CeADAR – Centre for Applied Data Analytics Research

Enterprise Ireland Data Analytics Technology Centre

Changing User Behaviour Based on Analytics - State of the Art Review

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ABSTRACT

In this review, we discuss the task of changing user behaviour based on analytics. We discuss the role of feedback, both as a means of allowing a user the ability to change, as well as the motivation to do so. The role of comparative social feedback is found to be important in motivating change, particularly when the participants are involved in direct competition through the use of social media. The motivation or ability to change is typically not sufficient on its own to promote a variation in behaviour and requires a further factor: a trigger. This trigger, however, must be well-timed so as to avoid frustration on the part of the user. The use of gamification, involving game dynamics, can be used to entice people to keep engaged with a program once a threshold of performance is reached as continually emphasising a desired improvement over historical performance may otherwise result in

frustration on the part of the participant. We will focus on the field of Sustainable Human-Computer Interaction (HCI) due to the initial presence of two energy-focused organisations (Climote, Cylon) as industry partners but also because of the large body of work on behavioural change that has already been done in this field. The conclusions drawn from our review of Sustainable HCI, in terms of promoting behavioural change, are applicable to many different domains.

Contents

1 Introduction

To change human behaviour, one must first attempt to understand the drivers of that behaviour. One of the pioneers in this field has been B.J. Fogg [12], whose behavioural model includes three factors that must always be present for a person to perform a target behaviour: he or she must (1) be sufficiently motivated, (2) have the ability to perform the behaviour and (3) be triggered to perform the behaviour. In order to investigate how this model (or elements of it) can be applied in the real world, we will focus, in this review, on the field of Sustainable Human-Computer Interaction (HCI). We do this due to the initial presence of two energy-focused organisations (Climote, Cylon) as industry partners but also because of the large body of work on behavioural change that has already been done in this field. In the rapidly expanding field of Sustainable Human-Computer Interaction (HCI), research is undertaken at the intersection of people, technology and environmental concerns [7]. A significant proportion of this research is devoted to encouraging people, through the use of persuasive technology [11] and monitoring devices, to change their behaviour and live in a more sustainable way. It is our contention that the conclusions drawn from our review of Sustainable HCI, in terms of promoting behavioural change, are, in any case, applicable to many different domains.

2 The Effect of Feedback

Ultimately, in order for a user to change their behaviour, in this case their behaviour in terms of sustainable energy use, they first need information or feedback on their everyday usage. In reference to Fogg's behavioural model, this will provide the user with the ability to change their behaviour.

This feedback can take the form of either direct feedback or indirect feedback. In direct feedback, the feedback can come from a number of new monitoring devices for the home. For example: (i) direct display monitors that provide instant feedback on electricity use in kWh and cost in cents, e.g. The Energy Detective [19]; (ii) interactive feedback via a PC, e.g. Holmes [8]; (iii) ambient displays, such as Wattson [9] or the Energy Orb [6] or; (iv) Cost Plugs on appliances, e.g. the Kill-A-Watt device [15] which provides energy usage for appliances plugged into the proxy outlet.

In indirect feedback, by comparison, the raw data is externally processed by the relevant utility company and later sent out to customers electronically or by post. Indirect feedback can take the form of more frequent bills (by which a user can adapt their behaviour by reading and reflecting), frequent bills based on readings plus historical feedback, i.e. a temporal comparison by which a user can compare their usage at two different points in time and, finally, frequent bills based on readings with comparative feedback. In this last case, the comparative feedback is typically feedback about an individual household's performance relative to the performance of others in society (social comparison). A reduction in electricity usage of between 5-15% has been found with direct feedback, while the reduction in electricity usage with indirect feedback is lower at between 0-10% [5].

The best known example of using comparative (indirect) social feedback to change users' behaviour would be the series of programs run by the OPOWER utility company [17]. OPOWER

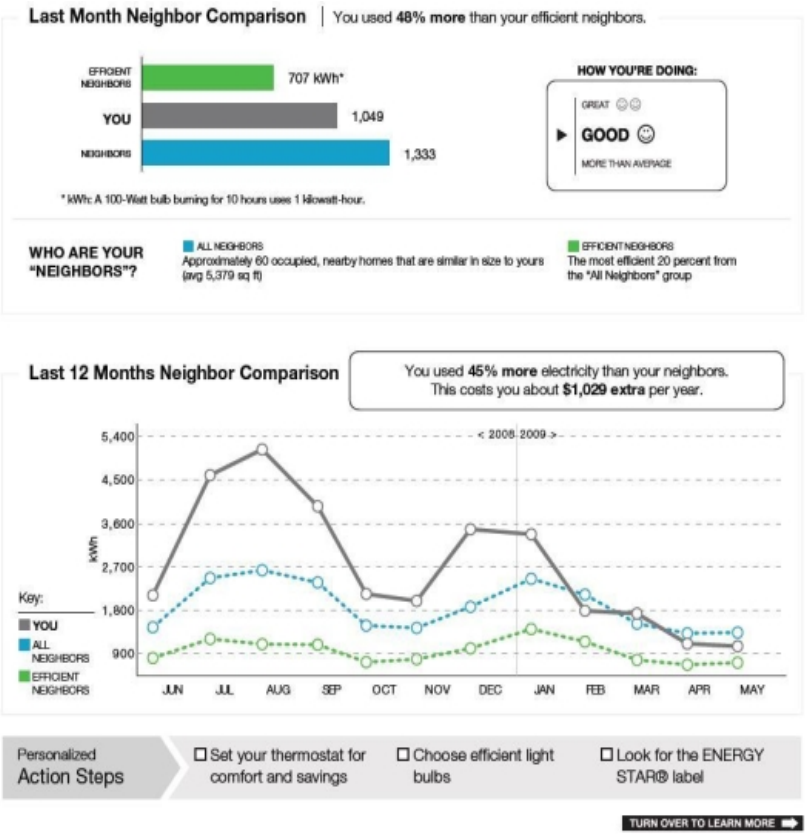

Figure 1: A typical OPOWER Home Energy Report showing the comparison with neighbours. Note the smiley faces used as a positive reinforcement of the message.

mails out Home Energy Report Letters that compare a household's energy use to that of similar neighbours (defined as 60 occupied nearby homes that are similar in size in terms of square feet) while also providing energy conservation tips (see Fig.1). It has been estimated [2] that OPOWER's programs typically reduce energy consumption by 2%. It is interesting to note that a similar program implemented by Camden Council in London, in relation to the use of gas, achieved a 6% reduction in gas demand through its district heating system by sending out household bills comparing a user's energy use to those in similar properties and by giving simple tips on how to save energy [17] .

3 Motivations for Behaviour Change: the role of feedback

Comparative social feedback has been shown to have a significant effect on energy usage, as we have seen. However, up to this point, we have only discussed indirect comparative feedback, e.g. the program implemented by OPOWER. The spread of "smart meters" [4], however, brings closer the possibility of widespread direct comparative (social) feedback. In this context, social media sites such as Facebook and MySpace, which have found wide adoption worldwide, provide new opportunities for communicating energy-related feedback to a larger social group, with a view to motivating behavioural change. Mankoff et al. [16] first proposed the use of information displays ("badges", modules, RSS feeds), that could piggyback on large networking sites like MySpace, which would show users information about how well they and the people in their social network were reducing their ecological footprint.

This idea evolved to StepGreen.org, an online community built to promote energy-saving behaviours by fostering public commitment and competition. Foster et al. [13] used an application called "Wattsup", which displayed live autonomously logged data from the Wattson energy monitor, to allow users to compare domestic energy consumption via Facebook. They found that an element of competition, engagement and banter helped motivate energy savings. Petkov et al. [18] in their study of energy conservation through feedback concentrated on four different types of social comparative feedback: (i) temporal comparison, i.e. an individual compares their performance at two different points in time (ii) normative, i.e. a social comparison in which an individual is compared to an average performance (statistically) of similar people, e.g. neighbours, etc.; (iii) one-on-one, i.e. a comparison between two individuals or households, etc., also known as "competition"; and (iv) ranking, i.e. an ordering of individuals and groups depending on their performance. Petkov et al. [18] developed a fully functional prototype of a mobile application called EnergyWiz that was Facebook enabled and which combined the four types of comparative feedback discussed above. They found from the 17 individuals involved in their test that temporal self-comparison was a "must-have" feature, that the similarity between the user and the people they compare to in terms of usage patterns is crucial in normative comparison, and that the one-on-one competition feature (by which users directly challenged their peers, especially friends) was undisputedly the favourite. It is interesting to consider why it is that social comparison is so successful in causing a change in user behaviour. Petkov et al. [18] speculates that this form of social comparison may be more effective than temporal self-comparison as it facilitates competition that taps into a user's intrinsic drive for knowledge and understanding as well as their extrinsic need for social recognition and status. It should be pointed out, however, that Petkov et al. [18], in their study, found that none of the participants mentioned social validation (doing what other people are doing) or recognition as their primary motive for comparison. The main motivations for comparison were instead found to be competition, e.g. competitively comparing energy usage with friends, etc., curiosity about how the neighbours were doing, learning and improving, e.g. through tips and advice and feedback from the monitoring devices, and benchmarking (comparing oneself with "neighbours", i.e. those with similar consumption patterns).

The nature and design of the feedback system are also important. Froehlich [14] mentions ten different design dimensions for feedback systems. These are:

(i) the frequency at which a feedback system updates; this appears to increase an individual's consciousness about the consequences of their actions;

(ii) the measurement unit used, i.e. kWh, dollars/hour or the amount of CO_2 produced (Petkov et al. [18] found that those who primary motivation for conservation was saving money were interested in energy consumption priced in dollars while those with a pro-environmental motivation varied between kWh and amount of CO_2);

(iii) the data granularity, i.e. the resolution and scope of the data, e.g. this may be in terms of time (consumption per month), space (specific rooms, etc.) or specific source (refrigerator, washing machine, etc.);

(iv) the push/pull of data, i.e., should information always be available (e.g. via an LCD display in the kitchen), only inform the user when excessive usage has been detected

("push") or only be available through a portal or a website that must be explicitly navigated ("pull");

(v) the presentation medium, e.g. the use of paper or electronic displays;

(vi) the location of the feedback, i.e. the feedback may be highly localised, (e.g. on the appliance itself) or completely independent (e.g. via an internet portal or paper bill). McCalley & Midden (2003) gave consumers immediate feedback about washing machine energy usage via an attached control panel and found a 21% reduction in energy use;

(vii) the visual design, e.g. a household's reaction to a particular feedback message depends on the overall aesthetic of this message, its comprehensibility, the choice of graphs, the measurement units used and the choice of wording;

(viii) the recommended action, i.e. the use of the written or verbal messages (called prompts) to promote conservation, e.g. "Use energy wisely", etc. Investigations into general prompting strategies have shown it has limited influence on behaviour but can be made more effective by improving specificity, timing and placement [14] ;

(ix) the comparison used, e.g. providing methods for consumers to compare their current performance to past performance. In addition to self-comparison, there is also social or normative comparison, as mentioned above. Fischer [10], in a review on feedback, found that none of the twelve studies that incorporated normative comparisons could demonstrate an effect. She offers that, "while [normative comparisons] stimulates high users to conserve, it suggests [to] low users that things are not going so bad and they may upgrade a little. These effects probably tend to cancel out each other.";

(x) the role of social sharing, e.g. the role of Facebook and other social sharing sites in supporting social issues, e.g. grassroots political campaigning, sustainability, etc. A number of studies ([16], [13], [18]) have shown the effect social media can have on reducing energy consumption, e.g. Foster et al. [13] measured a reduction of 130 kWh in eight homes over an eighteen day period when social comparison information (i.e. participants could access each other's data) was made available via Facebook during those days.

4 Triggers

An important factor in producing behaviour change is the trigger ([12]). Without an appropriate trigger, behaviour change may not occur even if both motivation and ability are high. Fogg [12] defines three kinds of triggers for three different contexts:

(i) sparks - a motivating trigger, applied where there is high ability but low motivation, e.g. videos that inspire hope or pity (charity ads)

(ii) facilitators - enabling triggers, applied where there is high motivation but low ability, e.g. software updates often use facilitators to gain compliance by implying that one click is all that is needed to get the job done.

(iii) signals - a prompt, applied where both motivation and ability are high, e.g. a traffic light

If one of these three elements is missing, the behaviour will likely not occur. Timing of a trigger is critical in terms of successfully engaging someone in a behaviour and the participant's

experience. For example, if we want to perform an action, a timely trigger is welcome. However, if our motivation is low, a trigger can be distracting. Similarly, if we want to perform an action but lack the ability, then a trigger can lead to frustration.

It should be pointed out that computer systems often cause a lot of frustration through the triggering behaviour they adopt. For example, spam and pop-up ads are triggers but they rarely convert a user's behaviour because a user will have a low motivation to do what they say. The choice of trigger, to accompany a suitable motivation, therefore, will be a crucial element in achieving any required behavioural change.

5 Gamification

A key point in this work is working out how to entice people to keep engaged with a program of energy saving, or indeed any program in which one is attempting to change a user's behaviour. For example, one problem with using comparison as a motivator is that eventually a threshold of performance is reached and continually emphasising a desired improvement over historical performance may result in frustration [14]. As Petkov et al. [18] point out; receiving rewards for reductions in consumption will not be effective in the long run since users will likely reach their acceptable minimum at some point and, from then on, will be unmotivated to keep playing. One way to keep users' interest is to use game dynamics or gamification, Gamification is the application of the mechanics of gaming to non-game activities in order to change people's behaviour. The overall goal of gamification, which is a marketing discipline that borrows key concepts from a number of related areas including game design, customer loyalty programs, behavioural economics and community management, is to engage with customers and to get them to participate in some activity or community [3]. Bunchball [3] define "game mechanics" as the various actions that are used to "gamify" an activity, while the motivational impulse for engaging in this activity is defined as "game dynamics". Game mechanics would include things like points, levels (ranking), challenges (trophies, badges), leaderboards, and competitions. Game dynamics would involve things like rewards, status, sense-of-achievement, self-expression (tying into the human desire to show off a sense of style, identity and to show off an affiliation with a group), competition and altruism, i.e. all those things that would motivate or compel someone to engage in the "game". As shown in Foster et al. [13] , an element of competition, whereby customers challenged each other to lower their electricity use, helped motivate real energy savings. Petkov et al. [18] suggests keeping users' interest by using rewards such as frequent flyer points, status schemes, and by trying to get more from the integration with Facebook apart from wall posts and group discussions. It is interesting to note, however, that the use of rewards, particularly monetary rewards, while encouraging energy conservation at first, has been shown to have short-lived effects, e.g. there is some indication of the effects disappearing as soon as the monetary intervention is discontinued [1]. Based on the above discussion, it is likely that some elements of gamification will have to be included in any attempt to change user behaviour in the long term, with the use of competition (social comparison) being the most obvious early candidate for this. Other elements such as the integration of social media platforms and the use of points, leaderboards, etc. are things that could be explored as the project progresses.

6 Conclusions

We have discussed above the role of feedback, both as a means of allowing a user the ability to change as well as the motivation to do so. The role of comparative social feedback would appear to be important in motivating change, particularly when the participants were involved in direct competition through the use of social media. The motivation or ability to change are sometimes not sufficient on their own to promote a variation in behaviour and require a further factor: a trigger. This trigger, however, must be well-timed so as to avoid frustration on the part of the user. A further factor that must be taken in consideration is the fact that, for example, by using comparison as a motivator eventually a threshold of performance is reached and continually emphasising a desired improvement over historical performance may result in frustration. This is where the use of gamification comes in, by using game dynamics in a bid to entice people to keep engaged with a program.

The task of changing user behaviour based on data analytics, particularly in the field of home/business energy use is a new and evolving research area. As Froehlich [14] puts it, "as the cost of home energy sensing decreases, we will see a huge upsurge in the amount of data available to be visualised and fed back to the consumer about their energy usage." The challenge for CeADAR is to find ways to process this "huge upsurge" in information so as to provide useful insights into consumers' behaviour and by doing so allow customers themselves the opportunity and incentive to change that behaviour. It is towards answering this research question that the research in CeADAR is being undertaken.

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