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# Engaging users in tracking their water usage behavior

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**Abstract**

WATERNOMICS is an EU funded project that aims to raise awareness about efficient water management using ICT to provide users with insightful and actionable information. A crucial problem faced in our pilot settings was to enable personalized tracking of water consumption in a non-enforcing and invasive way. This paper presents two scenarios of such a system using storyboards that describe them in a university building setup, trying to encourage students to become more water aware. The paper continues to present the findings from the user tests conducted in the experiments in two pilot sites and concluded by presenting the changes in the design of the final application for the public space environment.


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*Keywords:* Innovation, technology, water measurement, raising awareness, user experience, habit formation

## 1. Introduction

The WATERNOMICS project is an EU funded project that aims to raise awareness on water consumption and conservation issues in a range of different contexts and users. The project is going to explore and test applications in

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three different contexts (pilot sites). The first will be in Italy in the large corporate environment of an airport. The second is to be conducted in Ireland at a primary school building and the Engineering building of NUI Galway. Finally the third pilot is to be conducted in a set of households in the municipality of Thermi (Greece) engaging domestic environment users.

In the first year of the project, an extensive series of user tests took place for all three pilots using paper prototypes of the initial applications in order to identify needs, ideas and potential problems. A key feature of the project is the WATERNOMICS Information Platform [2] (WIP) which will be collecting consumption data of the different users and pilot sites. The WIP will then combine this information with various open data sources that are publicly available such as weather forecasts, in order to provide more useful and meaningful information to users. Data will be provided to a range of applications using a set of support services.

Having as a primary aim of the project to raise awareness through ICT for water consumption and conservation, a problem that showed up early in the project was an absence of this information itself. Consistent responses across pilot sites were that they are missing basic information about their water consumption in a timely fashion. For example, in the case of domestic environments, users are receiving a cumulative water bill every 4 months, which is a quite large period so keeping track of water consumption is tiresome and not engaging and to keep track of consumption. Most people are mainly concerned in only cases where the bill is unexpectedly high so they try to identify the potential problems.

In the case of the public space environment pilot, information about water consumption is already displayed on a public display. However, it is not updated regularly and not very salient resulting that users typically ignore the information and detailed data granularity is lacking. Finally, in the case of the airport, it showed that a major opportunity to affect passengers and employees behavior exists but is currently not utilized.

Although users from all pilot sites identified that user behavior can have a significant impact on water consumption, most of the users were not able to identify how much water they personally consume and for what purposes. Environmentally friendly oriented users were particularly interested to identify those cases where they would waste water.

The aforementioned observations lead to a significant question that still lies unanswered. How much water do we personally consume in our everyday lives? This also leads to the question of how much of that consumed water can be saved and how? The Water Footprint Organization has published recently a report [2] that indicates how much water a person consumes either directly or indirectly. Users visiting the organization's web site can find out that per capita, water consumption is dependent on a number of factors and that it ranges per country. However, knowing consumption per capita is just an indicator and calculators can only give an estimate of the water consumption per person. How can a specific person know exactly (or at least more accurately) how much he/she is consuming is still a problem to be tackled.

One of the missions of WATERNOMICS project is to design and implement novel interfaces for water decision support by a) engaging non-technical users who are unfamiliar with water management systems by asking them to report on their behaviors and perform water saving tasks, b) informing users about their water consumption to increase awareness of water waste problems occurring in their environment and provide a decision support on what actions to take and c) motivating their behavior change for water saving to maximize user involvement and cooperation and to encourage long term habit formation.

This paper presents a study on two different scenarios to attract users to track their personal water consumption using recent technologies such as smart phone applications. Through interviews with users based on two storyboards, we try to figure out what the possibilities and problems might be for the future application domain. Finally, the paper will describe the decision made in WATERNOMICS project on how the concept of water consumption accountability can be used in our pilot sites.

## 2. Background

Many areas are starting to develop applications where personal tracking can be of great value. Personal health and well-being is one of these areas where personal tracking has become an important tool in providing users with feedback to support them in leading a healthy lifestyle. Recent statistics (2014) from google state that there are over a 100.000 health and fitness apps available for Android and iOS and that this market is worth $4 billion and expected to rise to $17 billion in 2017[2]. One of the leading apps according to google is MyFitnessPal[3]. The app can scan barcodes of food items and use this information in tracking nutrient and calorie intake to give the user insight into what he/she is consuming. In similar fashion, there are countless QR scanner applications that can link to a website when scanned with a phone. An interesting study where QR codes are used to make children more aware of what they eat states that QR codes is preferred over Bluetooth and RFID tags in their case because a camera is on every phone and children generally enjoy taking pictures [3].

In some cases, tracking is done without any explicit action by the user like scanning or taking a photo. For example, almost 60 million fitness trackers will be in use by 2018 [4]. One of the most popular fitness trackers, the Jawbone UP24[4], tracks your steps and activity and enables insight into the amount of calories burned. It therefore does not require an action to initiate the tracking except wearing it.

Other fields have also shown a drastic increase in the utilization of tracking technology. Energy is a good example where tracking a user's consumption has been focus of several studies. Tracking all of this information is one thing, but using it in a way to actually persuade people into performing a certain behavior is another. For this reason the term Eco-feedback technology was introduced. It is technology that is oriented around the fact that people lack a certain awareness and understanding about their own behavior. The goal is to provide feedback on individual or group behaviors with a goal of reducing environmental impact [5]. Several interesting applications have been developed that can be labeled under this eco-feedback technology.

An interesting example of giving eco-feedback in an ambient way is the ambient power chord [6]. Instead of using an interface through the usual channels like a phone or computer screen, the power chord directly shows the amount of electricity consumed by that appliance by emitting a certain color of light through the electricity chord. In this way, it is making people more aware of what energy is being consumed. In similar fashion, energy orb[5] is an orb with a display that displays real-time information about energy consumption in households. It communicates changes in consumption and pricing by changing its color and by its numerical value display.

Although these many shapes and ways of giving eco-feedback, the smart phone seems to be popular choice for most designers. Doppler [7] for example, is an application that allows you to travel with the least amount of CO2 emissions. It increases awareness of these emissions by comparing them for each mode of transport. In similar fashion there are applications focused on giving feedback on emissions and relate them to relatable measures like hours played in a band[6], Trees saved by walking[7] or growing trees with in-or decreasing polar bears /fish [8].

The goal of all these applications is to give insight into the users' consumptions or physical state to persuade them to take action accordingly. Currently, the number of studies that use eco-feedback for water consumption are scarcely present but as the need to conserve water becomes greater more apps will appear including WATERNOMICS project.

Examples of eco feedback on water consumption are diverse and differ from giving numeric to ambient feedback. Pebble[8] is an example of a domestic setting ambient eco-feedback system in the shower. It is a small device that is placed on the floor of the shower. It registers the passing water flow and changes its colors when a shower is taking too long. Other designers focus on the visualization of duration and frequency of showers in order to persuade people to take shorter showers by comparing them to other persons in a household. The shower calendar [9] is a display in the shower where users select their ID at the start of a session. The display then shows how long every family member has showered on a calendar where circle size encodes the amount of water consumed during their showers.

Although the shower is a popular area due to it being a major source of water consumption, there are applications that focus on other water consumption behaviors. Waterbot [10] is a faucet attachable ("add-on-sink") product that

[2] http://mhealtheconomics.com/mhealth-developer-economics-report/
[3] https://www.myfitnesspal.com/
[4] https://jawbone.com/store/buy/up24
[5] http://www.ambientdevices.com/about/energy-devices
[6] http://wheregoodgrows.com/works/view/77
[7] http://www.samsung.com/us/aboutsamsung/news/newsIrRead.do?news_ctgry=irnewsrelease&news_seq=14986
[8] http://waterpebbleus.com/

gives feedback on water consumption. This feedback occurs during ("just in time") or after use and uses positive reinforcement principles to promote sustainable water use and reminders. Waterbot gives feedback by visual and auditory cues when the tap is closed which can be positive or negatively charged. Continuous feedback during use occurs in the form of two illuminated bar graphs. A similar application is the faucet display by Kuznetsov and Paulos [11]. It is a small box attached to the faucet where there are two sources of information (lights), one related to the individual consumption at that point in time, the other relating to the total building consumption.

Surprisingly few smartphone applications have been explored in relation to water consumption. The ones, who are out there, try to make users aware of water consumption by giving a water footprint rather than giving actual insight into water consumption. Virtualwater[9] for example is an application that gives feedback to the user in the form of a water footprint meaning that water consumption is translated to the amount of water it takes to produce certain products. Other smartphone applications engage the user into drinking enough water[10] by letting the user input their own readings and then give feedback on consumption. Currently there are no applications available that use real-time sensor data in order to give feedback to the user. However, realization of sensor data being valuable for water consumption feedback is beginning to emerge [12].

It is obvious that the field of personal tracking will keep on growing the coming years. Health and fitness is a major field where personal tracking is an important part of giving actionable information to users. Eco-feedback can especially benefit from personal tracking of consumption since its philosophy is to give insight into the users own behavior. The energy sector has already started to realize this importance and for water consumption this awareness is also slowly resulting into several applications.

#### *2.1.1. Fogg Behavioral Model*

An important requirement when trying to engage users in an interactive manner is to provide a clear and engaging call to action that triggers this process. Therefore, an important part of the user research is to find out what these triggers actually should be, how they look like and how they should be implemented in a solution. A theoretical model that can help figure out how to best trigger behavior is the Fogg behavioral model or FBM in short [13]. The FBM states that when technology tries to persuade the user into performing a target behavior, this will only occur when the user has sufficient motivation, ability and is triggered in the right way. If the user lacks either motivation or ability, the model prescribes ways to increase them to facilitate a target behavior.

**Motivation:** For motivation, Fogg describes three core motivators: pleasure/pain, hope/fear and social acceptance/rejection. Each motivator has a positive part and negative counterpart. Positive awards can be applied to promote a target behavior like a free sample food (pleasure) in order to make people buy a product, showing an expensive car in order to promote buying a lottery ticket (hope) or showing how many of your friends already purchased a product (social acceptance). On the other hand, there is also a negative approach to persuading people like not getting food for not performing a behavior (pain), enforcing fines for speeding (fear) or not complying to a dress code for a club (social rejection). For example, products like the previously described energy orb[5] can motivate users to engage the product due to fear of losing money but also hope of saving money.

**Ability:** Fogg describes ability as the scarcest resource at the moment a behavior is triggered. To increase ability, the model states several ways of doing so: time, money, physical effort, brain cycles, social deviance and non-routine. Designers should ask themselves questions like; does the user have enough time to perform the behavior? Does the user have enough money to perform the behavior? Does it require too much physical effort? Does the behavior require a lot of thinking (brain cycles)? Does the behavior break any rules (social deviant) and is the behavior a routine action? However, which factors of ability apply is different from person to person. Fitness trackers like the Jawbone UP24[4] have been successful because their design looks like a wristband (social deviant), they require minimal physical and mental effort to wear and use them, no additional time to use them and they don't break any of their routines.

[9] http://virtualwater.eu/
[10] http://waterlog.gd/

**Triggers:** A trigger is something that tells people to perform a behavior now. Fogg describes three types of triggers: a spark, a facilitator and a signal. A spark trigger should be used when the motivation of a user is low and this trigger can draw upon the three core motivators described earlier. The facilitator is convenient when motivation is high but ability is low in users. The facilitator wants to trigger behavior by making it easier. When both motivation and ability are high, the only thing that is needed to trigger a behavior is called a signal. A signal simply acts as a reminder. Waterbot [10] for example triggers when an action is using too much water. In this case, motivation and ability are both sufficiently present and all the user needs is a signal trigger to remind the user he is using too much water.

Although there are other persuasive models and theories to choose from like Heuristic Systematic model [14], Elaboration Likelihood Model [15] or Theory of Planned Behavior [16] etc., they mostly focus on information processing or attitude change. These are different things than behavior. Because conservation of water is an actual behavior, the FBM gives a structured way of understanding the user and therefore guidelines for a design solution. The FBM is relevant because it gives thorough handles to think about triggers (money, time etc.) and targets (motivation and ability) in the process of understanding the users and applying this knowledge in a design solution.

### *2.2. The hooked model*

Based on the FBM, Nir Eyal on his book “Hooked” [17] describes a model for designing applications that helps form habits. The model described is called the Hook model and consists of 4 phases, namely the trigger, action, reward and investment phase. In designing applications for tracking personal water consumption, it is important to take this model into account so that applications will gradually build a habit into users’ daily routines rather than forcing them to report their consumption every now and then which will inevitably become an annoyance to the user. Therefore, it is crucial to explain this model so that we can later identify how suggested applications are designed based on it.

The first phase in engaging a user with an application is the trigger which can be external or internal. External triggers are objects, signs, stickers, messages and in general anything that prompts us to engage with the application. However, the strongest triggers are internal triggers. Internal triggers are emotions or specific occasions that can be associated with specific actions and using an application can be one of them. Especially boredom is one of the most often used internal trigger for many of the popular applications such as Facebook, YouTube, etc. This description of triggers supplements thinking about triggers described in the FBM.

The next phase in the hook model is the action. The action is what we ask the user to do following a specific trigger. In order for a user to take action, there are three major factors as seen in the FBM. Therefore, it is important that actions in the first stages of engagement are quite easy to take requiring minimal cognitive, or physical effort.

Action leads to a reward which acts as a motivator. Rewards can be diverse and are categorized in three main categories: a) rewards of the tribe are rewards that relate with social acceptance such as the number of likes a person gets in a post on Facebook, b) rewards of the hunt relate with feeling of finding something that a person searches for, such as the interesting news from a news feed stream and c) rewards of the self relate to self-achievement such as mastery, competence, consistency and control and an example can be found in badges earned in applications like Foursquare. A critical factor however, for increasing engagement and making those rewards even more interesting and desirable for the user is their variability. If users know what they are going to get as a reward each time they take an action, they will probably lose interest after some time but with variable rewards users will continue taking actions to discover new rewards.

The final phase of the hook model is the investment phase. In this phase an application should promise to the user a bigger reward and/or a more farfetched goal to keep them returning to the application and using it again and again. It is crucial that the investment phase builds gradually on next iterations so that when a goal is achieved a new and bigger one is revealed to keep the users engaged.

This model is applied in most of the successful applications nowadays (i.e. Facebook, YouTube, Instagram, etc.) and is also one of the basic principles behind concepts such as gamification. WATERNOMICS takes this model into account so that applications will gradually build a habit into users daily routines rather than forcing them to report their consumption every now and then which will inevitably become an annoyance to the user.

## 3. The WATERNOMICS approaches for water usage behavior changing applications

Given the previous behavior models, we developed two different but also complementing scenarios for a mobile application that could be used to personalize water consumption tracking it in a way that is unobtrusive to the user. The applications proposed use personal tracking similar to tracking of fitness activities and are inspired by the hook model as will be explained in the following paragraphs.

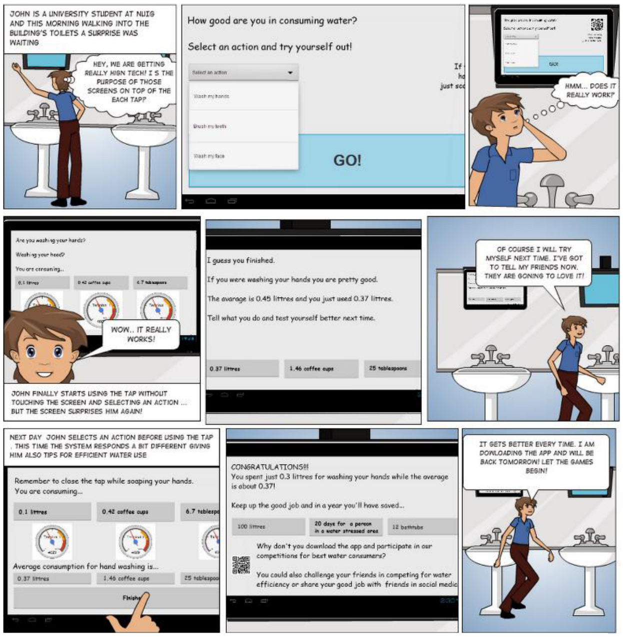


Figure 1: Public display application storyboard

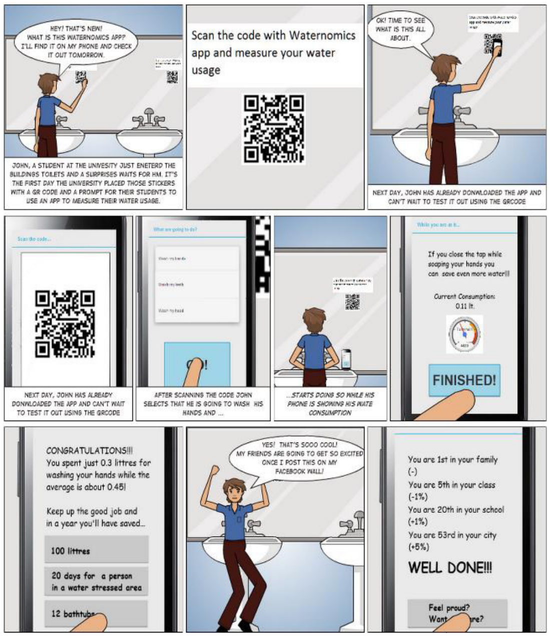


Figure 2: QR Code based mobile application storyboard

### 3.1. Public display application

In the first scenario (**Error! Reference source not found.**), a university student, walks into the toilets where draw attention through a public display that is mounted nearby the sink where students usually wash their hands. The display asks the user to input his/her intended water consumption from a short list of most common water uses (i.e. washing hands, washing teeth, etc.). The trigger in this case is an external one with potential of being connected in the long term with an internal one (the routine followed walking in or out of the toilet). The action required is a quite simple one with minimal physical and cognitive effort. The user just has to select one of the available options by tapping it.

However, whether the user selects an option, as soon as the tap is on, the system starts displaying information about how much water has been consumed in that session. This way even if the user has not taken the action, he is able to get a glimpse of the actual reward if he selected it. The information is accompanied with a generic water conservation suggestion that appears on screen. If the user selected the intended water consumption, the same information is displayed with some additional targeted information for the specific action (i.e. the average amount of water being used while washing ones hands). In the final screen, after the water consumption session has ended, the user sees some statistics about his water consumption into different perspectives and is prompted to download a mobile application on his phone for the next time so that he/she can keep track of his personal statistics.

Revisiting the scenario with the hook model in mind, we can see that even without the actual action we request from the user, we do trigger a reward by showing real time consumption and related tips. This in turn builds up into an investment by calling the user to select the action next time. The next time the user visits the system, knowing what kind of reward to expect will increase the chances of interacting with it. So the reward becomes more personal and relevant and in the investment phase, an even larger goal (personal consumption tracking) is revealed. By gradually revealing newer and bigger rewards and investments, the design tries to engage users in a personalized mobile application for tracking their own water consumption.

### *3.2. QR code based mobile application*

The second scenario (**Error! Reference source not found.**) focuses on the mobile application and can be seen as the continuation of the previous scenario. However, we developed the second scenario as an alternative to the first one, based on a QR code sticker near a public space water tap. The QR code in this case facilitates taking action. . The QR code can be accompanied with a text informing the user that if he/she scans the QR code using the WATERNOMICS app he/she can track his/her personal usage.

Therefore, the action required from the user is to scan the code with the mobile application. Once the user scans the QR code the application asks him to input the type of water usage he is about to start similar to what was happening in the public display. The reward in this case is that as soon as the user starts using the water tap, he sees the live consumption information on his phone. When the user finishes using the water tap, he can tap on the finish button to get to the next screen showing his consumption in different metaphors. Lastly, the final screen shows his ranking on different groups (i.e. family, class, etc.) based on his consumption. Note that this reward is internally triggered meaning that it comes from a motivation to already wanting to conserve water, unlike monetary rewards.

This final screen of the different leaderboard statistics serves as the investment phase of the application. It also prompts the user to share his results on social networks in order to exploit social networks to market the application while also allowing user to gain some reward of the self by publishing his achievement.

This scenario can easily be adapted to domestic environments as well where different taps can be assigned to different QR codes so that users can easily identify which source they are using. Another crucial factor for the ability to be used in domestic environment is that apart from the sensors installed there are no other requirements for installation of displays as in the previous scenarios.

## 4. Experimental analysis

### *4.1. Protocol and methodology*

Having presented the two different storyboards, the methodology for conducting user research was divided in two different types of tests that took place with 8 domestic users from the Thermi pilot and 6 public space users from the NUIG Engineering building. We used the storyboards as a main reference point for interviews with the domestic users. Those interviews had two main points of focus. The first being the use of such an application in a public building such as their work environment and the second being the use of such an application within their domestic environment. Users were asked to identify if they could relate to the character of the storyboard or not, the reasons for their reactions and the pain points that such a process creates for them.

However, in the case of NUIG, we conducted a focus group where users were shown the actual screens of the two applications and were asked questions about each of them. The flow of screens in those focus groups followed the one in the storyboards. Users were asked their opinion and which elements in each screen were interesting and which ones they would change. Similar questions about the reasons for their reactions to each step of the process and potential problems were also explored in those focus group sessions. Participants in the focus group included a mix of under graduate students, post graduate students and researchers from the engineering building.

A qualitative analysis of the interviews and focus group discussions followed to suggest potential improvements for the suggested applications. These findings identified a set of interesting new ideas as well as pain points in the process described in both storyboards. In the following paragraphs, we are going to present the key findings for each storyboard.

### *4.2. Findings for the public display application*

The public display attracts more attention than the QRCode since its requires less cognitive and physical effort to engage the user and therefore it is more possible to attract attention as an entry point than the QR core.

The fact the public display application is reacting to the users' natural workflow (using the tap) increases the attention attracted and curiosity. Curiosity is a critical factor in increasing engagement emphasizing the fact the public display is showing consumption information even if the user has not selected an intended action.

The suggestions shown in the screen while using water could attract more attention if they used more salient but also relatable graphical representations. Some suggestions that users liked were the use of comics, animations, and funny eco-feedback. Especially for the metaphors, users pointed out that "The visualization is important, I want it to show something I can relate too". The fun element was also suggested as well for the metaphors. Quoting a participant form the NUIG test "the funnier they are the better they will stick to mind".

A very interesting point made from the engineering building staff was that in some cases, such as the toilets and washing hands usage, using less water might mean increased danger for safety and health due to hygienic reasons. It was emphasized that they already try to enforce good practices in washing hands and other cleaning routines so that these regulations are not violated. Therefore, an application asking users to use less water might not serve the right purpose in all cases and a balance is important.

However, in the final step of engaging users even more to download the mobile application and personalize the measurements, there were two kinds of responses. In one group, participants both in NUIG and Thermi embraced the idea of using a mobile app to track their water consumption and answered positively. In the other group, more skeptic participants answered that it is not clear what they will gain from using the mobile application so they did not see a significant point to download the application.

### *4.3. Findings for the QR Code based mobile application*

QR codes might attract less attention in a public space environment because it does not increase motivation for the reward users recieve from the action. To quote a participant "If I have to take the trouble to scan something, I would like to get something in return". However, due to the ease of installation (which requires only the sensor installation in the tap and no other additional installations). These QR codes might be more suitable for domestic environments. In fact, many of the domestic users expressed their willingness to use a similar system in their home if it was that easy.

However, the same users also expressed their concerns around the fact they would have to scan the code and select an intended action every time they used a water source in their home. As many of them said, it is not something they would like to do every time they use water. This is mainly because the additional cognitive and physical effort introduced are quite high for such a quick and in some cases natural process that it is difficult to interrupt. Participants did express cases in which they would try the application namely to benchmark different practices in using water. Quoting a specific participant; "I would like to know which is best. Washing small amounts of dishes by hand or stacking them up to use the dish washer for all of them?". This shows that participants do not think the application is simple enough to use for small routine water usage actions.

Given the previous finding, there were also some suggestions by some more tech-savvy users on how such a process could be embedded easier in small water consuming actions. An example is the usage of NFC based identification of the sensor so that does not take that much time to identify that a user is using a specific tap. Another suggestion is changing the process of input of the intended action so that it does not interrupt the natural action of using water. The application could ask the user in retrospect for water consumption information or even provide a mechanism to input this information in bulk, some time that the user is more relaxed. Finally, another suggestion was to reason for the action based on the time, the tap used and specific consumption patterns.

The rewards of the application were another potential pain point in the process. Participants felt reluctant in some cases to publish to social media or similar mechanisms their own consumption as the following quote suggests "I want the data to be anonymous". A leaderboard in a family context did not seem that attractive for parents. However, some participants expressed their opinion that such an application could have more traction if used in a school environment between students or other groups as the following quote suggests: "Making it competitive might be a good idea, like city vs city". In other cases, rewards for public environments were also suggested by participants such as in the following quotes: "If I could save for a free pint in the pub or something, I would definitely use the application" and "I think that free Wi-Fi in an airport for example would be an excellent reward"

These final comments align with the observation in NUIG that participants felt keener to use the public display application whereas they expressed concerns and reluctance for using similar applications in their domestic environment. In following up the observation participants noted that in the university environment they felt more relaxed and keen to explore new ideas and behaviors.

### *4.4. Specific findings about the actual implementation setting*

Apart from the overall feedback and comments on the two storyboards, the focus groups with NUIG participants revealed another set of very crucial pain points in the storyboards that affects the design of the final application to be developed. The first point has already been presented earlier and has to do with health and safety regulations that would contrast with the desired outcome of consuming less water in the toilet faucets. It is therefore important to keep a balance between saving water and keeping health and safety regulations.

The second problem is that placing sensors in the toilet sinks was though as a not crucial point of measurement for the building. Instead, the building manager suggested that a more critical source of wasted water is in the showers were the pilot was already planning to install sensors to measure the overall consumption in male and female showers separately. Therefore, it might be a relevant to adapt the scenarios by compromising some of the personalization aspects and gaining potentially more impact that a similar application in the showers could have.

Moreover, safety regulations would make very difficult the installation of public displays within the showers area but it would be easier to place such displays near the entrance of the showers area. Given all the aforementioned findings and restrictions, the design implications have become clear.

## 5. Conclusions

The goal of the WATERNOMICS project is to raise awareness about efficient water management using ICT to provide users with insightful and actionable information. The goal of this paper is to explore two different systems that might help in achieving this goal. Using the hook model, we can try to understand how this actionable information might actually lead to long-term behavioral changes or habits.

Based on the previous findings, it seems that the favorable scenario would be a public display (scenario 1). It seems that especially ability (simplicity) is crucial in order for users to engage with the application of scenario 2. Scenario 1 however, requires little effort to engage with and might therefore use triggers based to boost motivation with perhaps things like social acceptance principles while acting as a signal for already motivated users. Competitive elements also showed to be a favorable way to motivate users.

During the interviews, ideas started to come to mind that giving users this Eco feedback, regardless of which principles to apply to a design, can also occur in physical forms instead of purely displays. The realization that feedback for some triggers might benefit by utilizing several human senses will be taken into account into further application development. This is especially interesting because findings showed that it is important not to interrupt the users' flow of action and using other senses might help accomplish this.

The action requested from users as the prompt suggests, is to initiate the intended action but being more considerate of water consumption in the process. This action does not require any additional effort. In this case, we are actually using the already intended action of the user as the action phase. Scenario 1 asks users to complete their usual routine with a minor cognitive effort of keeping in mind their water consumption.

The reward from the action is that when completed, they are able to see the updated real-time statistics. This means that users will be able to understand the impact of their action easily. In the case of a competitive application, the balance between competitors will become clear immediately. Findings showed that visualizations are important factor in scenario 1. Therefore, the project will look for relatable and fun visualizations to give feedback.

Finally, the investment phase can include the promise of rewards for the group (i.e. free shower gels for females) on a monthly or weekly basis based on the outcome of the competition. Similarly, it could also include penalties or punishment for the losing team. These long-term rewards or punishments will work as a goal for a whole group and introduce group accountability for their actions. During the implementation phase, we will explore different rewards/punishments to see which of these engage the user best and might facilitate habitual behavior.

The paper concludes by suggesting a number of enabling technologies and changes in the design of the original applications of the storyboards having the domestic environment in mind. The first identified technology for an easier uptake of such applications is the use of new near range communication systems such as NFC or Bluetooth that could make the process of identifying the user that interacts with water easier. In addition, new devices and especially wearables such as smartwatches that are currently flooding the market could make that process even easier by simply tapping the watch.

Finally, for all the aforementioned suggestions to work in a domestic setting, a crucial problem to be solved is the installation and cost of water consumption sensors for such environments. If users are able to install and use such sensors in an easy low-cost way, the engagement of such applications will definitely benefit from it.

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