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A FIELD EXPERIMENT ON NUDGING PRO-ENVIRONMENTAL BEHAVIOUR

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ABSTRACT

Currently, India battles a massive water crisis. With 14 years of water-conservation policy measures falling short, aggressive controls may not be the solution. This study aims to investigate whether nudges can be used as an effective tool in persuading hotel guests to take shorter showers, serving as a proxy for other behavioural-economic interventions which can be used to encourage pro-environmental behaviour. The experiment tested two different types of nudges, a social-proof nudge and an information-based nudge, through the medium of posters and timers in hotel-room showers. Findings showed that the social-proof nudge decreased daily shower water consumption by 8.86%, which could save 62.02 litres of water per guest over the course of a week and the information-based nudge decreased daily shower water consumption by 13.88%, translating to 97.16 litres of water conserved in a week by one guest. Therefore, the study concluded that guests can be successfully 'nudged' into reducing the duration of their showers.

Background

A nudge[1] is defined as a small, non-intrusive push that promotes a more desirable outcome for the individual as well as for society. Over the past few years, nudging has become an increasingly utilised tool in various environmental sectors such as energy use, waste management and resource efficiency. Water conservation, in particular, is a key area where many developed countries have started to investigate methods of nudging in order to save depleting water resources. For example, the U.S. Department of Interior launched the WaterSMART[2] program in 2009 which has been successful in reducing water use by an estimated 5%

[1] Thaler and Sunstein (2008). Nudge: Decisions about Health Wealth and Happiness.

[2] US Department of Interior (2017). WaterSMART.

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

through a combination of peer comparisonsand feedback resources.

Currently, India battles a massive water crisis. More than 50% of the Indian population has no access to safe drinking water and approximately 200,000 people die every year as they lack accessto safe water[3]. Furthermore, the World Resources Institute[4] ranks India 13 amongst the 17 worst affected countries in terms of water stress. While India has been struggling with the issue of water scarcity since 2007, there have been no concrete improvements in the management of water resources and the situation continues to become progressively more alarming as India seems to approach a 'Day Zero' scenario[5].

At this time, a change in consumer behaviour is of utmost importance. With 14 years of policy measures falling short, aggressive controls may not be the answer to all environmental issues. It is crucial for the government to look into new and creative policy ideas which get to the heart of this crisis and address the pressing need for changed consumer behaviour. Leveraging concepts of behavioural economics can be extremely useful in meeting this aim. The study in this report aims toserve as a proxy for other forms of nudges which can be implemented to encourage pro-environmental behaviour and save water.

Introduction

While conserving water is important for everyone, it is particularly important for the hospitality industry which requires large quantities of water per day, as unlimited water supply seems to be considered a necessary luxury to create a comfortable environment for guests. This growing demand-side problem of massive water consumption also makes up a large proportion of operational costs. Therefore, with both an environmental and financial incentive, it has become imperative for hospitality businesses to increase efforts to conserve water resources.

Showers are a major source of water consumption, not only in hotels but in households as well since the average person uses 76 litres of water[6] in the shower every day. Therefore, reducing shower duration can have a significant impact on the management of water resources. If an individual spent only two fewer minutes in the shower, they could save up to 140 litres of waterover the course of a week (using a shower-head with a flow rate 10 litres per minute).

[3] Financial Express (2020). India's water crisis: Is there a solution?

[4] Rutger Willem et al. World Resources Institute (2019). 17 Countries, Home to One-Quarter of the World's Population,Face Extremely High Water Stress.

[5] Times of India (2018). Is Day Zero on the horizon? Taps could run dry in Bengaluru, Pune.

[6] Sustainability at Harvard (2020). 4 Ways to Measure a 5 Minute Shower.

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

The study in this report aims to address these two problem areas by investigating whether small nudges can be used as an effective tool in persuading guests to take shorter showers, thereby saving water. Nudging is considered to be a relatively cheap and simple intervention mechanism, aimed at filling the gap between intention and actual behaviour. This experiment tests two different types of nudges, (1) a social-proof nudge and (2) an information-based nudge, through the medium ofposters and timers in hotel-room showers.

(1). Although basic economics presumes that humans only interact out of necessity or when they gain from an encounter, behavioural economics challenges this assumption by suggesting that individuals are "easily influenced by the statements and deeds of others". In 1955, Solomon Asch7 conducted a series of experiments to test this principle. When asked to attempt a simple test, participants were able to complete it quickly and with ease. However, when others gave incorrect answers, participants deviated from their original answer one-third of the time. This tendency of people to change their own actions based on social influences and 'follow the herd' can be utilized in order to create socially beneficial behaviour. The social-proof poster in this study was used to see how likely people were to reduce their own water usage if they knew that majority of other guest took 5 minutes showers.

(2). Nudging through the provision of information is one of the most predominant types of nudges and in this study, it was used to make guests aware of the amount of water they would be able to save by cutting down the duration of their shower by five minutes. With limited, and sometimes imperfect information about the negative externalities of taking longer showers, it can be challenging for individuals to fully comprehend the impact of their actions. The information-based poster aimed to address this issue.

Through the implementation of both of these nudges in hotel showers, using posters and timers, this report seeks to explore: **To what extent can nudges be used to reduce shower water consumption in hotel rooms**

Method

I. Design

A natural field experiment was conducted in which nine bedrooms in a hotel were randomly allocated to three different conditions. Three rooms had no nudge (**NN**), no poster or timer, another three rooms were set up with a social-proof nudge (**SPN**) with poster 1 and a timer, and the lastthree rooms had an information-based nudge (**IBN**) with poster 2 and a timer. Rooms

[7] Thaler and Sunstein (2008). Nudge: Decisions about Health Wealth and Happiness.

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

were randomly allocated to conditions prior to any data collection. The experiment was designed over a one-month course such that Week 1 and 2 were *baseline weeks* where no posters were placed, and Weeks 3 and 4 were *experimental weeks* where all the three experimental conditions were simultaneously implemented.

The experiment used an independent measures design so that both nudges could to be tested in parallel, alongside the control group. A repeated measures design could not be used as the average travel duration of each guest was two days, and each of the conditions would need to be tested for a minimum of one day. Therefore, in most scenarios, the visit was not long enough to test all three conditions on each guest. The two independent variables were the presence or absence of a nudge, and the type of nudge used. The dependent variable was the amount of water (in litres) used by eachguest in the shower per day.

An important control implemented was ensuring that every room was single occupancy, as more than one guest in each room was likely to have increased the daily water consumption in theshower. Moreover, the poster was also put up in the same place in each shower so that it was equally visible to all participants. Other controlled variables included a uniform shower-head ineach room, identical timers, and each poster being of the same size.

Despite efforts to create a completely fair experiments design, certain extraneous variables still remained. Firstly, the most significant confounding variable was the lack of certainty about how many times per day each person took a shower. The experiment assumed that each person showered once a day, based on research by Euromonitor International[8] which shows that the average Indian takes one shower a day. The results corroborated this statement as the daily average water consumption in most trials was not large enough to support multiple showers. However, since a few people could have still taken two or three showers in a day, anomalous results were removed. This reduced the possibility that the data included a day where multiple showers were taken. Secondly, the guest in each room was continuously changing throughout the experiment. Therefore, there was a high risk of demand characteristics becoming a confounding variable. General differences in lifestyle, work schedules and amount of free time per day may have impacted the results.

II. Participants

[8] Euromonitor International (2018). Survey Shows Regional Differences in Bathing Habits Around the World

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

In total, 65 participants took part in the study. All the participants were guests from a guesthouse located in Gurugram, Haryana. The demographic consisted entirely of middle-aged businesses executives, travelling to Haryana for work purposes. Approximately 86.15% were male and 13.85%were female. Due to the Covid-19 pandemic, there were no guests visiting from foreign countries.

The sample population was composed only of Indian citizens from 6 different cities in India. The average duration of the visit was 2 nights per guest.

Before beginning the experiment, a random number generator with numbers 1-3 was used torandomly allocate each room to one of the three conditions. The study used a cluster sampling method as participants were divided into subgroups, based on which rooms they stayed in. Simple random sampling was used for the allocation of each individual to a specific room.

III. Materials

The materials used in this experiment included:

1. Six posters, three aimed to provide a social-proof nudge (poster 1) and three aimed to providean information-based nudge (poster 2) - see Appendix A
2. Six shower timers (placed beneath the posters) - see Appendix B
3. Nine flow metres (installed in the pipes of the showers in each room) - see Appendix C

IV. Procedure

Guests staying in 9 different rooms took part in the experiment, and the experiment ran for a total of28 days. During the baseline weeks (weeks 1 and 2), no nudges were implemented. Every eveningat 8 pm, the flow metre reading on each room's shower was checked and recorded in the data table (see Appendix C). After the last readings of week 2 were taken on the 14^{th} day of the experiment, laminated posters and shower timers were placed on the shower walls in six out of the nine rooms, known as the *nudge rooms* (see Appendices A & B). No posters or timers were placed in the other three rooms, which served as the control group. Three out of the six nudge rooms received poster 1, a social-proof nudge that aimed to convey to hotel guests that the majority of guests took 5-minute showers, encourage them to follow in the steps of other guests. The other three nudge rooms received poster 2, an information-based nudge that aimed to educate guests on the environmental benefits of taking shorter showers, by telling them how much water they could save if they chose to take 5-minute showers instead of 10-minute

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

showers. Underneath each poster, a digital timer was placed so that guests could time their showers if they chose to. Guests were informed about this option on the poster. The same process to take flow metre readings used in the baseline weeks was used in the experimental weeks (weeks 3 and 4). After testing was completed, data of the shower water consumption in each room was compiled (see Appendix D) and analysed (see Results below).

Results

Although a total of 252 readings were taken throughout the experiment (9 rooms × 28 days), only 213 were used in the final data calculations and analysis. This is because certain values were 0 and omitted as they interfered with the accuracy of the results. A reading of 0 on the flow metre was either due to the guest taking a bucket bath or not showering at all on a particular day. Additionally, outliers were also removed from the data set, which were calculated using the formulas Q1 - (1.5 × IQR) and Q3 + (1.5 × IQR).

I. Raw Data Summaries

Table 1 shows a summary of the data collected for weeks 1 and 2, whereas Table 2 shows asummary of the data collected during weeks 3 and 4.

Table 1: Baseline Weeks - Number of Flow Metre Readings, Mean Amount of Water Consumed inthe Shower Daily, and Standard Deviation

	Number of Readings	Mean (litres)	Standard Deviation
Room 1	12	79.17	23.53
Room 2	11	81.82	33.71
Room 3	13	66.92	29.83
Room 4	11	56.36	22.48
Room 5	14	67.14	24.94
Room 6	10	69.00	33.81
Room 7	12	85.00	39.43
Room 8	10	87.00	42.44
Room 9	14	81.43	39.20

Table 2: Experimental Weeks - Number of Flow Metre Readings, Mean Amount of Water

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

Consumedin the Shower Daily, and Standard Deviation

	Number of Readings	Mean (litres)	Standard Deviation
Room 1: NN	10	78.00	30.11
Room 2: NN	13	66.92	34.49
Room 3: NN	12	80.00	35.16
Room 4: SPN	9	67.78	27.28
Room 5: SPN	13	63.08	23.94
Room 6: SPN	12	65.83	26.10
Room 7: IBN	11	70.91	31.13
Room 8: IBN	14	56.43	29.25
Room 9: IBN	12	55.00	31.48

(It should be noted that all readings from the flow metres are shown to the nearest tens as the scale on the flow metre only displays values rounded to one significant figure)

To see the data tables for day-by-day water consumption in each room, please refer to Appendix D.

II. Data Processing - Phase 1

The first phase of data processing involved comparing the difference between the daily average water consumption during the baseline weeks and experimental weeks. The absolute change and percentage change in mean from the first two weeks to the second two weeks were calculated.

Table 3: Daily Average Shower Water Consumption - Baseline Weeks versus Experimental

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

Weeks

	Mean X (litres) Weeks 1 and 2	Mean Y (litres) Weeks 3 and 4	Change in Mean (litres) (Mean Y - Mean X)	Percentage Change
Rooms 1-3	74.15	74.57 (NN)	0.42	0.57%
Rooms 4-6		65.29 (SPN)	-8.86	-11.95%
Rooms 7-9		60.27 (IBN)	-13.88	-18.72%

(The negative sign represents a decrease)

III. Data Processing - Phase 2

The second phase aimed to investigate whether the nudges had an impact on the amount of water consumed during a shower. This analysis was done through a chi-squared test of independence by dividing the data of the rooms from the experimental weeks into two groups - Group 1: Rooms 1-3, which received no poster and no timer (NN) and Group 2: Rooms 4-9, the nudge room, which received either poster 1 (SPN) or poster 2 (IBN) and a timer. Data used for this phase was only from weeks 3 and 4.

Null hypothesis: Water consumption in the shower is independent of the presence or absence of anudge.

Alternative hypothesis: Water consumption in the shower is dependent on the presence or absenceof a nudge.

Significance level (α) = 0.05

Table 4: X^2 Test of Independence (No Poster and No Timer vs. Poster and Timer) - Observed Matrix

	≤ 70 litres	> 70 litres	Total
No Poster and No Timer (NN)	17	18	35
Poster and Timer (Nudge Rooms)	49	22	71
Total	66	40	106

(The value of 70 litres was used as it was the median of all the data values in the experiment)

Table 5: X^2 Test of Independence (No Poster and No Timer vs. Poster and Timer) -

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

Expected Matrix

	≤ 70 litres	> 70 litres
No Poster and No Timer (NN)	21.79	12.21
Poster and Timer (Nudge Rooms)	44.21	26.79

X^2 = 4.17

p-value = 0.0411

Degrees of Freedom (*df*) = (2 - 1) × (2 - 1) = 1

Since the p-value (0.0411) is less than alpha (0.05), there is enough evidence to reject the null hypothesis. It can be concluded that water consumption in the shower is **dependent** on the presence or absence of a nudge.

Furthermore, box and whiskers plots were also constructed for the two groups which allowed for a comparison between the mean and interquartile ranges of the rooms which had a nudge versus the rooms which did not.

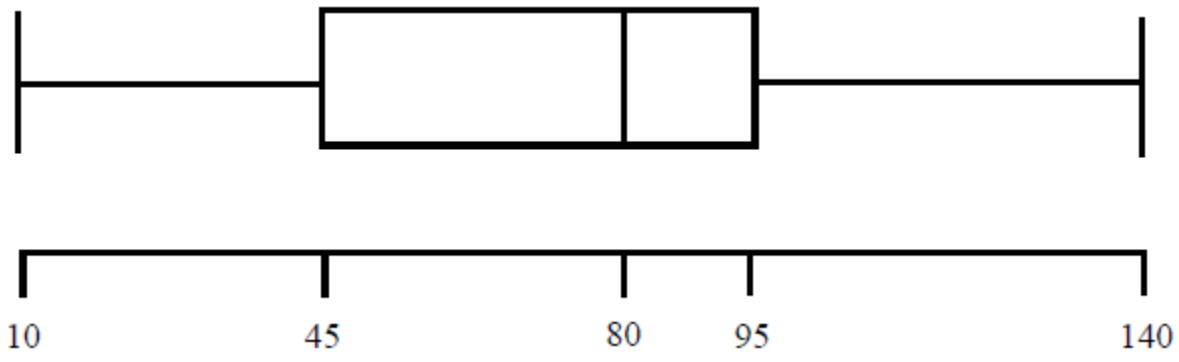

Figure 1: Group 1 (NN) Box and Whiskers Plot

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

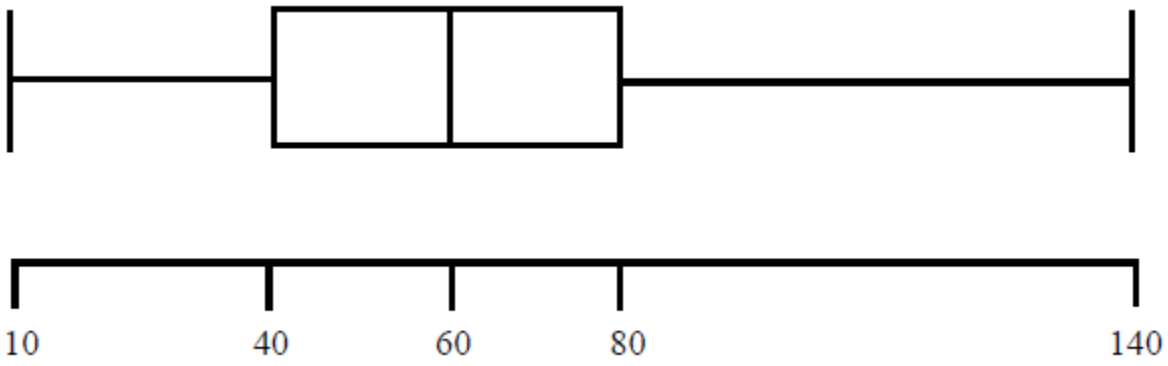

Figure 2: Group 2 (Nudge Rooms) Box and Whiskers Plot

Although the overall range of both the groups remained the same (130 litres), the inter-quartilerange was larger in Group 1 (50 litres) as compared to Group 2 (40 litres). Moreover, the lower quartile was 45 in Group 1, whereas it was 40 in Group 2. Similarly, the upper quartile was 95 in Group 1 and 80 in Group 2. A significant difference was also observed in the median, which was 80in Group 1 and 60 in Group 2.

IV. Data Processing - Phase 3

The third and final phase of data analysis seemed to determine which nudge was more effective, poster 1 (SPN) versus poster 2 (IBN). This was done through a chi-squared test of independence as well, and the data used was only from weeks 3 and 4.

Null hypothesis: Water consumption in the shower is independent of the type of nudge used(social-proof versus information-based).

Alternative hypothesis: Water consumption in the shower is dependent on the type of nudge used(social-proof versus information-based).

Significance level (α) = 0.05

Table 6: X^2 Test of Independence (Poster 1 and Timer vs. Poster 2 and Timer) - Observed Matrix

	≤ 70 litres	> 70 litres	Total
Poster 1 and Timer (SPN)	19	15	34

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

Poster 2 and Timer (IBN)	30	7	37
Total	49	22	71

Table 7: X^2 Test of Independence (Poster 1 and Timer vs. Poster 2 and Timer) - Expected Matrix

	≤ 70 litres	**> 70 litres**
Poster 1 and Timer (SPN)	23.46	10.54
Poster 2 and Timer (IBN)	25.54	11.46

X^2 = 5.26

p-value = 0.0218

Degrees of Freedom (*df*) = (2 - 1) × (2 - 1) = 1

Since the p-value (0.0218) is less than alpha (0.05), there is enough evidence to reject the null hypothesis. It can be concluded that water consumption in the shower is **dependent** on the type of nudge used.

Discussion

The findings of this study were successful in suggesting that nudges can be used as an effective tool in reducing shower water consumption in hotel rooms. Using the nudges helped reduce the water consumption per day by an average of 15.34%. Additionally, the investigation into which type of nudge would be more effective showed that the information-based nudge worked better than the social-proof nudge. Based on the results of this experiment, the implementation of the information- based nudge could save 97.16 litres a week per guest. Since these methods of nudging were relatively low effort, non-intrusive and inexpensive, yet yielded significant results, similar concepts can be applied in other hospitality businesses to help conserve water. Furthermore, although these nudges were designed for a specific setting, the findings show how behavioural economic interventions can be used as a powerful tool in policy-making in order to help protect the environment.

However, despite promising results, certain design issues may have impacted the reliability of

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

the outcomes. Firstly, the independent measures design meant that comparisons between the conditions were less accurate as demand characteristics could have come into play. Conducting this experiment in a setting where guests stay for longer periods of time, such as serviced apartments, would allow for a repeated measures design to be used, contributing to a larger set of controls. Secondly, the nudges were only implemented for two weeks and in six rooms, which may not have been sufficient in drawing a concrete conclusion on the effect of nudging. Increasing the duration of the experiment may be beneficial if the study were to be replicated in the future.

Moreover, the external validity of this experiment needs to be carefully considered before generalising results. The disproportionate ratio between males and females could have impacted the effect of the nudges. Although the effect of gender is unknown, the lack of information on the behavioural pattern of female participants reduces the ecological validity of the study. There was also a lack of cultural diversity as the travel restrictions, due to the pandemic, meant that all the guests were from India. Since people from different countries have different levels of information and awareness in this issue, and varying behaviours, it may be hard to generalise these results to a population outside India. Furthermore, majority of guests were business executives with high levels of education, which may have made them more responsive to information about the significance of water conservation. The impact of these nudges is likely to differ significantly in rural setting where people are less educated. It cannot be taken for granted that the nudges would perform in a similar manner in different environments, which calls for further research to close this knowledge gap.

Another interesting avenue for future research is to investigate other types of nudges to encourage pro-environmental behaviour, based on different behavioural economic principles such as changing the default option or regular feedback (for example, by display screens which show active water usage in the shower). In addition, the effect of utilising modern technology to create nudges which help the environment can be studied as well.

Conclusion

This study looked at whether nudges can be used to reduce the shower water consumption in hotel rooms. Two types of nudges were tests, a social-proof nudge and an information based nudge. Itwas found that the presence of either of the two nudges encouraged guests to reduce the duration of their shower, and thus, reduce water consumption. The information-based nudge was the more effective than the social-proof nudge.

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

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Appendices

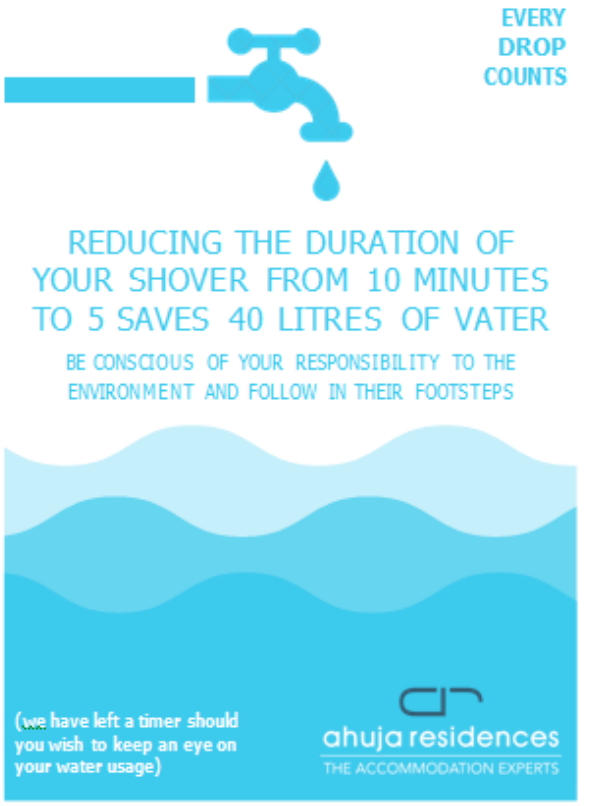
ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

Appendix A

Figure A1: Poster 1 (social-proof nudge)

Figure A2: Poster 2 (information-based nudge)



ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

Appendix B

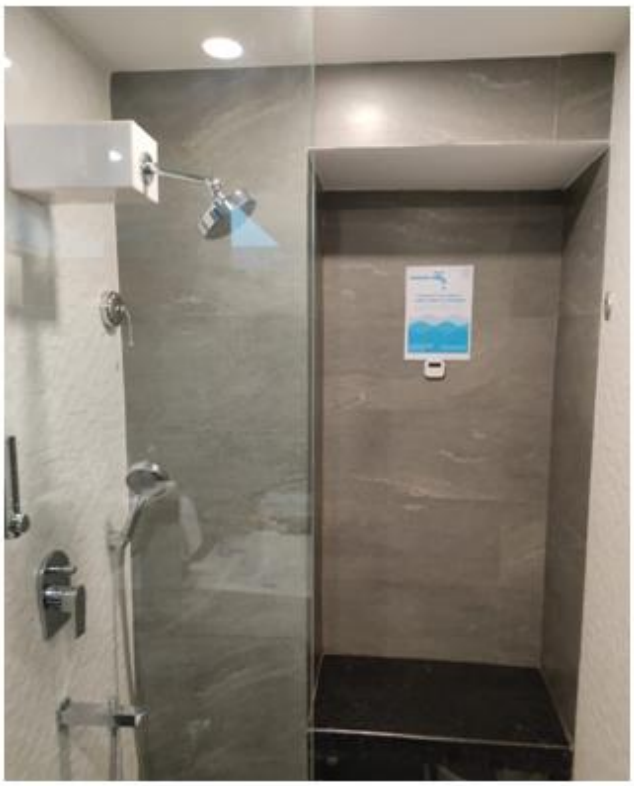
Figure B1: Shower timer

(Although the image displays the timer in a standing position, the stand was retracted and eachtimer was pasted on the shower wall)

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

Figures B2 and B3: Example of the set-up in nudge rooms during experimental weeks



Appendix C

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

Figure C1: Flow meter

Figure C2: Video demonstration of running flow meter

vimeo.com/546864520

Figure C3: Example of a flow meter cover around the pipe behind each shower-head

Appendix D

Please note:

1. The tables below represent daily shower water consumption in units, where 1 unit = 10

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

litres.For example, 6 represents 60 litres and 14 represents 140 litres.

2. 'R' stands for room, and 'D' stands for day. For example, R1 is Room 1 and D2 is Day 2.

3. As aforementioned (under the Results section), during experimental weeks rooms 1-3 received no nudge, rooms 4-6 received poster 1 and a timer (SPN) , and rooms 7-9 received poster 2 and a timer (IBN).

4. Values with an asterisks (*) represent outliers and were omitted from data calculations

Table A1: Daily Shower Water Consumption in Each Room - Weeks 1 and 2

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
R1	6	7	11	4	5	8	7	12	10	0	9	8	8	0
R2	14	0	6	4	0	11	8	9	9	0	7	2	11	9
R3	0	5	4	8	7	7	7	9	1	13	10	5	6	5
R4	3	4	5	5	5	10	3	9	5	7	6	0	0	20*
R5	5	4	5	8	4	9	11	5	9	3	10	8	6	7
R6	10	10	3	7	6	3	0	0	8	8	0	12	2	0
R7	8	12	16	4	7	9	9	0	0	14	5	3	6	9
R8	0	13	0	10	4	13	9	9	13	11	0	0	3	2
R9	12	7	14	12	8	9	8	8	4	2	15	6	5	4

Table A2: Daily Shower Water Consumption in Each Room - Weeks 3 and 4

	D15	D16	D17	D18	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28
R1	7	8	10	11	0	5	0	9	12	9	4	3	0	0
R2	5	8	8	2	13	11	3	10	4	3	8	17*	4	8
R3	5	14	12	12	4	0	6	2	8	8	9	0	9	7
R4	9	8	0	5	3	9	10	0	0	0	9	4	0	4
R5	3	4	0	4	8	8	5	11	8	4	6	7	9	5
R6	8	12	7	0	6	6	3	9	8	8	4	0	4	4

ISSN: 2455-8834

Volume:06, Issue:08 "August 2021"

R7	4	4	6	7	14	0	7	5	5	11	0	0	9	6
R8	5	10	4	6	3	7	5	3	2	13	7	4	5	5
R9	0	5	5	5	1	6	3	3	11	12	4	5	18*	6