



DROPS OF KNOWLEDGE

WATER AUDIT SERVICE

Sophia Balaski, Chloe Jackson, and Jody Nace

TABLE OF CONTENTS

INTRODUCTION	1
PROBLEM	1
SOLUTION	2
BUSINESS MODEL	4
IMPACT	5
MINIMUM VIABLE PRODUCT	6
WHAT'S NEXT?	6
REFERENCES	7
APPENDIX	8
A. Theory of Change	8
B. Randomized Control Trial	9
C. Empathy Maps	10
D. Business Model Canvas	12
E. Prototype Documentation	13
F. Prototype Feedback	14
G. Financial Details	15

INTRODUCTION

Bengaluru is a city whose water story was complex from the start. Unlike many ancient cities, Bengaluru is not near any bodies of water or along a coast. To supply its water, wells were used for domestic and non-domestic purposes, especially irrigation. In the year 1896, Bengaluru began to supply piped water to its residents, which quickly led to the decrease in open well use[1]. Borewells and piped water from the River Kaveri became the new main sources of water for the city.

But as the population of Bengaluru increases rapidly, these water sources are beginning to face difficulties. Currently, BWSSB provides 1440 million liters per day, by withdrawing the maximum possible from the River Kaveri, which is over 200 kilometers away. As the municipal tap network expands to reach the new developments in the edges of the city, residents have begun to see less consistent water quantity from their connections. At this time, the city falls 650 million liters short daily[2].

This has led to 70% of Bengaluru's 75,000+ apartments relying on sources other than BWSSB for their water supply[3]. Most have turned to digging borewells and building their own water treatment plant to supply their residents with water. However, the heavy reliance on borewells is causing the deep aquifers to be depleted and borewells to dry up. Some borewells have to be dug 10 times deeper than they would have just a decade ago, leading some people to comment that "what is happening now is groundwater mining, not extraction[4]."

PROBLEM

When private borewells and municipal tap fails to provide for the water demands of a residence, secondary water sources are required such as truck mounted water tanks called tankers. In the dry summer months, when the municipal tap and private borewell supplies are most likely to be dry and inconsistent, tanker demand increases significantly.

Tankers are unregulated, usually filling up with water from deep borewells that have high levels of total dissolved solids. Many of the tankers are unlined, resulting in water being hauled in rusty tanks, further lowering the quality[5]. Tankers are also much more expensive than BWSSB or borewell water, costing residents on average 12 times more than the cost of BWSSB supplied water[6].

By interviewing 13 residents of apartment complexes and gated communities affected by this water scarcity, we have learned that frustration is high with this undesirable secondary source. Admittedly, most residents we met felt they did not know what they could do on their part to resolve these issues. Though residents in the most newly developed areas of Bengaluru feel the impact of this problem now, if no major change occurs all of Bengaluru will come to feel the pinch.

SOLUTION

To reduce demand on unfavorable secondary water sources, the water demand of residences must be decreased. In order to decrease their apartment's water consumption, Resident Welfare Associations (RWAs) can hire Drops of Knowledge, a water audit service. Drops of Knowledge will provide different levels of audits for apartment complexes, both at the apartment and residential level, providing tips on where water usage can be improved and how those improvements can be achieved. We will identify and quantify water usage throughout the apartment and provide personalized solutions that target behavioral and structural inefficiencies to reduce water consumption.

METHODS

Drops of Knowledge will provide three different levels of service to RWAs and apartment residents.

1. Initial Consultation

The initial consultation will be a preliminary measurement of inefficiencies in an apartment's water usage. Our initial report will provide a total efficiency score based on observations we gather from an apartment walkthrough, as well as apartment specific data we gather from the RWA. The efficiency score will be further broken down in the following areas: overall residential water usage, rainwater harvesting facilities, water recycling facilities, maintenance and operations of apartment grounds, and appliances in building, such as toilet, faucet, and shower appliance types. This initial consultation, purchased by the RWA, will serve as a tool for the RWA and Drops of Knowledge to determine the need for further intervention in the apartment. This consultation will not provide solutions or tips, it will only serve as a primary evaluation to determine if and where the apartment can benefit from a more in depth water audit.

2. Primary Report

The primary report follows the initial consultation, if it has been determined that a significant amount of inefficiencies exist that need to be addressed. This report contains two deliverables:

- **Resident Engagement Material:** The first half of this report goes to individual residential units. Along with their water bill, residents will receive a personalized pamphlet that informs them on their household water consumption, provides them with attainable goals on how much water they should be using, and gives them tips on apartment complex specific ways they can reduce their daily water consumption. Residents will receive these pamphlets with their water bills over the course of a year, to maximize engagement and make lasting behavioral change.
An example of a resident pamphlet is found in Appendix E.
- **Cost Benefit Analysis:** The second half of this report will go to the RWA. Drops of Knowledge will target the identified areas that received low efficiency scores in the initial consultation. The RWA will receive suggestions on what changes can be made on an apartment-wide scale to decrease water wastage. We will also provide a cost benefit analysis that estimates the cost of individual changes to the apartment and projected water savings the apartment would see as a result. These changes will be both behavioral and structural. In an effort to avoid any possible conflict of interests, Drops of Knowledge will not provide any referrals to contractors that would be able to complete the work or changes we have suggested.

3. Private Consultation

If residents are interested in a water audit that is specific to their unit, they can hire Drops of Knowledge for a private consultation. We then visit the apartment unit and perform an analysis, using water metering and observation to better understand how water is used and where it is wasted within the home. At the end of the audit, the unit would receive the following:

- **Unit Water Map:** This map provides a visual representation of water usage throughout the home (i.e. bathrooms, kitchen, laundry, etc.). The map will highlight zones of least efficiency.
- **Cost Benefit Analysis:** Along with the water map, the unit will also receive suggestions on what changes can be made within their home to decrease water wastage. This is similar to the cost benefit analysis given to the RWA, but more personalized to the apartment unit. We will estimate what individual changes would cost the residents and projected savings on water they would see as a result. These changes will be both

behavioral and structural. Again, Drops of Knowledge will not provide contractor referrals.

EVIDENCE FOR SOLUTION

A water sustainability assessment of Gurugram City in Northern India stated that citizens and RWAs have a responsibility to “practice water-saving measures at an individual level” and that “one of the foremost elements of efficient water management planning involves engaging communities and other stakeholders regularly[7].” A water audit is an excellent way to invite participation from stakeholders and begin community involvement in water consumption practices.

A study in Bengaluru published in June 2021 suggests that in order to achieve long lasting consistent behavioral changes in household water consumption, three main components are needed: usage information, goal setting, and water conservation tips[8]. Based on this study, we know that these three main components are essential for the framework of our intervention.

A study in Columbia published in May 2020 that analyzed how providing a household with information about their water and electricity “consumption, comparisons with their neighbors and saving tips” impacted their water and electricity usage. It concluded that “feedback information has a positive effect on water consumption and motivates changes in water use at the household scale that impacts per capita consumption[9].”

A case study conducted by the United States Environmental Protection Agency (EPA) studied how different efficiency programs helped to save water and water associated costs. The study observed different conservation methods across multiple cities. In Albuquerque, New Mexico, they implemented a water conservation strategy which included residential water audits. This strategy resulted in a 14% reduction in peak water demand. Ashland, Oregon similarly implemented a water conservation program that included audits and reduced their winter water demand by 16%. In Irving, California, a water conservation program that included audits reduced residential water use by 12%. These examples illustrate how water audits can be used as part of a successful water conservation plan[10].

BUSINESS MODEL

Our customers are Resident Welfare Associations in newly developed apartments in Bengaluru who are interested in gaining insight into the apartment’s water usage and how to optimize it. We have heard from members of RWAs that there are concerns about the high cost of supplemental

water sources, such as tankers. The reliance on supplemental sources are especially high in rapidly developing neighborhoods in Bengaluru where municipal connection is slow to connect and borewells frequently dry due to high demand. In one interview, the treasurer for one of these committees discussed the potential need to ration water in his apartment. RWAs are looking for ways to be more efficient with their water usage, but find it difficult to approach themselves, especially when “there are a lot of other things to work on.”

Another customer group are apartment residents. In nearly all of our interviews with Bengaluru residents, we observed that they showed a concern about the long-term outlook of Bengaluru’s water supply. However, they had a lack of knowledge about available solutions and about appropriate water use. These residents also do not feel the immediate effects of water scarcity as they are able to afford secondary water sources and temporary water scarcity solutions. Due to this, it is difficult to create long-term water usage change among residents. With Drops of Knowledge, residents will have the option to receive a water audit of their individual water consumption. This will engage residents in proper water use and allow them to be more informed about their role in Bengaluru’s water system.

Our primary beneficiary is apartment residents. With our services, they will be more informed on their water usage and will significantly decrease their water consumption. This can lead to greater savings on water cost, and more security in times of water scarcity.

To remain financially sustainable, RWAs will pay for both a water efficiency report for ₹2500, and a primary report for ₹7000 base rate and an additional ₹10 per unit. Residents will pay for a private consultation for ₹900. These charges account for people, materials and overhead. More specific financial details are included in Appendix G.

Partners we will need to be successful are a water conservation NGO and a water expert, which can both act as an advice council for Drops of Knowledge. We would also partner with a water meter company, which would provide us with more detailed information on our customers. All three partners will help us gain more credibility and knowledge to better our services.

IMPACT

The report we provide to the RWA will encourage them to implement changes throughout the apartment complex that will make their water usage more efficient. Paired with this, the information, goals and tips we provide will help residents develop new habits and use new methods to decrease water consumption. These changes from both the RWA and residents will collectively lead to a significant decrease in the complex’s total water demand, reducing the need for secondary water sources and the cost of water.

By proving our methods can save water for apartment residents, it will give Drops of Knowledge more credibility as a consultant. This will allow us to expand our customer base to more apartment complexes and gated communities. As a result, Bengaluru's overall water demand will decrease. This will put less of a strain on BWSSB to provide piped water and will allow for water supply to be more sustainable. The Kaveri River and borewells will have less demand as water sources. A lower water demand from residents will allow Bengaluru to use water sources sustainability, which will help to avoid water scarcity in the future.

MINIMUM VIABLE PRODUCT

The minimum viable product consists of contacting friends and family, and offering to give them a free household water usage audit. This would consist of collecting their water bills from the previous year. An inspection would be conducted measuring the water usage of their appliances such as taps, toilets, bidets, showers, dishwashers, laundry machines, and any other water appliances. It would also include shutting off all water usage in the house, and checking the meter to determine if there are any leaks.

The information gathered will be used to analyze the resident's usage patterns and identify where the most effective water reducing interventions can be made. A list of interventions and behavioral recommendations will be given to the resident along with an estimate of how much they will cost, how much it will reduce their water bill, and how long it will take for the savings to offset the cost of any interventions. We would then follow up with the resident on a monthly basis to view their water bill, have a short discussion, and identify where our model can be improved.

WHAT'S NEXT?

Our primary next step is to complete our minimum viable product (MVP). The feedback we receive on our prototype materials from the MVP will allow us to refine our deliverables so they are best tailored to our customers. The MVP would also show us which of our suggestions are most effective in reducing household water consumption. With this information, we will implement the randomized control trial (RCT) described in Appendix B.

The RCT will give us solid evidence that when we implement our solutions, our customers are more likely to display lasting changes in water usage habits. It will also prove that installing water saving infrastructure in apartments and individual units will decrease total water usage.

Following the implementation of our MVP and RCT, we will begin connecting with potential customers.

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APPENDIX

A. Theory of Change

Drops of Knowledge Theory of Change

What is the problem you are trying to solve?	Who is your key audience?	What is your endpoint to reaching your key audience?	What steps are needed to bring about change?	What is the measurable effect of your work?	What are the wider benefits of your work?	What is the long-term change you see as your goal?
Resident Welfare Associations (RWAs) and Apartment Management Committies struggle to supply enough water from their primary sources.	<u>Beneficiary</u> Residents of apartment complexes in Bangalore <u>Customer</u> RWA Residents of apartment complexes in Bangalore	Network with organizations such as Bangalore Apartments Federation to build connections with potential clients. Attend and present at workshops and conventions for Welfare Associations and Management Committies such as Neighborhoods of Tomorrow to meet members of RWAs. Contact Apartment Owners Associations from government register. Track customer engagement over time using Customer Relationship	Work with RWA to identify any system wide changes that could be made to the apartment/layout to improve water effeciency.	Liters of water saved per month.	Residents save money on water costs.	Reduced water usage in the city of Bangalore.
			Provide Beneficiaries with brochures detailing their water usage, goals for what it should be, and apartment complex specific suggestions and advice for how to get there.	Volume of effluent treated by STP per month.	Reduction in STP operations cost.	Less water scarcity in apartment complexes in Bangalore.
			Conduct water audits for residents to provide personalized, specific reccomendations to help residents reduce their usage and save money.	Apartment and layouts require fewer water tanker deliveries.	Water quality in the apartment and layout is better.	Bangalore residents have a better understanding of the individual actions they can take to decrease water use in their households.
Key assumptions	Key assumptions	Key assumptions	Key assumptions	Key assumptions	Key assumptions	Stakeholders
Residents and RWA members are unhappy with secondary sources such as tanker water.	All RWAs will be interested in our service.	We will be able to gain access to workshops and conventions. RWAs are open to being contacted about water conservation.	We can quickly identify water conserving interventions that will pay for themselves.	Water savings are due to our interventions. Reduction in water usage results in reduction in effluent.	Reduction in water usage reduces operational costs.	RWA/Apartment Management Association. Community residents. BWSSB.

B. Randomized Control Trial

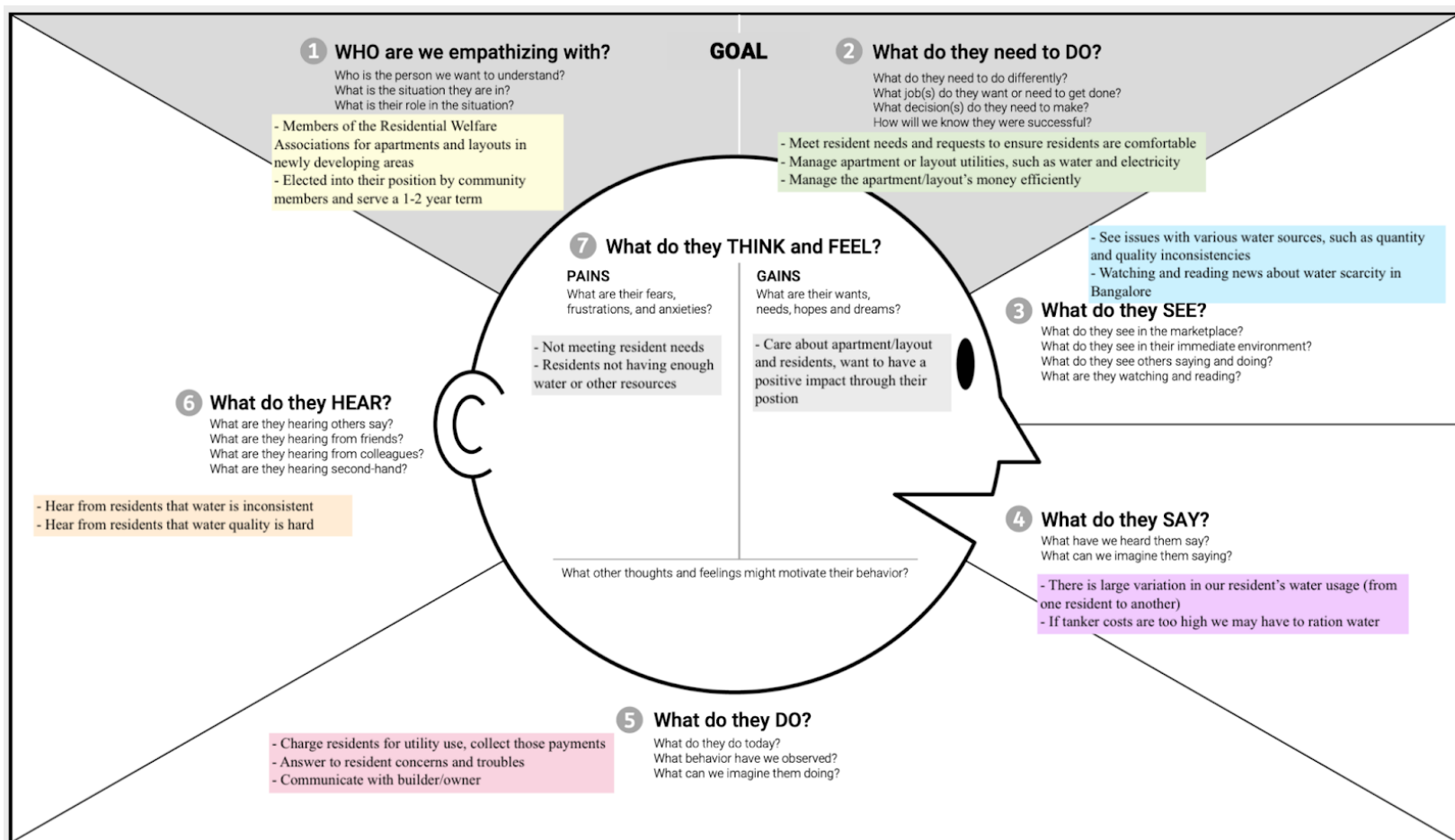
The randomized control test would consist of an apartment complex with multiple towers that have individual tower infrastructure. At the start of the trial, the water usage habits of each household would be identified by collecting their water bills. This will be used as the base condition which can be compared against the monthly water consumption throughout the trial.

The apartment complex would be divided into two equal groups by tower, with one group receiving our consultation and the primary report that details their current usage, smart goals to reduce their usage and specific tips to reduce water waste on an individual resident level. The other half would act as a control and receive no such intervention. Over the next year, each unit's water usage would be monitored. The units that received the intervention would then be analyzed to determine if they had a significant change in their water demand. The project would be monitored on a monthly basis and our materials and approaches for the intervention group members could be modified as needed.

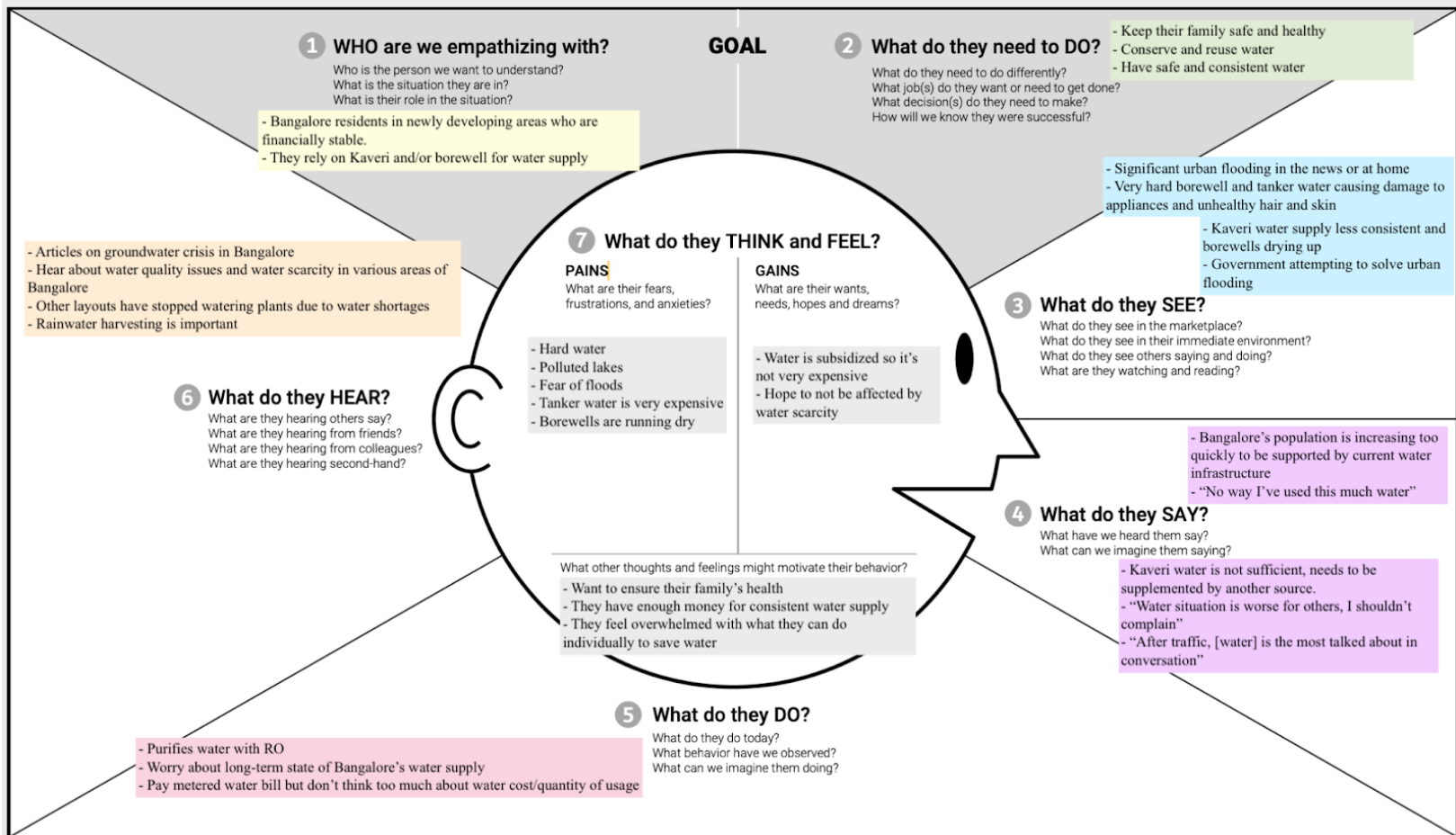
If a full year is not available, the project could be scaled down to 3 months and still give valuable information. This leaves time for both immediate behavioral shifts and more long-term structural interventions. A longer time period would also provide insight into the longevity of this intervention's effectiveness. If the project was to be shortened to 3 months, the timing of this intervention would be at the start of summer, when water is likely to be a higher priority for communities.

C. Empathy Maps

Customer (Resident Welfare Associations)



Beneficiary (Residents)



D. Business Model Canvas

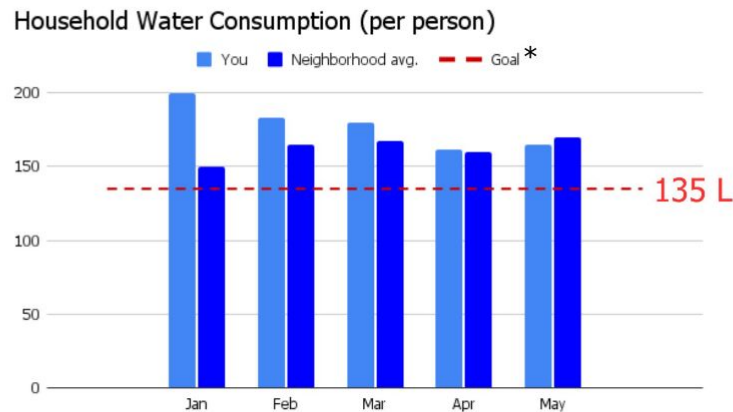
<p>Key Partners</p> <ul style="list-style-type: none"> • Water Expert - provide credibility and counsel • Water Conservation NGO - provide credibility and advice • Water Meter Company - provide credibility and detailed information 	<p>Key Activities</p> <ul style="list-style-type: none"> • Network with RWAs • Research newest water saving tools • Analyze apartment and resident water behaviors 	<p>Value Proposition</p> <ul style="list-style-type: none"> • Water efficiency scorecard including: overall rating and breakdown • Water Audit including: cost benefit analysis for all suggested interventions, resident engagement material • Resident Audit including: personalized cost benefit analysis and tips for conservation 	<p>Customer Relationships</p> <ul style="list-style-type: none"> • Availability for questions throughout year • Personal assistance for individual audits 	<p>Customer Segments</p> <ul style="list-style-type: none"> • Resident Welfare Associations (RWAs) • Residents in apartments and independent villas
<p>Cost Structure</p> <ul style="list-style-type: none"> • Consultancy Fee - Water Expert • Salary - Management and Analyst Staff • Materials cost for pamphlets and reports • Overhead Costs, Benefits 		<p>Revenue Streams</p> <ul style="list-style-type: none"> • Water Efficiency Scorecard - Fixed Pricing • Apartment-wide Water Audit Fee - Volume Dependent Pricing • Private Residence Water Audit Fee - Fixed Pricing 		

Water Usage Report

Apartment Name
Unit ###



How much water are you using?



*Goal is based on the India Ministry of Housing and Public Affairs suggested Liters per Capita for Urban Residents

Are you wasting water?

Did you know each month you lose **₹ 350**
due to water inefficiencies within your unit?

How can you save water?

Modify Toilet Flow



Add an Aerator to Tap



Take a "Navy Shower"



To learn more about what can be done in your home, go here:



F. Prototype Feedback

We prototyped the informational pamphlet that would be sent to every resident at the completion of the primary report. This pamphlet serves as an introduction on the resident level to the findings of our report. We provide enough information to show that this relates to them, and provide a link to more information, tips and goals. Once visiting the link, residents would also learn about the premium consultation offered for guidance unique to their home.

We sampled three versions of the informational pamphlet. Each had a different focus: monetary savings, progress towards water use goal, environmental impact of water overconsumption. We presented these pamphlets to residents, which helped inform us on what messaging residents would best respond to.

We received feedback that it is very important to include visual elements to our pamphlets. We decided that the prototype should include both financial and environmental motivations to make sure that we were advertising our product best to different residents. From there, we detailed each element of the pamphlet, trialing through constant feedback from peers and mentors what elements made the most impact.

G. Financial Details

Costs Structure:

People				Other	
	Expert	Manager	Analyst		(₹/mo)
Monthly Salary (₹/mo)	150,000	50,000	25,000	Overhead	125,000
Time (fraction of month)	1/20	1	3	Printing	4000
Cost per month	7,500	50,000	75,000	Travel	6000
Total People Cost			132,500	Total Other Cost	135,000
Total Cost					267,500

Revenue Structure:

Assuming 53 person-days per month. Assuming 7 Apartments per month, with an average of 300 units each.

	Efficiency Report	Apartment Water Audit	Resident Water Audit
Time to complete (day)	0.5	1	0.20
Charge (₹)	2500	10,000	900
Number per Month	7	7	210
Revenue	17,500	70,000	189,000
Total Revenue			276,500