Helping guests consume less water in hotels

1st Seetharaman Subramanian
Global Innovation Design
Imperial College London & Royal College of Art
London, UK

2nd Dr Nejra Van Zalk
Dyson School of Design Engineering
Imperial College London
London, UK

Abstract—**Freshwater is an invaluable, integral and irreplaceable part of our lives. Acute water shortage in severe droughts forces people to become conscious of their usage and curtail their daily consumption. Multiple behavioural interventions have been tried to change people's consumption habits for the better in various contexts such as in schools, in people's homes, offices and commercial buildings, and while people are travelling and staying in hotels. The last environment is an exciting study as people are often promiscuous in their resource consumption while travelling. The impact of tourists on local natural resources has been well documented. Helping their guests adopt more sustainable consumption habits is no longer a purely financial incentive for the hospitality industry; it is fast becoming a matter of need. This report examines this issue in great detail and looks at how guests can be nudged to change for the better. A case is made for helping guests monitor and regulate their daily water consumption habits, and a design solution is proposed to aid them in this endeavour. Different elements of the intervention are then tested with target users, which provide a future direction for the platform's development.**

I. INTRODUCTION

The human body is more than 60% water [1]. 70% of the Earth's surface is covered by water [2]. Water is one of the most crucial natural resources on our planet and the metric by which we judge other planets as habitable. However, water is not infinite. We are running out of fresh water to access and use in our daily lives. Many places globally are slated to run out of fresh water in the coming decades, as shown in Figure 1. The UK is projected to face acute water shortage by the year 2050 [3]. Many major cities around the world, like Cape Town and Chennai, are already facing seasonal shortages.

This project intervenes at the personal level, forgoing the group and governmental levels based on the work of Cheung et al. [5], and aims to nudge guests in hotels to adopt more sustainable consumption habits. The choice of water scarcity as a problem space and why it is an essential and relevant issue for the author
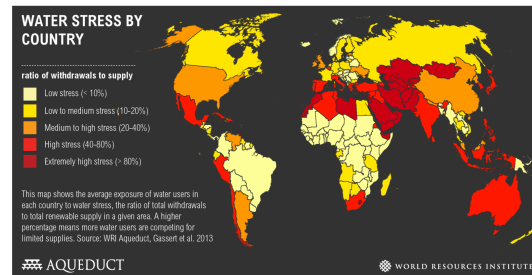

Fig. 1: Map showing water stress levels in various countries around the world. Source: World Resources Institute [4]

is explained in section 2. Section 3 covers the existing literature on pertinent topics. The development of the design and evolution of the intervention is observed in section 4. Testing of the prototype and validation is presented in section 5.

II. BACKGROUND AND MOTIVATION

The roots of this project lie in the Chennai drought of 2019 [6], where hundreds of students like me were asked to vacate their hostels and return home early due to acute water shortages. This incident brought the impending water crisis to sharp relief for the author, who sought to examine how prevalent the issue of water deficit is around the world and why more people are not concerned about the issue. This formed the core of their Critical and Historical Studies report. It was found that there is a disconnect between the natural sources of freshwater and people's water usage due to the hygiene industry's influence. This insight drove the design of solutions that would nudge and motivate people to save water by changing their water consumption behaviours in various contexts.

Fig. 2: Satellite image of Redhills reservoir taken by Maxar Technologies. Source: Hindustan Times [7]

III. Literature Review

Various academic studies have been conducted over the years to investigate different levers that can be used to change people's behaviour. A review of such studies in the 1980s by Dwyer et al. [8] categorises the levers used to induce behaviour change into *antecedent and consequence conditions*, with further subdivisions in each category. They concluded that though most studies failed to report long-term effects of their interventions and only focused on short-term results in behaviour change, there was potential for *consequential interventions* to create an impact in the short term and *antecedent interventions* had a lesser impact but a higher retention rate. Further investigations by Fransson et al. [9] into literature that evaluated efforts to increase environmental knowledge and concern categorised efforts into four broad strategies, *appealing, incentives, information and feedback*. They found that all four methods induced positive behaviour changes in people towards being more conscious of the impact of their actions on the environment. There has been extensive research since then on individual environmental concerns, such as air pollution and the impact of fear and actionable information being provided to people [10] which are based on a study of using fear as a lever to affect change [11].

When trying to induce behaviour change, it is essential to understand the fact that people behave differently in different contexts, such as at home, work or on vacation. The initial focus was to understand how people behave in their homes, which activities consume the most water and the behaviours associated with those factors. Typically, in the UK, people consume 142 litres of water per day [12] in their homes, a majority of which is used while

showering and flushing the toilet. There have been many initiatives to encourage people to keep track of time spent in the shower and to take a shorter shower in order to save water, ranging from songs [13] to timers [14]. However, the adoption of such measures is not widespread and is driven by an immediate need more than by general awareness and understanding.
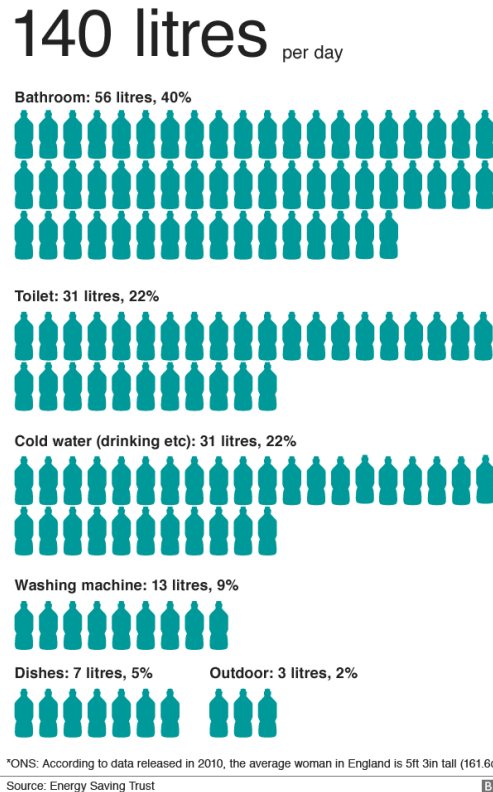

Fig. 3: Infographic showing the daily water consumption percentages in terms of bottles of water. Source: BBC news [3]

An adjacent but distinct use case is that of hotels and people consuming water while travelling, where it has been shown that people use more water than at home [15]. Popular travel destinations are also often in water-stressed locations and only add to the demand on the local water supply. The hotel industry has taken some steps to combat this, the most notable and widespread being asking hotel guests to reuse their towels instead of asking the hotel to change the towels and sheets in a room every day. Research by Gossling et al. [16] shows the importance of using

normative appeals to ask users to reuse their towels and bed linen for short stays.

Recent efforts on water usage reducing interventions have involved communicating the amount of water that is consumed by people in different forms [17], studying their emotional response to the various interfaces and the efficacy of the different designs on changing people's behaviours. This would be labelled as an *antecedent intervention* or a part of the *information* strategy by the aforementioned classifications. Three interface designs were proposed, which are outlined in Figure 4, and efficacy in creating behaviour change was measured along with their emotional reaction. The authors found that all three interfaces make a positive behavioural change in people and that people relate emotionally the most, albeit negatively, with the animated model of a fish in a tank whose water level is inversely associated with the user's water usage. As has been shown in research conducted in the broader space of environmental concern, there is rich scope in domestic water usage to incorporate additional elements of feedback and rewards to induce further positive behavioural changes in people that last for a long time.

IV. METHODOLOGY

Initial design exploration for the project followed the double-diamond approach, looking at the various ways of tracking water usage in the home. The factors that were considered in this exploration were:

- Ease of installation
- Accuracy of measurement
- Accessing the data
- Durability
- Inertness to environmental influence

Traditional methods include mechanical and vortex flow meters, ultrasonic measurement and magnetic flow metering, requiring manual installation on the pipe, extremely idealised pipe conditions and calibration for the environment. A third and more recent method of tracking resource consumption in the home has come from ambient sensing devices that use audio, thermal and regular vision technologies to understand the environment around them. Based on the factors outlined earlier, the significant methods of water flow measurement were scored and ranked, the summary of which can be found in Figure 5. As can be seen from the table, the best option overall
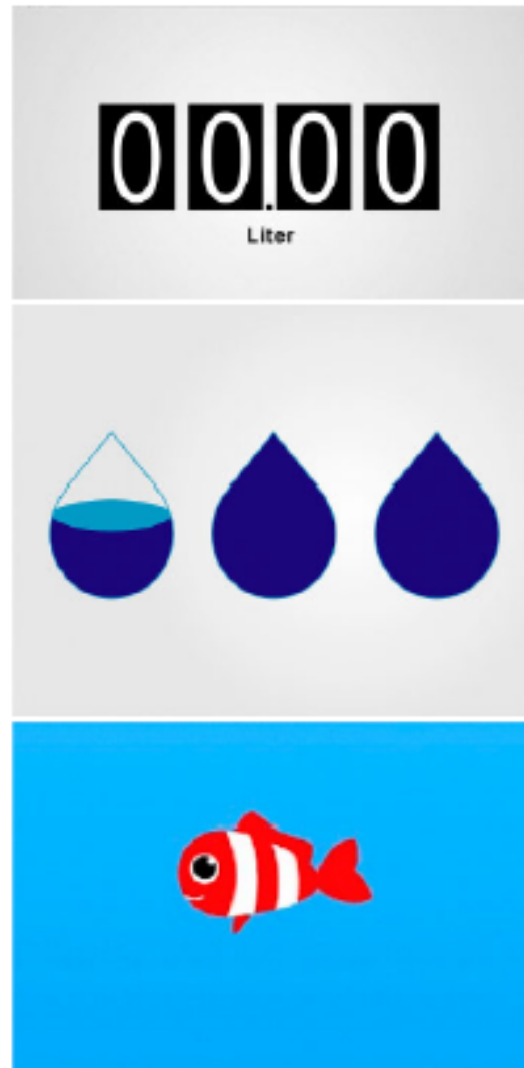

Fig. 4: Image showing the three interfaces tested for efficacy in inducing behaviour change. Source: Fang et al. [17]

turned out to be flow measurement using ambient sensor data, which compromises on measurement accuracy but excels in ease of installation and data access. Audio-based tracking has, using recent developments in machine learning, made it possible to approximately track water consumption by detecting events in the environment [18], such as a tap opening and toilet flushes. The research done by Fonseca et al. [19] shows the usage of such algorithms on the Freesound library. This algorithm has been made open under a Creative Commons license by its developers and can be used to track everyday home audio

events related to water.

Type of measurement\Evaluation metric	Ease of installation	Accuracy of Measurement	Accessing Data	Durability	Inertness to environmental influence	Total
Mechanical flow meters	1	5	2	3	5	16
Vortex flow meters	1	5	2	4	5	17
Ultrasonic flow meters	3	3	3	2	2	13
Magnetic flow meters	3	3	3	2	2	13
Ambient sensor based measurement	5	2	4	4	3	18

Fig. 5: Image showing the three interfaces tested for efficacy in inducing behaviour change. Source: Fang et al. [17]

The next step was to find a suitable context for any such intervention and exploring the various options and stakeholders in any such endeavour. The possible environments for such a water consumption tracking device to be installed are:

- In people's homes
- Offices, Hospitals and other commercial locations
- Schools and Colleges
- Hotels, resorts and hospitality

The initial focus was on designing an intervention for people in their homes, and a survey to understand how people use water in their homes was conducted. The survey aimed to conduct primary research and validate some of the findings of how people consume water at home as found in [12]. The responses validated some basic facts such as the average showering duration and laundry behaviours. However, there was no clear incentive for people to change their behaviours, and adoption of water meters in the UK has been slow, with only about 50% of homes having a meter by 2018 [20]. Hence most people do not have a precise measure of their consumption. This also serves to divorce the actual usage from the bills that people receive every month, thereby negating any monetary incentives that a design intervention may provide at people's homes.

To resolve this, the author spoke to domain experts and asked them whether this could be resolved or if they should switch contexts for a more favourable environment for an intervention. Based on the received feedback, it was decided to investigate more commercial contexts. The hospitality industry is adjacent to the behaviours exhibited by people in their homes. It has been shown to add to the water stress of a region [15]. Also of use were the architectural standards released by the Building Research Establishment (BRE) in the form of the BRE Environmental Assessment Method (BREEAM) for new [21] and

retrofit [22] buildings. The guidelines and specifications from these reports can be seen in Figure 6 and Figure 7.These helped form baselines for consumption based on the type of fittings present in a building and targets that people can aspire to adhere to for the duration of their stay.

V. RESULTS AND DISCUSSION

The platform can be broken down into three important parts:

- Appeal
- Measurement
- Feedback

A. Appeal

The appeal is the part where guests of a hotel are asked to save water by choosing to participate in the initiative and changing their behaviours. It is heavily influenced by the normative appeal studied by Gossling et al. [16], which can be found in Figure 8. The modified message that is proposed can be found in Figure 9. It informs users about previous guests who took part in the initiative and that savings from the room will contribute towards a charity that provides access to water for the poor. It also highlights the fact that the choices are optional and are not hard limits on the user.

There are three choices presented to the guest, which can be seen in Figure 10, can be summarised below:

- **Water Champion:** Shower time 6-8 minutes per shower and WC tap running time 5-7 minutes per day
- **Nature Lover:** Shower time 8-10 minutes per shower and WC tap running time 7-10 minutes per day
- **Leisure Seeker:** Shower time 10-12 minutes per shower and WC tap running time 10-14 minutes per day

As has been made clear to the user in the appeal message, the program is opt-in by default due to the sensitive nature of measurement and tracking at the proposition's core. This conscious decision made while acknowledging the power of choosing on behalf of the guest and asking them to opt-out, which is demonstrated by Thaler et al. [23].

Table 8.3 Water efficient consumption levels by component type

Component	Performance levels (quoted numbers are minimum performance required to achieve the level)						
	Base	1	2	3	4	5	Unit
WC	6	4.5	4	3.75	3.5	3	Effective flush volume (litres) (see Definitions on page 210)
Wash-hand basin taps	10	8	6	5	4	3	litres/min
Showers	12	10	8	6	5	3.50	litres/min
Baths	200	180	160	140	120	100	litres
Urinal (2 or more urinals)	7.50	6	3	1.50	0.75	0	litres/bowl/hour
Urinal (1 urinal only)	10	8	4	2	1	0	litres/bowl/hour
Greywater and rainwater system	0%	0%	0%	25%	50%	75%	% of WC or urinal flushing demand met using recycled non-potable water
Kitchen tap: kitchenette	10	8	7	6	5	5	litres/min
Kitchen taps: restaurant (pre-rinse nozzles only)	10.30	9	8.30	7.30	6.30	6	litres/min
Domestic sized dishwashers	17	13	13	12	11	10	litres/cycle
Domestic sized washing machines	90	60	50	40	35	30	litres/use
Waste disposal unit	17	17	0	0	0	0	litres/min
Commercial sized dishwashers	8	7	6	5	4	3	litres/rack
Commercial or industrial sized washing machines	14	12	10	7.50	5	4.50	litres/kg

Fig. 6: The BREEAM standards for new construction to get a suitable rating from the organisation. Source: BRE Group [21]

B. Measurement

The device for measuring the user's water consumption is based on taking audio inputs of the surroundings and detecting events such as the tap opening, the shower running or the toilet flushing. The underlying algorithms are identical to the one used in the Audio Set [18] and the matrix used is made available for use by Google [24]. It has been translated to run on an Arduino Nano BLE Sense [25], seen in Figure 11, using TensorFlow Lite, which has an on-board digital microphone, Bluetooth and a bunch of other sensors useful for most Internet of Things (IoT) projects. The process diagram for identifying events and tracking consumption can be found in Figure 12. The main metric being tracked here is time. It is the more relatable metric for people and is easier to connect to than litres/gallons, which are common volumetric units of measurement. It is also easier to measure and track than the actual volume of water being consumed. The current limitation of the previously mentioned AudioSet algorithm is that it can only detect the instance of an event such as a running tap or a flushed toilet, but it cannot measure or estimate the rate of flow of water being consumed. This limitation directly implies that the exact quantity of water being consumed cannot be measured with any degree of

Table - 24: Default performance data

Terminal fitting type	Average usage	Terminal fitting type
Showers	Mixer – traditional mixer	8 litres per minute
	Mixer – integrated power	10 litres per minute
	Mixer – separate pump	12 litres per minute
	Mixer – pressurised systems	12 litres per minute
	Mixer – bath and shower mixers	6 litres per minute
	Electric 7–7.9 kW	3.5 litres per minute
	Electric 8–8.9 kW	4 litres per minute
	Electric 9–9.9 kW	4.6 litres per minute
	Electric 10 kW+	5 litres per minute
Baths	Undersized bath – 1600 mm length	165 litres – volume to overflow
	Corner bath	140 litres – volume to overflow
	Shower bath	250 litres – volume to overflow
	Standard bath	225 litres – volume to overflow
	Roll top bath	205 litres – volume to overflow
	Whirlpool spa baths	225 litres – volume to overflow
WCs	Post 2001	6 litres
	1993–2000	7.5 litres
	Pre-1993	10 litres
Taps	Low pressure system (as defined in BS EN 200)	7.5 litres per minute per tap
	High pressure system (as defined in BS EN 200)	12 litres per minute per tap
Dishwashers	Domestic	14 litres per cycle
Washing machines	Domestic	55 litres per cycle

(a) Baseline water consumption rates for existing appliances in retrofit projects.

Table - 23: Equivalent terminal fitting consumption standards

Fitting	Baseline	Good	Excellent
Showers	14 litres per minute	8 litres per minute or less	6 litres per minute
Baths	200 litre capacity to overflow	140 litre capacity to overflow or less	140 litre capacity to overflow or less
WCs	6 litres effective flushing volume	4 litres effective flushing volume or less	3 litres effective flushing volume or less
Bathroom and WC room taps	12 litres per minute	5 litres per minute or less	3 litres per minute or less
Kitchen and utility room taps	12 litres per minute	5 litres per minute or less	5 litres per minute or less
Dishwashers	17 litres per cycle	13 litres per cycle	12 litres per cycle
Washing machines	90 litres per use	60 litres per use	40 litres per use

(b) Standards set for different water consuming elements in a household.

Fig. 7: The BREEAM standards for estimating and rating the water consumption of various elements in existing households and domestic buildings. Source: BRE Trust [22]

Original message as found in room (towel and bed linen message separately provided)

Dear guest,

It is our hotel chain's commitment to apply policies of environmental protection and this is the reason why we recommend using your towels more than only one day. If you leave your towels hanging on the bathroom rack it means that you want to continue using them; if you leave them on the floor, we understand that you wish to get clean towels. *[Additional information on housekeeping unrelated to water use]*

Thank you very much for helping us to improve our services.

Change of bed sheets

If you decide that it is NOT necessary to change your sheets, please put this card on top of your bed in the morning ... YOU ARE THE ONE WHO DECIDES ... At [name of hotel chain] we are committed to the protection of the environment.

(a) Normal message

Modified (simple) message

Dear guest,

Please help us to save natural resources. To use your towel for one extra day saves 6 L of water. We change towels on demand. If you want to have them replaced, please put the towel on the floor.

Thank you.

(b) Modified simple message

Comprehensive message

Help us protecting a precious resource!

Fresh water is scarce in Gran Canaria. For this reason, we would like you to help us minimizing our laundry volumes: each day you reuse your bathroom towels saves 6 L; and each day you keep your bed linen another 15 L.

In 2015, 82% of all guests in room [room number] reused their towels. As we expect a similar result this year, we have donated the equivalent of your savings from not having to wash the towels and bed linen to a charity, Blue Planet, which engages in providing safe water to people living in water-stressed areas.

Kindly note that towels and bed linen will only be changed on demand. If you demand an exchange of your towels, please place them on the floor in the bathroom; if you demand an exchange of your bed linen, please place the change request card on your bed.

Thank you for supporting our environmental initiatives

(c) Comprehensive modified message

Fig. 8: The three tested appeals tested by Gossling et al. [16] for effectiveness in getting hotel guests to reuse their towels and linen to save water and the environment.

Help save water!

Freshwater is a finite resource that we are depleting faster than it can replenish. For this reason, we would like you to help us reduce the daily water consumption in our rooms.

We would like you to select a water profile for your stay that you think you can adhere to from the options below. These will then be applied to your room, and you can then monitor and regulate your usage.

Since we started this program in 2021, more than 80% of our guests have selected a water profile suitable for their requirements. The savings from this initiative go to the Water Aid charity to help them provide clean water and sanitation to some of the world's most impoverished locales.

You can choose to modify or even completely opt out of your selected profile at any point in your stay. These are just guidelines to help you and not any hard limits that are set for your room.

We hope that you will choose to be a part of this initiative and help us save water and save the environment!

Fig. 9: The proposed normative appeal made to guests at the start of their stay in a hotel.

certainty. It can be estimated with some accuracy using standard flow rates specified in the BREEAM building guidelines [21], [22] and seen in Figures 6 and 7.

The form of the device is identical to the shape of a drop of water, with a flat back to make it easier to attach to a flat surface. Renders of the device can be found in Figure 13, with the outer shell made out of transparent glass to make it easier to transmit visual feedback while looking like an actual water drop. The aesthetic of the hotel industry inspires the choice of material. The electronic components are selected to fit inside the cover. They are mounted on a housing that also holds the glass cover in place and attaches to the wall.

C. Feedback

Information once tracked on the device needs to be communicated to the guest in the hotel room appropriately. The factors considered in designing a feedback system were the ease of understanding the system, demands on the device's size, integration with existing ambience and technical competence required to parse and interact with the device. Some of the feedback systems considered were:

- Digital dashboard showing information
- Audio feedback from the device
- Traffic light (red-amber-green) system of visual feedback

Users were asked to rank these options in a survey, which are discussed in the next part of the report. Renders of the traffic-light based feedback system were created to visualise the scene for the target user, as it is more difficult to visualise as compared to the other options; the renders can be found in Figure 14.

D. User Testing and Validation

The evaluation was primarily done using surveys, which enables quantitative data gathering from the target group, primarily potential hotel guests. This data would complement the secondary research that

Water Champion

Shower time: 6-8 mins
WC tap - 5-7 mins

Nature Lover

Shower time: 8-10 mins
WC tap - 7-10 mins

Leisure Seeker
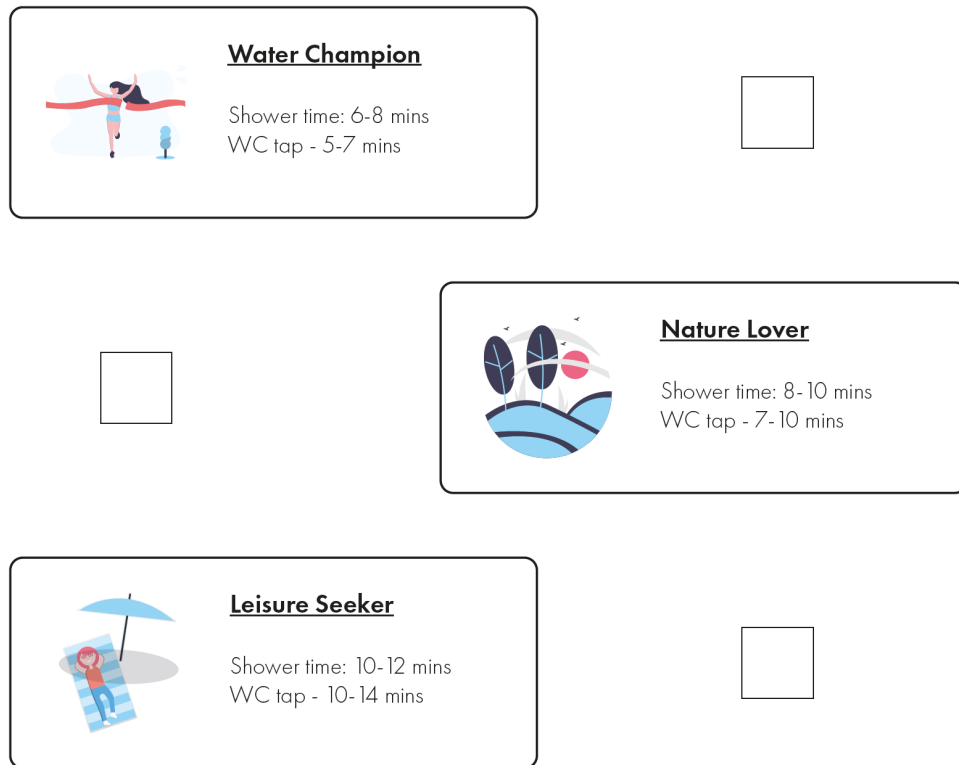
Shower time: 10-12 mins
WC tap - 10-14 mins

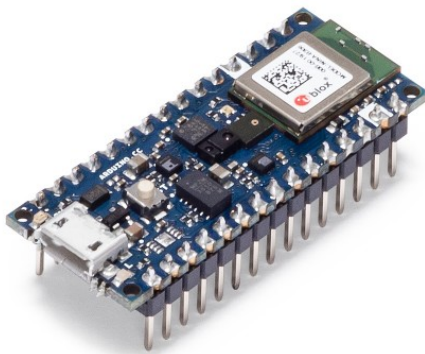Fig. 10: The three responsible consumption profiles presented to the user at the start of their stay.

Fig. 11: An Arduino Nano BLE Sense board; this forms the core processing unit of the device.

shows the impact of hotels and the hospitality industry on the local water stress.

The first survey was to understand the showering habits of people when they are travelling, how frequently they travel and the kinds of accommodations that they generally stay in. The survey can be found in Appendix A, and was conducted using the Qualtrics platform. The responses from the survey are summarised in the graphs in Figure 15. The important takeaways from the survey are:

- A majority of participants take 2-5 trips a year
- Most trips are for longer than 2 days, with longer trips from 4-7 days being the most selected option
- The most popular type of accommodation is chain hotels, followed by Airbnbs
- Most guests shower once a day, but about 30% of guests prefer to shower twice a day
- The typical shower duration is 5-10 minutes, but just as many people shower for longer than 10 minutes per shower
- Most respondents turn off the shower when they do not need it, but quite a few run it some-
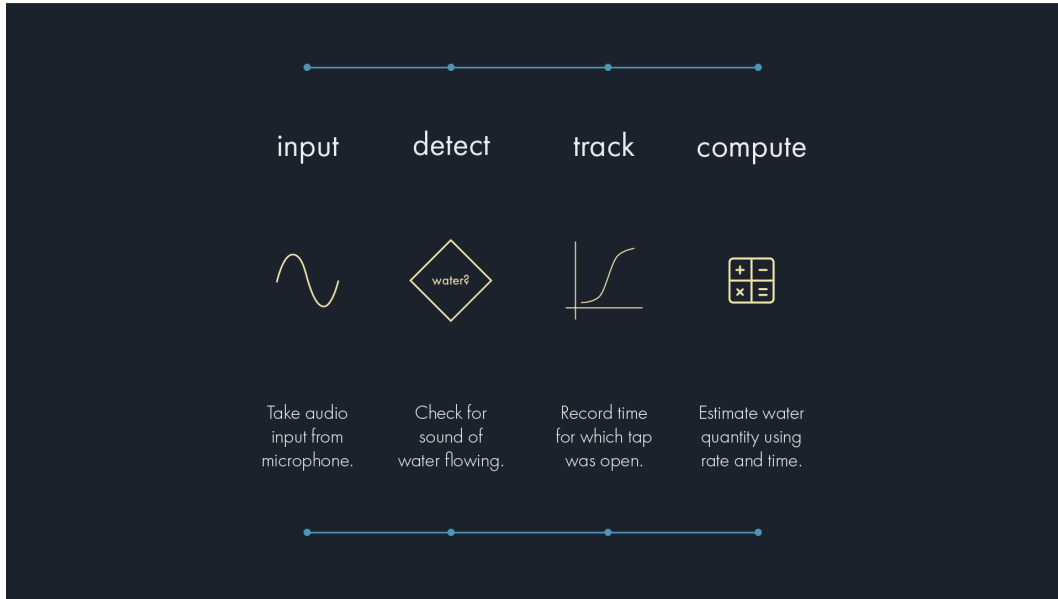
Fig. 12: A simple process diagram to illustrate the steps performed in detecting and tracking water consumption events using audio inputs and machine learning algorithms.

times/all the time

These responses highlight the opportunity that exists in this space, with hotel guests using more water on their trips than they would normally have. The duration of the trip also amplifies the benefits that would come from a successful adoption of the product.

The second survey aims to get feedback from the target user group on the three elements of the platform outlined above. The survey document can be found in Appendix B. The main features tested were:

- Touch-point to make an appeal to the user
- Appeal message
- Choices presented to the user
- Placement of the product in the bathroom
- Preference for the mode of feedback and nudging
- Presentation of data collected to the user

The results from the survey can be seen in Figures 16. Some key takeaways from the results of the survey are:

- Most people would like to see the appeal in their rooms
- The preferred position of the device is above the bathroom tap near the mirror

- The traffic-light based feedback system is the most favoured option while audio-based interaction with the device is the least preferred option

Based on this and other feedback from the survey, the testing of the device and further iterations on the platform's design can be done.

VI. Conclusion

A. Learnings

This project aimed to understand the wicked problem [26] of reducing the individual's water consumption and studying existing approaches in order to design a solution that would be able to nudge users towards more sustainable consumption habits. Some key takeaways from this project were:

- The main driving factor for people in adopting more sustainable domestic behaviours is the monetary cost of the consumed resource
- Upfront cost of adoption in any sustainable design intervention needs to be offloaded from the end-user to a different stakeholder, in this case, the hotel, in order to encourage adoption
- Simpler feedback is better, as has been shown in the user feedback survey where people prefer the traffic light form of feedback over a digital display of information

(a) Initial renders of the physical device with a screen up front.
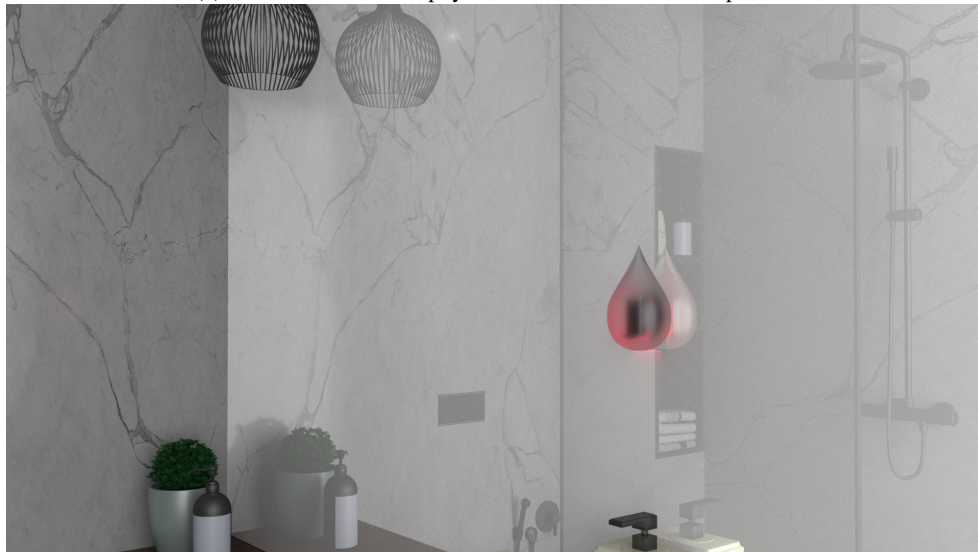
(b) Final version of the physical device rendered in a bathroom environment.

Fig. 13: The physical device renders showing the changes made in the design, going from a simple box with a screen up front to a more meaningful shape that users can connect with.
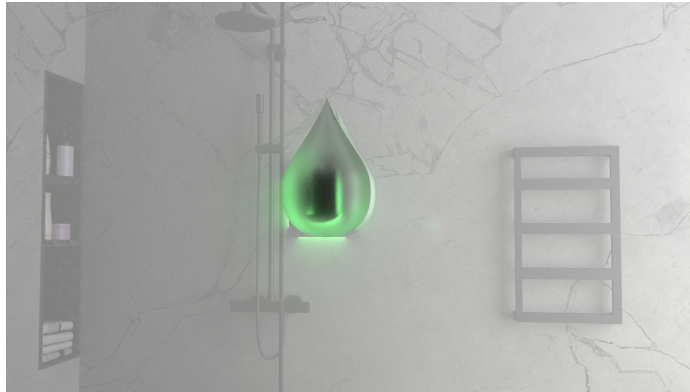
(a) The device glows green when the user is within their set limits.
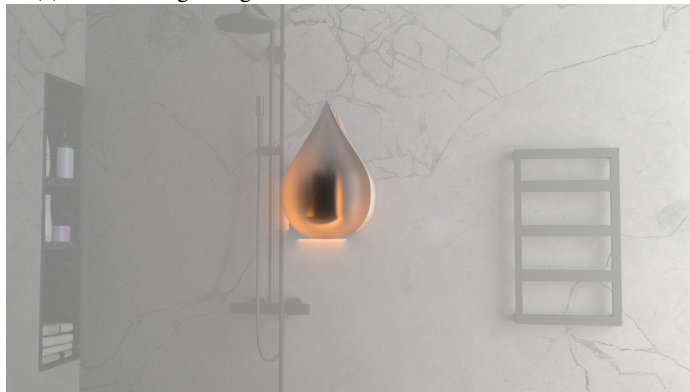
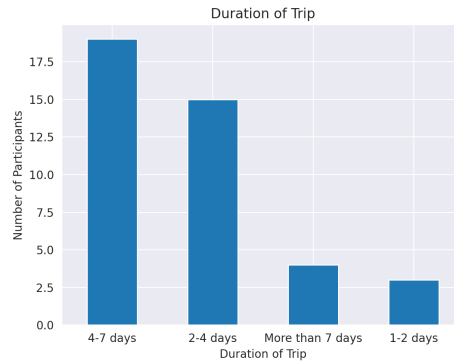(b) The device warns the user by pulsing amber when the user is nearing their usage limits.
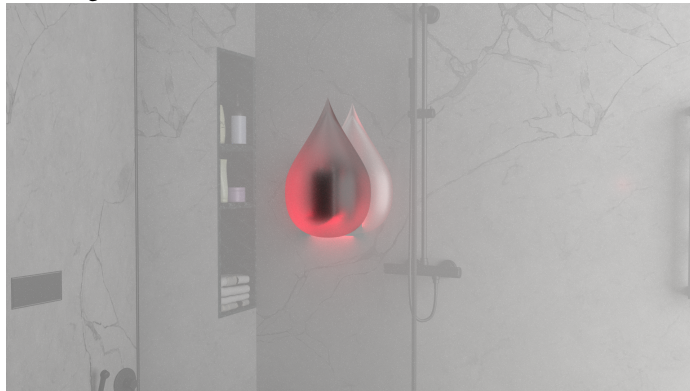
(c) The device pulses in a red color when the user exceeds the limit that they have selected.

Fig. 14: The three states of the physical device in the user's room, used to provide feedback to the guest on their water consumption.
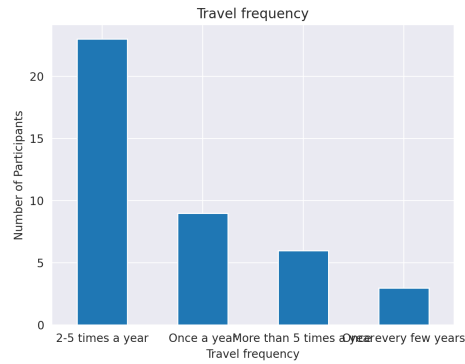
(a) Frequency of travel per year

(b) Average duration of trip
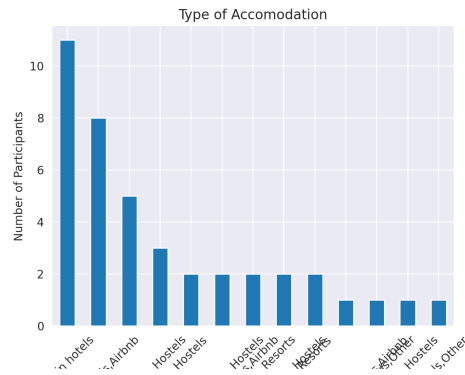
(c) Most chosen types of accommodation while travelling
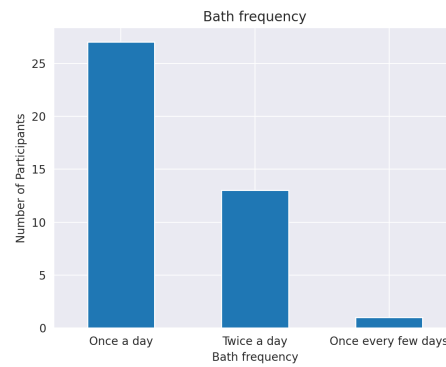
(d) Frequency of bathing while on a trip
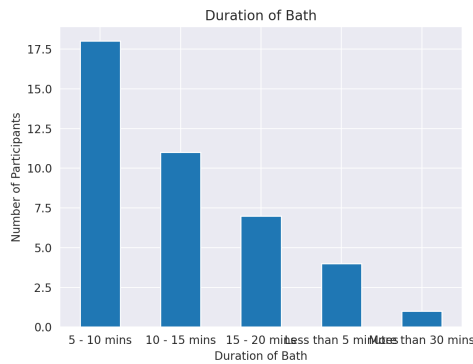
(e) Average length of shower/bath
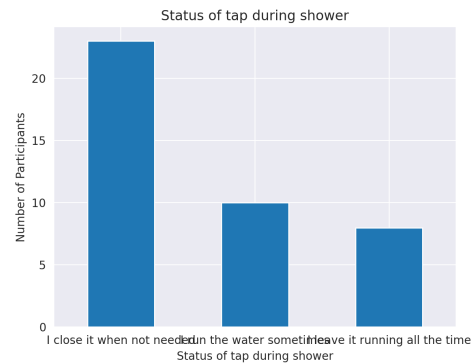
(f) Running/closing the tap when not actively using it

Fig. 15: A summary of the survey responses collected to understand common habits of people while they are travelling
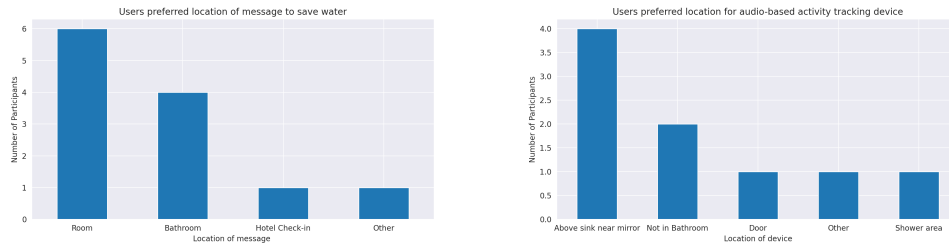
(a) Plot showing user preference on where they would like to see the appeal message.

(b) Plot showing the preferred placement of the physical monitoring device in guests' rooms.
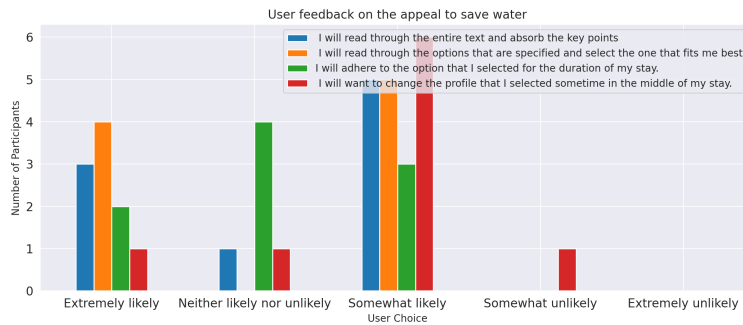
(c) The plot captures how likely users are to read through and select the option most suited for them when presented with the appeal message.
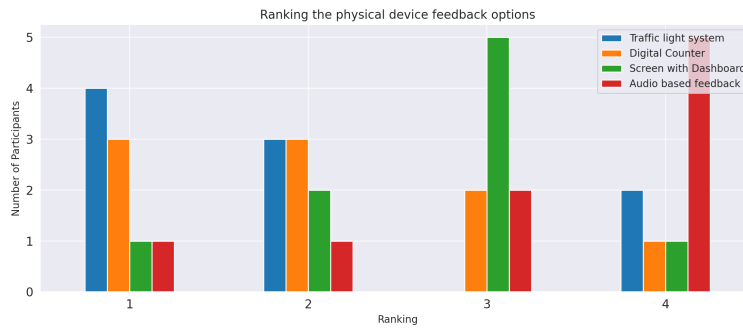
(d) Plot showing the preferred feedback method from the physical device.
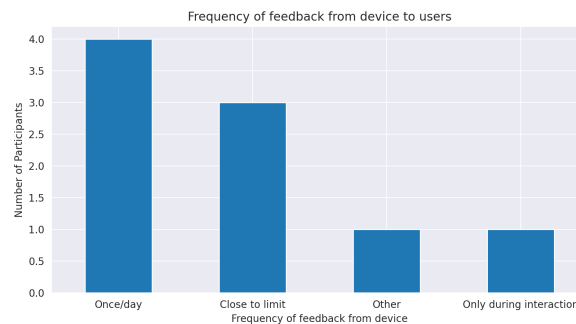
(e) Plot demonstrating users' preferences when it comes to accessing the data collected by the device.

Fig. 16: The compiled responses from the user feedback on various elements of the platform.

- It is always better to give the end-user the agency of choice rather than trying to enforce any limitations on them

B. Next steps

The design of the platform and the physical device needs to be iterated upon based on the user feedback. The key changes that need to be made in the next design iteration are:

- Privacy concerns need to be addressed clearly in the messaging of the appeal and, if possible, in the device itself. Multiple users have expressed the concern of having an active microphone in the bathroom, a private and sensitive location. This can be mitigated by
    - allowing the end-user the opportunity to turn the device off
    - options of setting private times when the device is inactive
    - effective messaging in and around the device to indicate when it is recording information and when it is not doing so
- Multiple users requested a summary of the information collected by the device to be provided to them. This handover needs to be designed, and an effective means of conveying this to the guest is to be developed
- The physical device needs to be tested with physical users in a physical environment in order to understand better how guests can and will interact with the platform

VII. Acknowledgements

VIII. Author Bio

Seetharaman Subramanian is an innovation-focused designer with a background in engineering from India who wants to impact the small and not so small problems that we face every day.

Dr Nejra van Zalk is a lecturer and researcher in psychology and human factors at the Dyson School of Design Engineering at Imperial College London.

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The following survey was conducted to obtain primary research and data directly from a target audience in order to validate some of the findings and inferences from secondary research.
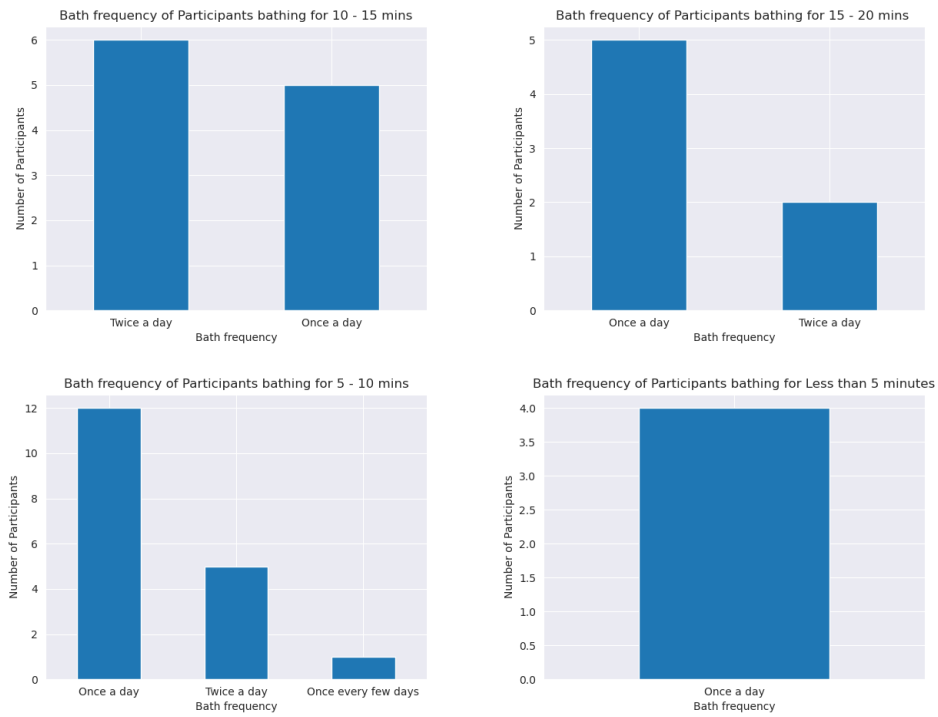

Fig. 17: Bath frequency vs duration of bath

Imperial College London

Default Question Block

Understanding how you consume water at hotels

You are invited to participate in this research to help understand how guests consume water in hotel rooms.

What is the purpose of this study?

This study's primary aim is to study activities in the hotel room that consume water and understand the behaviours of people when it comes to such activities.

Why is this important?

This data will form a critical part of the design process and help inform future design decisions when developing a solution to change water behaviours positively.

Why have you been invited?

You have been contacted because you are part of the target demographic for the study, and future design solutions informed by it.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be asked to sign a consent form. If you decide to take part, you are still free to

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withdraw at any time and without giving a reason. Consent will be obtained by ticking a box on the online survey. You can withdraw from the survey simply by exiting it.

How long will it take?

The one-off online questionnaire will take a maximum of 10 minutes to complete.

What do I have to do?

There is no specific preparation required. You will be asked to read questions and select answers from a list of possible options.

What are the possible disadvantages and risks of taking part?

There are no foreseeable risks of taking part in this study. You can choose not to answer any question that makes you uncomfortable. No IP addresses or location data will be collected. Your responses will be fully anonymised, and we will follow GDPR and Imperial College London policies. Some of the questions can be perceived as sensitive; however, you will be able to skip any questions that might be uncomfortable.

What are the possible benefits of taking part?

Your participation will help form a repository of water behaviour research that informs design solutions looking to positively impact water consumption behaviours of guests in hotels.

What if something goes wrong?

If you are harmed by taking part in this research project, there are no special compensation arrangements. If you have any concerns about the survey, you should immediately inform Principal Investigator Seetharaman Subramanian (e-mail: s.subramanian19@imperial.ac.uk).

What will happen to the results of the research study?

The results will generate an anonymised data set that will be used for educational purposes only. Even if you start the questionnaire, you do not need to complete it. You can withdraw your consent at any point during the survey and stop. Only data from questionnaires that are completed and submitted will be collected. Your email, if you choose to submit it, will only be used to contact you and will not be associated with the data.

Who is organising and funding the research?

The study is organised by the Principal Investigator Seetharaman Subramanian (s.subramanian19@imperial.ac.uk) and supervised by Dr Nejra Van Zalk (e-mail: n-van-zalk@imperial.ac.uk). The study is not funded.

Contact for Further Information

If you have any queries or would like further information, please directly contact the researcher:

Seetharaman Subramanian, Final year student in Global Innovation Design

E-mail: s.subramanian19@imperial.ac.uk

Thank you for taking part in this study.

Block 1

I confirm that I have read and understand the participant information sheet for the above study and have had the opportunity to ask questions which have been answered fully.

○ Agree

I understand that my participation is voluntary, and I am free to withdraw at any time, without giving any reason and without my legal rights being affected.

○ Agree

I consent to take part in the above study.

○ Agree
○ I do not agree

Personal Information

A few personal questions to start things.

All the following questions are optional and will only be used for the purpose of finding correlations within the scope of this project. No information will be shared with people not related to the project directly. If you feel uncomfortable answering any question in this section, feel free to leave the field empty.

In which country do you currently reside?

[dropdown]

How old are you?

○ Under 18
○ 18 - 24
○ 25 - 34
○ 35 - 44
○ 45 - 54
○ 55 - 64
○ 65 - 74
○ 75 - 84
○ 85 or older

What is your gender?

○ Female
○ Male
○ Non-binary
○ Prefer not to say
○ Transgender
○ Intersex
○ [_____] Let me type...

What is your ethnicity?

○ White
○ Black or African American
○ American Indian or Alaska Native
○ Asian
○ Native Hawaiian or Pacific Islander
○ [_____] Other

Hotel Questions

How often do you travel per year when things are normal (including business trips, vacations etc.) ?

○ Once every few years
○ Once a year
○ 2-5 times a year
○ More than 5 times a year

What is your typical trip duration?

○ 1-2 days
○ 2-4 days
○ 4-7 days
○ More than 7 days

What kind of accomodation do you stay in most often when you travel? Please select multiple options if that fits you better.

☐ Chain hotels
☐ Resorts
☐ Airbnb
☐ Hostels
☐ Airport hotels
☐ [_____] Other

How often do you typically shower/take a bath per day during your travels?

○ Once every few days
○ Once a day
○ Twice a day
○ More than twice a day
○ [_____] Other

How long do you take for a shower/bath when you are in a hotel?

○ Less than 5 minutes

○ 5 - 10 mins
○ 10 - 15 mins
○ 15 - 20 mins
○ 20 - 30 mins
○ More than 30 mins

How often do you leave the water running while bathing/showering?

○ I close it when not needed
○ I run the water sometimes
○ I leave it running all the time
○ [_____] Other

Any other comments on how you shower/take a bath when you travel?

[   ]

Block 4

If you would be interested in participating in a follow-up conversation to know more about my design intervention and provide direct feedback, please leave your email below and I will be in touch.

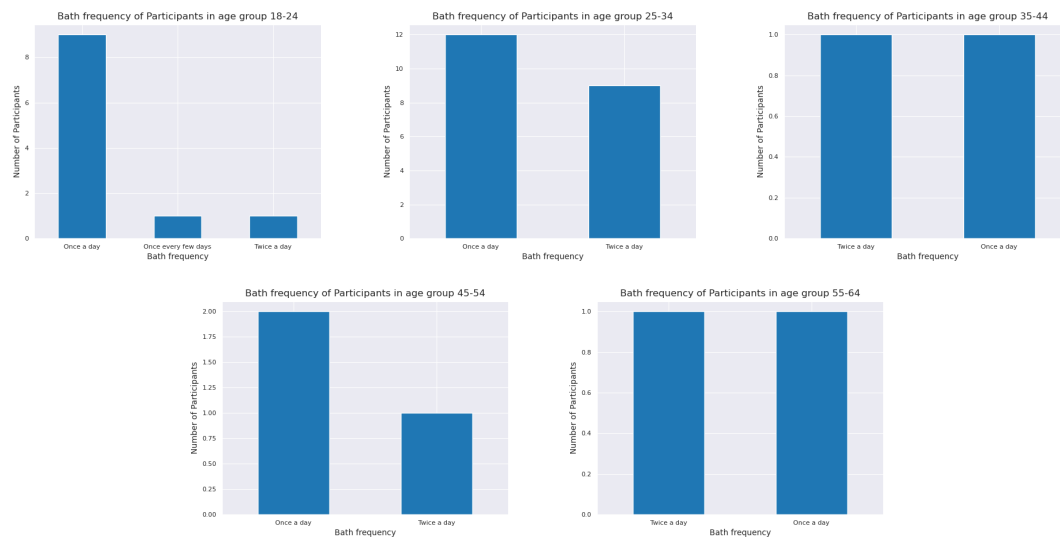Accessibility

Powered by Qualtrics

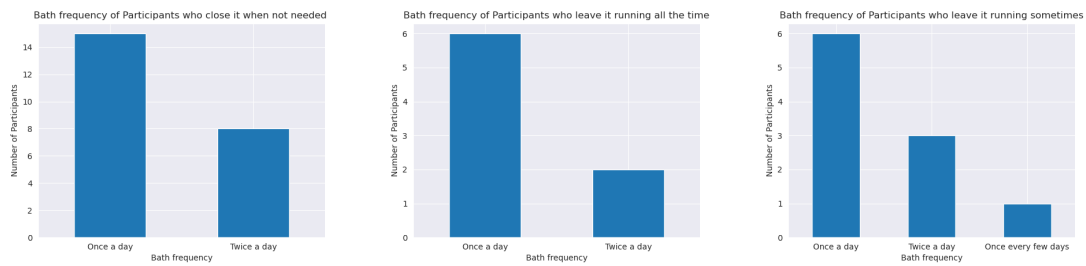Fig. 18: Bath frequency vs Age group of participants
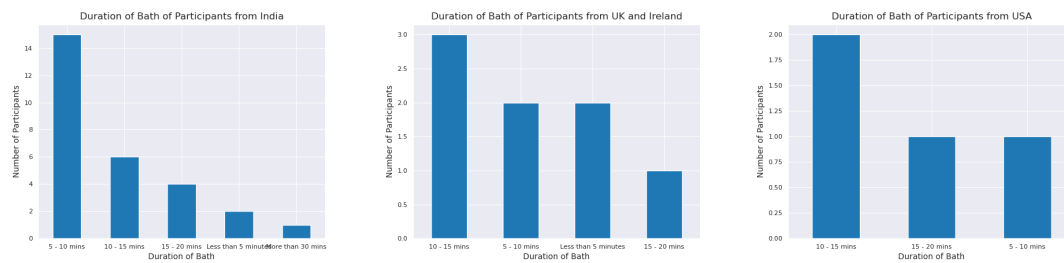

Fig. 19: Bath frequency vs Status of shower during Bath

Fig. 20: Duration of bath vs Demographic

APPENDIX B
SURVEY TO GATHER FEEDBACK ON PLATFORM FEATURES

Imperial College London

Default Question Block

Providing feedback on <u>Boond – helping guests save water in hotels</u>

<u>What is this about?</u>

Boond is a platform designed to nudge hotel guests to adopt sustainable water consumption habits in their rooms. It is split into three main elements,

- Appeal to guests to save water
- Tracking and terminal device in the guests' toilets
- Providing appropriate feedback to guests

You are requested to provide your feedback on these elements of the project and will be used to improve the design in further iterations.

<u>Fine Print</u>

If you have any concerns about the survey, you should immediately inform Seetharaman Subramanian (e-mail: s.subramanian19@imperial.ac.uk).

The results will generate an anonymised data set that will be used for educational purposes only. Even if you start the questionnaire, you do not need to complete it. You

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can withdraw your consent at any point during the survey and stop. Only data from questionnaires that are completed and submitted will be collected. This study is not funded.

Thank you for taking part in this study.

Consent

I confirm that I have read and understand the participant information sheet for the above study and have had the opportunity to ask questions which have been answered fully.

○ Agree

I understand that my participation is voluntary, and I am free to withdraw at any time, without giving any reason and without my legal rights being affected.

○ Agree

I consent to take part in the above study.

○ Agree
○ I do not agree

Appeal

The first section is all about asking guests to save water, and I would like your feedback!

Help save water!

Freshwater is a finite resource that we are depleting faster than it can replenish. For this reason, we would like you to help us reduce the daily water consumption in our rooms.

We would like you to select a water profile for your stay that you think you can adhere to from the options below. These will then be applied to your room, and you can then monitor and regulate your usage.

Since we started this program in 2021, more than 80% of our guests have selected a water profile suitable for their requirements. The savings from this initiative go to the Water Aid charity to help them provide clean water and sanitation to some of the world's most impoverished locales.

You can choose to modify or even completely opt out of your selected profile at any point in your stay. These are just guidelines to help you and not any hard limits that are set for your room.

We hope that you will choose to be a part of this initiative and help us save water and save the environment!

Water Champion
Shower time: 6-8 mins
WC tap - 5-7 mins

☐

☐
Nature Lover
Shower time: 8-10 mins
WC tap - 7-10 mins

Leisure Seeker
Shower time: 10-12 mins
WC tap - 10-14 mins

☐

Where would you like to see this appeal to save water? Please select multiple options if you think it would work better.

☐ It is a part of the room booking process
☐ You are offered this when checking in
☐ You see this message in your room and select your preference
☐ This appeal is in the bathroom and you discover it when you enter the bathroom
☐ [_____] Other

Please reference the image above and select how likely/unlikely it is that you undertake the action described in the following options.

	Extremely likely	Somewhat likely	Neither likely nor unlikely	Somewhat unlikely	Extremely unlikely
I will read through the entire text and absorb the key points.	○	○	○	○	○
I will read through the options that are specified and select the one that fits me best.	○	○	○	○	○
I will adhere to the option that I selected for the duration of my stay.	○	○	○	○	○

	Extremely likely	Somewhat likely	Neither likely nor unlikely	Somewhat unlikely	Extremely unlikely
I will want to change the profile that I selected sometime in the middle of my stay.	○	○	○	○	○

Device

Click to write the question text

Where would you like the audio-based activity tracking device to be present in the bathroom?

○ Above the sink near the mirror
○ Near the shower area/enclosure
○ Inside the shower area/enclosure
○ Near the toilet
○ On the door of the bathroom
○ I am not comfortable having something in the bathroom
○ [_____] Other

Please rank the kind of feedback you would like to receive from the device from most preferred to least preferred. (Drag and drop to move items up or down the ranking)

     Traffic light system (green -> amber -> red) to alert guest nearing their activity limit

     Digital counter showing the time left on your daily activities

     Screen with dashboard outlining activities that have been tracked

     Audio-based feedback of activities and time left on limits

How frequently would you like to receive feedback from the device on your usage and remaining consumption?

○ Only when I am close to exceeding my limits
○ Only when I interact with the device

○ At the beginning and end of my stay
○ Once a day
○ Three times a day
○ [_____] Other

Would you like a summary of your usage behaviors provided to you at the end of your stay?

○ Yes
○ Maybe
○ No

Block 4

A few personal questions to wrap things up.

All the following questions are optional and will only be used for the purpose of finding correlations within the scope of this project. No information will be shared with people not related to the project directly. If you feel uncomfortable answering any question in this section, feel free to leave the field empty.

In which country do you currently reside?

How old are you?

○ Under 18
○ 18 - 24
○ 25 - 34
○ 35 - 44
○ 45 - 54
○ 55 - 64
○ 65 - 74
○ 75 - 84
○ 85 or older

What is your gender?

○ Female
○ Male
○ Non-binary
○ Prefer not to say
○ Transgender
○ Intersex
○ [   ] Let me type...

What is your ethnicity?

○ White
○ Black or African American
○ American Indian or Alaska Native
○ Asian
○ Native Hawaiian or Pacific Islander
○ [   ] Other

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