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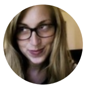
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Behaviour change and incentive modelling for water saving: first results from the SmartH2O project

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Abstract: Stimulating users to save water is a challenge and an opportunity for water demand management. Existing ICT-based systems for behavioural change often do not consider the underlying behavioural determinants in a systematic way. This paper discusses the design of the behavioural change and incentive model for the SmartH2O system, combining smart meter data with consumption visualisation and gamified incentive mechanisms to stimulate water saving. We show how the design of such a system can be related to a holistic behavioural change model and how this systematic mapping can inform the design of an integrated incentive model combining different incentive types (virtual, physical, social). The model is implemented in the SmartH2O system, and deployed in two pilots. We present the preliminary results for the Swiss pilot. Even though the interim status and sample size do not allow for final conclusions, first results indicate reduced water consumption, positive user feedback and suitability of the designed incentive model.

***Keywords**:* Behavioural change, ICT, water saving, incentive modelling, evaluation, real-world pilot

1 INTRODUCTION

Enabling new ways of water demand management through ICT has become a major challenge of supporting water efficiency. This ranges from the use of efficient water flow devices, to new adaptive pricing policies, to the use of smart meter data for demand profiling (Cominola et al., 2015), to awareness campaigns for sustainable water consumption (Stewart et al., 2010). Water utilities increasingly attempt to influence the behaviour of consumers towards improving water consumption. Water saving through consumer behaviour change has been traditionally addressed with awareness campaigns (Russell & Fielding, 2000) and financial incentives (Jorgensen et al., 2009). Recent efforts explore the visualisation of consumption data (Fielding et al., 2013) and game-like approaches for engaging users in water saving (Galli et al., 2015). Previous studies of awareness campaigns report savings of 5-10% (e.g. Fielding et al., 2013), but also point out a number of issues in ensuring sustainability of behaviour change over time (e.g. rebound effects). Understanding determinants and processes of behavioural change for environmentally conscious behaviour has been extensively studied in environmental psychology (e.g. Steg & Vlek, 2009) and persuasive systems (e.g. Oinas-Kukkonen, 2013), but the influx of these findings into the development of ICT-systems for water saving has been rather limited. In particular, a systematic foundation of the design of behavioural change systems and of incentive models in a theoretically-grounded model and their validation in real-world pilots has been rarely reported. At the same time, some trials with direct feedback systems have reported water savings of up to 27% (Willis et al., 2010), indicating a large potential of such solutions. In this paper we discuss the design of a behavioural change system and of the associated incentive model in the SmartH2O project, which combines smart meter data with consumption visualisation and gamified incentives to stimulate water saving. We show how the design of such a system can be systematically related to a holistic behavioural change process model to obtain an integrated incentive model combining different types of incentives (virtual, physical, social), adapted to the characteristics of two different pilot types (small-scale, large-scale). We report first results from the small-scale pilot, including impact on water consumption, analysis of platform activity and evaluation with end-users.

2 ICT-ENABLED SYSTEMS FOR RESIDENTIAL WATER SAVING

While in the energy domain different behavioural change systems have been explored, ICT-based systems that stimulate water efficiency in households are much less investigated (Tiefenbeck, 2014).

The adoption of smart meters by water utilities has increased the attention for such systems. They visualize consumption data from smart meters to provide consumption feedback to users and raise their awareness of water consumption (e.g. Froelich et al. 2012). One class of systems includes displays attached to water appliances, assuming that feedback is most effective when delivered close to the cause of the consumption (Kappel & Grechenig, 2009). Examples include a "Waterbot" displaying water consumption to at the tap in the kitchen (Arroyo et al., 2005), a shower display, which visualizes consumption with a range of LEDs (Kappel & Grechenig, 2009) or a "Shower Calendar" showing the water consumption of household members on a calendar display in the shower (Laschke et al., 2011). Similarly, the Amphiro on-shower device combines in-shower visualisation with reports viewable on web-based and mobile apps (Tiefenback et al., 2014). Another class of systems presents water consumption data on in-home displays, web-based or mobile apps and includes reporting functionalities for both end-consumers and water utilities. A prominent example is WaterSmart (WaterSmart, 2016), providing a software service for utilities, allowing their customers to compare their consumption against neighbours and like-sized homes on the basis of interactive (web, mobile) and paper-based monthly reports, including water saving tips and incentivizing use through rebates (from water suppliers). Their recent pilot in a Californian district reported about 5% savings per household (Mitchell et al., 2013). Several on-going EU projects follow similar approaches with some differences. Our SmartH2O project (Rizzoli et al, 2014) differs with its daily consumption feedback and integrated gamified incentive model (discussed in this paper) that goes beyond social comparison and rebates of WaterSmart, by combining visualisation and saving tips with personal, social, virtual and physical rewards (Section 4). The WATERNOMICS project focuses on integrating personalized feedback on water consumption, data from sensors and fault detection algorithms and enabling dashboards and decision support systems for water saving (Clifford et al., 2014). The WISDOM project aims at behavioural change in water consumption through near real-time consumption feedback on an in-home display and a virtual game (Terlet et al., 2016).

Even though limited in size and number, evaluations of such systems provide encouraging results on perceived usefulness of different types of displays and feedback (e.g. Froehlich et al., 2012). Only few evaluations address the impact on water consumption. As an exception, Willis et al. (2010) report a 27% water consumption reduction after deployment of shower alarms alerting household members when using more than a set amount of water (two-weeks pilot with 44 households). Long-term impact is however unclear due to limited time-spans and sample size. Similarly, while approaches to engaging consumers through game-like motivational mechanisms in non-game contexts (gamification) have been widely explored in energy (e.g. Sintov et al., 2015), the use of gamification in the water sector has been so far limited and scarcely documented in academic literature (Galli et al., 2015). Two promising examples include the aforementioned projects WISDOM, developing a virtual game for water saving (Terlet et al., 2016) and WATERNOMICS, which envisions “games and interactive learning applications” for water saving (Clifford et al., 2014). However, no published system implementation or evaluation of impact on water consumption for these projects is yet available, nor has a systematic grounding in a behavioural change process been so far provided.

3 MODELLING THE BEHAVIOURAL CHANGE PROCESS FOR WATER SAVING

In SmartH2O, a systematic approach is followed to induce sustainable change in water consumption behaviour grounded in motivational theory and research on incentive models. The SmartH2O system can be defined as a behavioural change support system (BCSS): “a socio-technical information system [...] designed to form, alter or reinforce attitudes, behaviours or an act of complying without using coercion or deception” (Oinas-Kukkonen, 2013, p. 1225). Accordingly, the SmartH2O approach considers that a change in water consumption behaviour can occur when underlying psychological determinants change through a combination of different incentive and persuasion strategies. We also model the behavioural change process as a multistage process (as considered in other domains) and the SmartH2O system is conceived to support all phases of the change process with an integrated incentive model that combines different incentive types matching the phases of the process. Research has shown that water consumption behaviour is affected by a multitude of psychological, demographic, climatic and economic factors. A behavioural change support system is only capable of influencing the psychological factors (determinants). Generic behavioural change models such as the Theory of Planned Behaviour (TPB, Ajzen, 1991), and water consumption-specific models (e.g. Jorgensen et al., 2009) highlight the determinants that have to be changed to induce a sustainable reduction of water consumption. Applied to water consumption, TPB postulates that beliefs (based on knowledge about water), attitudes (positive or negative evaluation of these beliefs), the subjective norm (perceived social pressure) and behavioural control (the user’s belief that s/he *can* save water) predict whether a user is willing to engage in water saving action (e.g. behavioural intention).

Behavioural intention is in turn a predictor of water saving behaviour. In environmental psychology and persuasive systems attempts have been made at modelling the behavioural change *process*. One of the most influential models is the trans-theoretical model for behavioural change (Prochaska & DiClemente, 1992; Prochaska et al., 2008) developed in the health domain. It models behaviour change through five consecutive phases that range from raising awareness ('precontemplation') to eventually creating new habits. While Bamberg (2003) has applied this model to environmental behaviour, it has not yet been applied to water saving behaviour. In SmartH2O we have applied and adapted this model to match the cognitive and motivational processes of water consumption. In doing so, we acknowledge that the behavioural change process is not completely linear, as users can and will relapse to earlier phases. Second, following Noël (1999), we postulate that users progress gradually from one stage to the other, rather than phases being strictly separated. Third, the pre-action phase and action phase are merged, arguing that the promoted change of behaviour is relatively small, and involves too little (or no) planning to justify a separate phase (in contrast to behaviours for which the model was originally developed). Finally, the first two phases are renamed to reflect the limited explicit cognitive effort usually invested in water consumption behaviour. Table 1 outlines the character of the individual behavioural change phases and the main issues that need to be addressed in each phase in order to stimulate a change in behaviour. The table forms the basis for the design and implementation of incentive elements and mechanisms, as described in the next chapter.

Table 1.Multi-stage behavioural change process model for water saving (phases, goals, needs).

BEHAVIOURAL PHASE & STATE	MAIN ISSUES & NEEDS
Pre-contemplation: people unaware of the need for behavioural change; no intention to change their behaviour *Motivational goal* Plant the seed" to acknowledge problematic water consumption behaviour	• *Moving from habits to active thought.* Habits are automatic behavioural tendencies that arise as a result of repetition and practice of actions in similar situations (Ouellette and Wood, 1998). Habits have a strong influence on water consumption behaviour (Jorgensen et al., 2009; Fielding et al., 2012). "Unfreezing" these habits is important, since water consumption is predominantly habit-driven and users first need to be motivated to expose themselves to information about their consumption. • *Negative environmental consequences* of consuming too much water need to be visualised to make negative environmental consequences of consuming too much water visible (e.g. Corral-Verdugo et al., 2003). • *Social norms are unclear or negative.* That is, users are unaware about the prevalence of water saving behaviour, and how users judge water saving.
Contemplation: people aware of the need for change, and intend to act; the consideration/identification of appropriate actions and their benefits can result in postponing the behaviour *Motivational goal* "Tip the balance in favour of change"	• *Provide factual knowledge about water.* In this phase, factual knowledge about water consumption and water behaviour can contribute to more positive attitudes towards saving water. • *Emphasize limited impact on hedonic values.* Goal framing theory (Lindenberg & Steg, 2007) suggests that it is important to demonstrate that hedonic values (to e.g. comfort and enjoyment) are not impacted by water saving actions, or that personal gains can be achieved in exchange for only a slight reduction of comfort (e.g. reducing shower time by one minute).
Action: people start taking small steps through first actions; need to be prevented from slipping back, requiring continuous reinforcements *Motivational goal* Reinforce sustainable water consumption	• *Increase perceived behavioural control.* Survey research has demonstrated that in the Sydney area 31% of the respondens were unaware of how to save water, suggesting that users should be provided with actionable tips to save water (Randolph & Troy, 2008). • *Provide positive reinforcements.* In line with classical reinforcement theory (Skinner, 1957) positive reinforcements with social, virtual or physical rewards water is expected to keep users engaged with water saving.
Monitoring: people have changed their behaviour; need to be aware of situations that may slip them back to old behaviour *Motivational goal* Maintain durable intrinsically motivated behaviour change in water consumption	• *Build new habits*. This phase should be focused on internalizing the new behavior into new habits, and that it becomes part of the individual's self. Users need to become intrinsically motivated to save water, without relying on external rewards. • Keep engagement. In this phase, it is also important to keep users engaged with water consumption. Ai He – in the context of energy behaviour – suggest to keep a cycle of interest, curiosity, challenge, feedback, and enjoyment. This cycle reflects the incentives provided in SmartH2O.

4 DESIGN OF THE INCENTIVE MODEL FOR WATER SAVING IN THE SMARTH2O SYSTEM

The incentive model for stimulating water saving with the SmartH2O system employs multiple motivational mechanisms orchestrated to reinforce each other and to cover all phases of the behavioural change process. The mechanisms include interactive water consumption visualisations, water saving tips, goal setting, different types of gamified incentives (personal, social, virtual, physical) and a hybrid physical-digital card game. The water consumption visualisations are designed to raise awareness about water consumption and point out the consequences of the current behaviour in early phases of the process. In later phases, continuous feedback helps to keep the user's attention. Water saving tips aim at facilitating transformation of favourable attitude towards water saving into concrete actions. Gamified virtual, social and physical rewards can motivate users by appealing to basic human needs, such as a sense of achievement and competitive comparison. Rewards help to reinforce positive water saving behaviour. Goal setting provides users with a sense of achievement, increases commitment and helps to establish new habits. Finally, the hybrid physical-digital card game extends the reach to the whole household, by first creating awareness in the whole family, subsequently giving tips to save water and then using the game playing to nudge the family into using the SmartH2O system. The roles of the individual elements across the different behavioural change process phases are outlined in Table 2.

Table 2. Incentive model elements with respect to behavioural change phases.

Functionalities	Pre-contemplation	Contemplation	Action	Monitoring
Interactive visualisation and monitoring of water consumption	*Mechanisms* • Raise awareness through water consumption feedback • Enable social comparison with neighbourhood averages • Highlight negative consequences by visualising longer-term effects • Unfreeze habits by increasing knowledge on water consumption	*Mechanisms* • Water consumption feedback makes users more favour-able towards saving water • Green and red flash lights indicate the right thing to do	*Mechanisms* • Water consumption statistics demonstrate necessity to start saving water now	*Mechanisms* • Water consumption statistics demonstrate necessity for actions to save water
	Motivational affordances • Visualisations designed for hedonic quality increase engagement with saving water • Daily feedback continuously raises attention to water consumption during behavioural change process			
Water saving tips	*Mechanisms* • Tips increase user's responsibility: what can the user *do* to save water?		*Mechanisms* • Actionable tips to save water give a sense of control over own consumption	
	Motivational affordances • Points are awarded for viewing tips and videos (see virtual/social/physical rewards)			
Virtual, social, and physical rewards	*Motivational affordances* • Gamified elements continuously reinforce user engagement with water saving • Points, badges and being on the leaderboard offer a sense of achievement • Leaderboard offers opportunity for social comparison with other users • Physical rewards engage users who are less appealed by game elements			
Setting water consumption goals			*Mechanisms* • Self-set goals create commitment to saving water / repeatedly achieving saving targets fosters new habits	
			Motivational affordances • Points for setting and achieving goals	
Hybrid online and card games (Drop! The question)	*Mechanisms* • Quiz questions raise awareness, increase knowledge and thinking about water within the household	*Mechanisms* • Game roles establish the norm: saving water is right thing to do.	*Mechanisms* • Saving tips give a sense of control of their consumption	
	Motivational affordances • Fun-of-use of the game increases household engagement with water saving • Game enables social learning between family members and motivates to use the SmartH2O portal			

4.1 Interactive visualisation and monitoring of water consumption

The use of visualisation as a means of stimulating behaviour change for water saving has been investigated by different approaches (e.g. Froehlich at al, 2012). Its effect on user behaviour can be attributed to the effect of feedback on underlying beliefs and attitudes towards water saving (Fielding et al., 2012) and its impact in the different *behavioural change phases* (Table 1, Table 2). While different approaches have employed different types of visualisations with varying success (Micheel et al., 2015), a systematic approach incorporating the lessons learned has not yet been reported. We have synthesised these lessons into design guidelines for consumption visualisation for behavioural change in Micheel et al. (2015). In the resulting SmartH2O model, water consumption visualisation has two elements (Figure 1). The first one visualizes the user's water consumption as bar charts, over different time spans. It includes the average consumption level of their neighbourhood (social comparison). The second element displays user's water consumption levels in a pipe filled with water (Figure 1). The historical baseline value depicted with a dashed line provides a point for reference for the consumed quantity (historical comparison). Users are encouraged to save water with the display of water saving levels of 5%, 10% and 15%. Benchmarks for comparison are important, as they allow users to judge if their consumption is "normal", excessive or economical (Froehlich, 2012), attributing meaning to their behaviour. The green or red light on top of the water pipe also gives an injunctive normative message. If consumption is lower than the historical base value, the light is green and a positive reinforcement message is displayed. Otherwise, a red light and a warning message are displayed. The effect of current consumption extrapolated over a year is also displayed as a number of swimming pools filled with water. This can raise awareness about the negative consequences of the current behaviour, important for supporting the pre-contemplation phase (Bamberg, 2003).

Figure 1. Interactive water consumption visualisation and monitoring.

4.2 Water saving tips

A significant share of consumers is unaware of how they can save water (Randolph & Troy, 2008). It is thus not surprising that providing water saving tips can induce behaviour change. Fielding et al. (2013) have demonstrated that showing users how to save water indeed leads to lower levels of water consumption. In SmartH2O, both brief textual tips and engaging videos are available, that demonstrate how exactly water can be saved. The theory of planned behaviour (Ajzen, 1991) and self-efficacy theory (Bandura, 1977) suggest that the user's self-confidence about performing the desired behaviour affects the likelihood of actually starting to save water. Water saving tips are included in the SmartH2O incentive model to increase the user's confidence on being able to save water. This is important for the pre-contemplation phase where users need to be persuaded that they can do so and in the action phase where users must get support to put their positive attitudes into practice.

4.3 Reinforcements through virtual, physical and social rewards

The SmartH2O incentive model draws on gamification to increase awareness and engagement with water efficiency. Gamification is the use of game design elements in non-game contexts (Deterding et al., 2011). While gamified approaches to change water behaviour are under-investigated, in the energy domain they are more widespread. Studies in the latter domain have shown that not only real prize-like rewards but also gamified social interaction can foster behaviour change, through competitive and cooperative approaches (Micheel et al., 2015). Our incentive model awards points and badges for specific user actions, while a leaderboard is used to stimulate competition and comparison between users. It is designed to appeal to both intrinsic and extrinsic motivations. Intrinsic motivation is stimulated by allowing users to show their ability to themselves and to others (need achievement theory, Atkinson & Litwin, 1960). Points (virtual rewards) are given and displayed for various actions. They can be collected in four different thematic areas: water saving (reducing consumption), water efficiency education (e.g. reading tips, watching videos), data collection (providing details about the household) and participation (e.g. posting results to social networks). Achievement is awarded with thematic badges: e.g. reaching the first 1000 points in the water saving area, users get the "smart saver"-badge. Top achievers are displayed on weekly and overall leader-boards, exploiting social comparison to induce behavioural change.

Extrinsic motivation is encouraged with physical rewards, in two versions. In the Swiss pilot (small scale, up to 400 households), physical rewards can be collected continuously by reaching a certain level of points. They consist of the Drop! card game and water saving gadgets (e.g. efficient shower heads). In the Spanish pilot, rewards are given at three moments in time. Initial engagement is encouraged by granting a reward (the Drop! card game) after a set amount of initial user activity. To encourage ongoing engagement, every week the top user on the weekly leaderboard also receives a prize (two museum tickets). This scheme also reflects economic constraints on large-scale incentives (this pilot reaches up to 400k users), where a cap on the number of awards must be set. Finally, a small number of "big" prizes (high-end tablets) are awarded at the trial's end. Thus, users are encouraged to remain continuously active in both the short and the longer term. This acknowledges the reinforcement theory (Skinner, 1957; Richter et al., 2015), which demonstrated the need for continuous reinforcement to maintain the change in behaviour until new habits have been formed.

4.4 Setting water saving goals

Even though self-setting goals have shown promising results in energy consumption (e.g. Abrahamse, 2015), this has received less attention in the water domain. Goal setting provides users with a sense of achievement and increases commitment towards saving water, while supporting the formation of new habits. In SmartH2O, users can set weekly and monthly water saving goals at three different levels (5%. 10% and 15% reduction). More points are awarded for achieving self-established goals than for achieving the same reduction without setting the goal. The more ambitious the goal, the more points a user will receive. The impact of a goal is visualized by showing how many bathtubs filled with water one would save if the goal is achieved for one year's time (Figure 3). Demonstrating how much one can save results in increased awareness of the consequences, a higher self-efficacy and a higher responsibility. Achievement of the goals motivates users intrinsically, as it strengthens their feeling of competence and mastery (Deci & Ryan, 1985). Finally, goal-setting is linked to the gamification incentives: achieving goals yields points, which results in social recognition when the user gets visible on either the weekly or global leaderboard. These social rewards are expected to further motivate the user and increase intrinsic motivation (Deci & Ryan, 1985). This supports the formation of new habits (Dahlstrand & Biel, 1997), which contributes to the sustainability of the behavioural change.

4.5 Incentivizing water saving by playing a hybrid online and card game

A hybrid physical-digital card game 'Drop! The question' (Fraternali et al., 2015) was designed to raise water saving awareness and encourage social learning within households. This is important, not only as the composition of the household is a strong predictor of water consumption (Jorgensen et al., 2009), but also to influence the water conservation culture of the household (Fielding et al., 2012). The game is a hybrid card and mobile game for 3-6 players. The game features Lilly, a little girl who wants to save water, and a clumsy monster who keeps spilling water. Users take turns in drawing cards. For Lily cards, they get points; for monsters points are deducted, but this can be recovered by correctly answering questions in a mobile app after scanning a QR-code on the monster card (Figure 2).

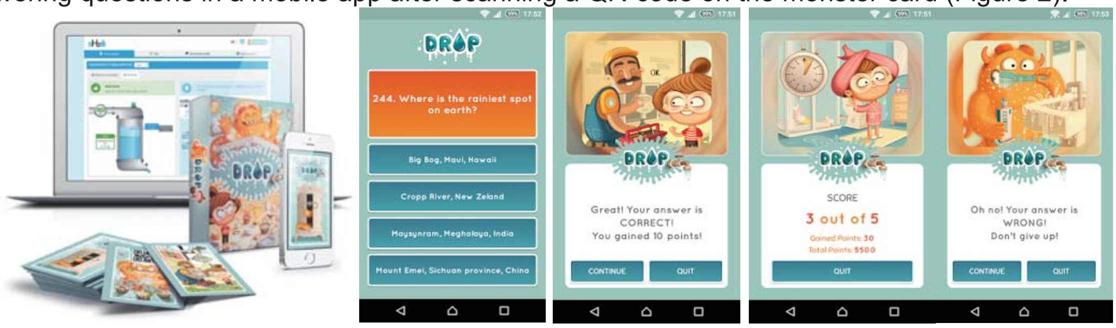

Figure 2. Drop! game integrating physical card game and mobile game.

Apart from the motivational effect of the card game, users are also incentivized to use the SmartH2O portal as correctly answered questions in the mobile app yield points on the portal. Playing the game and answering questions increases users' knowledge, which helps to create favourable beliefs about water saving. This supports the contemplation phase where users should be convinced that saving water is necessary and possible. It also stimulates the desire to act appropriately (Lindenberg & Steg, 2007), as the game associates water saving with achievement and water spilling with losing.

5 IMPLEMENTATION OF THE SMARTH2O INCENTIVE MODEL FOR WATER SAVING

The described incentive model has been implemented in the SmartH2O system in two different versions, adapted to two pilot locations (Table 3). The *basic portal* implements only the "pragmatic" elements, such as the interactive water consumption visualisations and water saving tips. The *gamified portal* adds goal setting and the full spectrum of gamified incentives and rewards (Figure 3).

Table 3: Different implementations and features of the pilots of the SmartH2O system.

	Swiss pilot (small municipality)	**Spanish pilot** (large city)
System version	Basic portal + gamified portal	Gamified portal
Potential reach	400 households with smart meters	400.000 households with smart meters
Main goal	Test system & incentive in small-size pilot	Large-scale impact assessment

The control of the delivery of incentives is implemented in the Gamification Engine (Galli et al., 2015) that transforms user actions into points based on a set of inputs and rules (parametric rule engine). The different inputs include consumption data from the smart meters, actions and points achieved in the Drop! mobile game and the user actions performed on the portal. The rules map individual actions (e.g. reading a water saving tip) and achievements (e.g. achieved consumption reduction) to the defined incentive elements through assignment of points and badges, which are in turn visualized (e.g. leaderboard, badges) or made transferrable into external rewards (e.g. prizes offered by the utility).

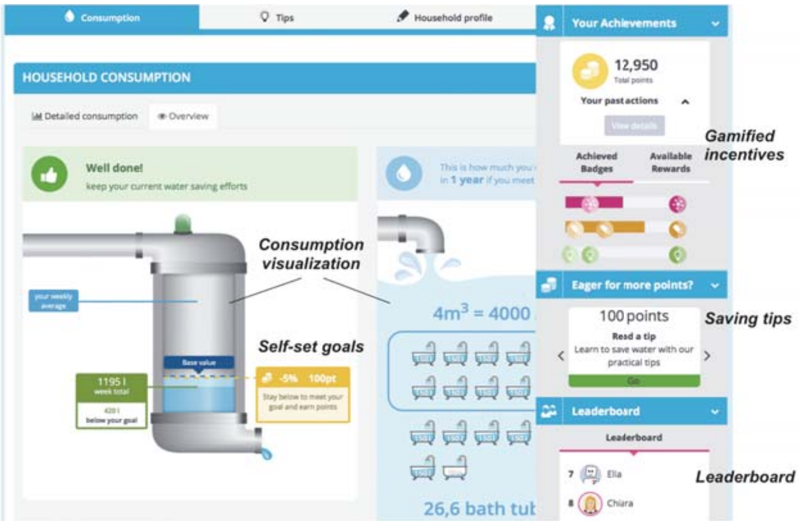

Figure 3. SmartH2O portal implementation (gamified version).

6 PRELIMINARY RESULTS FROM A SMALL SCALE PILOT

The SmartH2O system has been first deployed in a small-scale pilot in Switzerland from July ‘15 to February ‘16. A first basic version with consumption visualisation and water saving tips was available from July, followed by the gamified portal in December. After 4 months of basic portal trial with 40 users (households) interim results have been evaluated. User feedback was collected with an online questionnaire (n= 15 / 37,5% response rate). Responding to technology acceptance questions (UTAUT, Venkatesh et al., 2003) adapted to the water domain, most users found using the system made water conservation more interesting (11/15 users) and that using it was a good idea (9/15). Half of them found it fun to use (7/15), indicating that even a non-gamified system incentivizes use. Most replied that the system was easy to use (12/15) and easy to learn using (11/15), that interaction with the system was clear and understandable (9/15) and that it was easy to get skilful at using it (8/14).

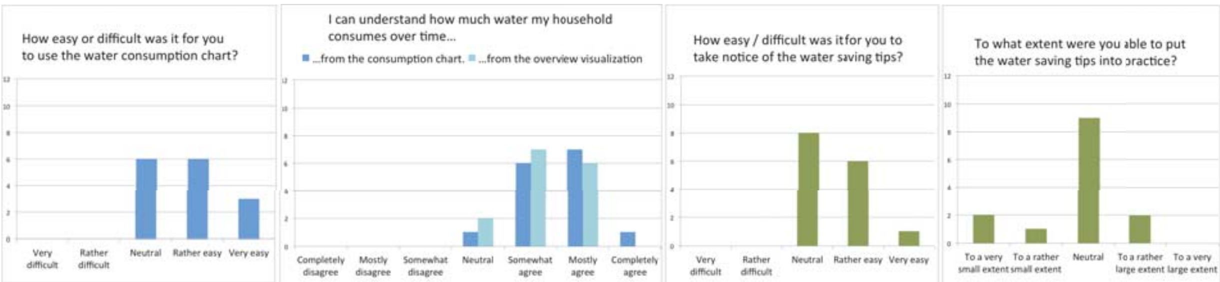

Figure 4. User response to consumption visualisations and water saving tips.

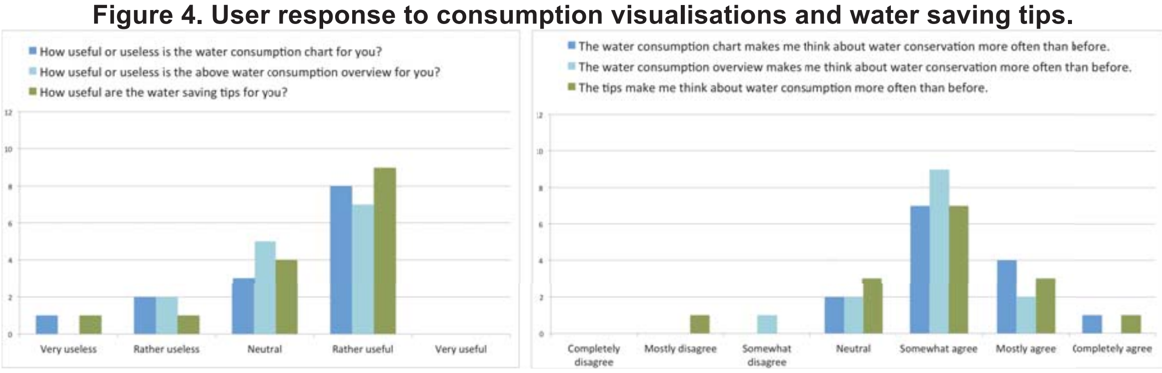

Figure 5. Perceived usefulness (l) and awareness increase (r) of main basic portal elements.

Most respondents found the interactive water consumption chart easy to use and nearly all respondents agreed that from the chart and the overview visualisations they could understand how much water their household consumed over time (Figure 4). They found the water saving tips rather useful, but were neutral towards the extent they were able to put them into practice. This was to be expected since the tips were of varying complexity and household characteristics. However, the impact of different water saving tips needs to be investigated in more detail in upcoming evaluations. The perceived usefulness of the three main elements (water consumption chart, consumption overview and water saving tips) was rather positive for most users (Figure 5, left). For all three features we also observed a positive perceived influence on increasing water saving awareness, as most users stated that they made them think about water conservation more often (Figure 5, right).

Consumption effects were measured with respect to a historical yearly baseline for each user. The average consumption reduction is 33.4%, with large individual differences. We have observed that the highest reductions are achieved by users with a low and medium consumption volume. It needs to be noted that 25-30% of measured reduction could be attributed to seasonal variations (e.g. Firat et al., 2009). If we discount the likely effect of the winter season on lower consumption, we can still observe a water consumption reduction that can be attributed to the use of the portal (3.4-8.4%, respectively). This first encouraging result needs to be validated once detailed consumption logs will be made available for the whole year, enabling us to make a meaningful comparison with the baseline.

The main objectives of this pilot phase have been to recruit and familiarize a core user group (in a rather conservative population) with the portal, upon which a larger active user base could be built in the pilot continuation. Recruitment campaigns resulted in 27 basic and 16 gamified portal users. To gain first insights into incentive dynamics, user activity logs (Dec'15-Feb'16) were analysed. After the launch of the gamified portal in December '15, little activity occurred on the basic portal (20 logins; m=0,74/user, sd=1,9), compared to the activity on the gamified portal version (292 logins; m=18,25/user, sd=42). This suggests that the gamification features prompted more interest, with activity peaking after a mail campaign to current users. Inspection of individual elements revealed that the consumption chart has been viewed and interacted with the most. Other key elements like the leaderboard, achievements and actions panels were also accessed more than once by over half of the users. Almost all gamified portal users collected badges (13/16). These indicators suggest that the gamified SmartH2O system appeals to this first user base, and that the incentive model is capable of motivating users to access and use it, and thus to engage with water consumption information.
The logs also revealed several clear lead users (high activity), with quite different usage patterns. For example, one lead user earned all his badges within a very short time, and after a short period of intense usage claimed the available rewards all at once, shortly after earning the necessary points. Yet he continued to login frequently and view his consumption chart and checking the leaderboard during most visits. This suggests him being intrinsically motivated by the combination of consumption feedback and gamification features. Another user earned his badges within a very short time, too, but continued to frequent the portal at a moderate pace until he reached enough points to redeem the main reward. Shortly after, he stopped using the portal, which suggests that his usage was mainly driven by the high external reward. Interestingly, this user achieved only 18% consumption reduction, compared to 52% of the other lead user, not driven primarily with external rewards. Such observations suggest that the designed incentive model is versatile enough to stimulate different types of users. The overall results suggest that even with a small user community and a short period for the incentive model to yield effects, the system was able to induce different participation dynamics and a reduced consumption. Differences in responses to the incentive model highlight the importance of a holistic approach comprising different motivational affordances to support behavioural change for all users.

7 CONCLUSIONS

The preliminary results of applying the described incentive model for behavioural change in the SmartH2O system and its small-scale pilot suggest the suitability of the designed incentive model and its systematic alignment with the adopted behavioural change process. The observed positive effects on water consumption and user attitudes will be more closely assessed in the continuation of the Swiss pilot aiming at enlarging the user base, and in the large-scale Spanish pilot being deployed.

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