60 monthly.

"I spend some $40 to $45 also on bottled water."

Their major contaminants concerns were bacteria, iron, microplastics and dirt.

"Kind of come to share with microplastics because microplastics is like, everywhere not only a water, but I have also read that on food, many other stuffs."

"Too much nickel too much iron, I don't know."

They prefer to own a large-sized water purification system that could serve the whole household to be used for drinking, washing clothes, and showering. Their affordability range is less than $100.

"The system should be like my dispenser."

"Well, I'd like for it to first be for all of the house."

"Well, see like in the main entrance, there, there is a part behind the residence near the terrace around there. A place where it wouldn't, where I wouldn't have any inconveniences. That it isn't a bother and leave it fixed in one place."

"Like around $60. Maybe $60 dollars."

They prefer to learn about the system through TV, YouTube, or Facebook, as these are the main resources they rely on to learn about new technologies.

"I watch a lot of TV on channel 2.2, I watch a lot, and when I notice that the water is dirty, I say, hey."

"We use Facebook a lot, emails are used very little, but Facebook is used by many people."

Therefore, community feedback helps defining the design characteristics, maintenance expectations, cost, and perceptions about the risks of a new water system in Puerto Rico.

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