BEYOND THE WATER EFFICIENCY CALCULATORS

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ABSTRACT

Evidence suggests that since water shortages are partly rooted in human behaviour, the environmental impact can consequently be managed through behaviour change. Before behaviour change can occur the existing behaviour must first be observed, and the influences understood. Even though research in environmental behaviour is abundant, past studies attempting to link psychological variables to conservation behaviour are thought to have produced mixed, inconclusive findings. Moreover, most of this research has concentrated on recycling and energy conservation, and there are still few studies investigating the combined physical, sociological and psychological aspects of household water usage to a sufficient level of detail and granularity.

This paper presents findings of an initial review of behavioural theories and models in existing literature learning from the broad evidence in resource efficiency studies for specific applications to water efficiency. The paper concludes with an integrated framework for the design and delivery of water efficiency interventions. This framework will provide the theoretical basis to a study which aims to propose a simplified intervention approach that integrates the physical, sociological and psychological influences in water efficiency interventions.

The resulting framework is also beneficial in the wider context to align detailed and accurate water end use data with a range of socio-demographic, stock inventory, residential attitude and behavioural factors. This will aid the development of tools and techniques that are capable of revealing the determinants of water end use. This will contribute to even more robust understanding of water demand and inform the design of effective water use interventions.

Keywords: Behaviour, Demand management, Domestic, Framework, Water Efficiency.

INTRODUCTION

The inefficient use of water combined with environmental factors such as climate change contributes to the increasing stress of water resources in parts of the UK in the future (EA 2011). The need for improved and efficient water resource management within the UK is therefore apparent. The long term uncertainty of supply and the continuous need to

manage demand and efficient water use supports the need for water efficiency practises across the supply and demand spectrum. The strategies for promoting water resource efficiency require a multi-faceted approach, that is; water efficient policy and regulations, water efficient planning, water efficient buildings, water efficient products, and water efficient people. The role of the user is widely accepted to be crucial for achieving any resource efficiency goal (Korfiatis *et al* 2004). Understanding the propensity, tendency and motivations of the water user is also important for the design and implementation of water efficiency interventions. This knowledge is particularly useful for policy makers to define groups who are both active and less enthusiastic with regard to saving water (Gilg 2004).

In addition to policy aimed at understanding users and promoting behaviour change, policy and legislative instruments also target building design and systems particularly in buildings to ensure that buildings deliver the baseline targets for water efficiency. Section 7 and Part G of the current Building regulations in England and Wales (HMGovernment, 2010) specifies this baseline requirement. The water efficiency requirement in this instrument is further supported with the water calculator (BRE 2009) and other assessment methodologies to aid designers, specifies and building providers in their efforts to comply. These tools also provide good estimations of the potential water savings that can be derived through first design or retrofitting water saving fixtures and fittings in a house. The main criticisms of these tools and assessment methods are that the evidence used in the algorithms often rely on average use factors, whereas water conservation technologies are susceptible to the bias of human judgement and rely on human interaction to conform to the desired behaviour (Corner, 2012; John, 2011).Also, they often disregard the unpredictable use of water or the variability in household in location, community attitudes and behaviours (Corral-Verdugo *et al*., 2003; Turner *et al*., 2005; Stewart *et al*., 2011). Therefore, this bias towards water conservation technologies as the sole means of achieving water efficiency in buildings does not always guarantee actual water savings.

Research into environmental behaviour is abundant, however past studies attempting to link psychological variables to conservation behaviour are thought to have produced mixed or inconclusive findings (Cook & Berrenberg, 1981; Stern & Oskamp, 1987). Therefore, the understanding of what determines or informs water use behaviours by water users will contribute to a more robust evidence base for water demand forecasting and management which will be beneficial for informing government and water company instruments but more importantly, empower water users to make personalised appraisals towards the design and implementation of water efficiency interventions to suit their needs and preferences.

BEHAVIOURAL MODELS

How behaviour is formed is a key step to understanding consumer behaviour (Sofoulis 2005). Previous research and the resulting models demonstrate the factors and associated

relationships that generate behaviour (Jackson, 2005). This review presents four of the primary environmental behaviour models; Rational choice model (Simon, 1955), Reasoned model (Ajzen and Fishbein 1980), Interpersonal model (Triandis 1977) and the Gregory model (Gregory 2003) . It then explores the key characteristics and limitations of each of the models.

The rational choice model

The rational choice model first outlined by Simon (1955) suggests that human beings behave in such a way to maximise the expected benefits from the actions (Jackson, 2005). The model suggests that the consumers' pro-environmental choices require that sufficient information must be provided to make informed decisions. However, Jackson (2005) noted that the private decisions of an individual does not always account for social influences or wider interests, which have been proven to have an effect on personal behaviour. One central criticism of this model is that it overlooks cognitive deliberation, and disregards mental short cuts such as habits, routines and cues, which are proven to reduce the effect of cognitive deliberation. Another is the assumption that self-interest provides the foundations for human behaviour, where in fact social, moral and altruistic behaviours also form human behaviour.

The reasoned model

One of the best known attitude behaviour models is Ajzen and Fishbein's (1980) theory of reasoned action. The reasoned model assumes that all behaviour is formed from intentions to perform specific behaviours, and that these intentions are formed from the relative importance of attitudes, subjective norms, suggesting that factors external to cognition have a role on behaviour formation (Jackson, 2005). Some criticisms of the reasoned model are the distinction between subjective, moral and personal norms. However, Fishbein and Ajzen (1980) suggest that personal norms are essentially subjective behavioural beliefs whilst others argue that moral and personal norms need to be considered as separate components of the model (Jackson, 2005). Furthermore, this model fails to acknowledge the diversity of cognitive deliberation. It also ignores the role of habits, routines and cues and their influence on behaviour. Nonetheless, the reasoned model has been applied to many areas of research with feasible research outcomes (Leonard, 2004).

Interpersonal model

First outlined by Triandis (1977), the interpersonal model is a multidimensional model incorporating both internal and external influences on determining behaviour. As with the reasoned model, intentions are the primary antecedents of behaviour (Jackson, 2005). The interpersonal model also seeks to verify that the conditions exist to facilitate the intended behaviour. According to this theory, behaviours are neither fully deliberative nor automatic, nor they are influenced by moral beliefs but the impact of these is moderated by emotional drives and cognitive limitations. The limitations of this model is that as with the reasoned and rational choice models it follows a linear formation process, assuming that intentions and habits are not influenced by one another. The interpersonal model also

assumes that the facilitating conditions only enable the desired behaviour and does not influence any factors contributing to the behaviour.

The Gregory model

As every student of psychology knows, explaining human behaviour in all its complexity is a difficult task (Ajzen, 1991).The Gregory model begins to address some of the limitations of the previous models. The model considers relationships to be non-linear with defined feedback loops between behaviour and influencing factors. It also suggests that influences can change as the effect of behaviour changes. The initial research framework conducted into environmental behaviours as developed by Gregory (2003) presents the impact of stimuli and influences on behaviour (Ronis, 1989). It utilises factors such as awareness, unreasoned influences (cognitive processes), reasoned influences, and situational influences (e.g., income, family size) to explain behaviour. This framework is supported by previous research which suggests that behaviours may be a function of both reasoned influences (e.g., attitudes, intentions) and unreasoned influences (e.g., habits; Aarts, 1998; Thogersen & Moller, 2008).

Discussion of the models

The four models explored in this review demonstrate similar yet unique methods of understanding behaviour. Table 1 illustrates the four models and the behavioural influences of each model.

Table 1 - Review of behaviour and influence models

	Rational choice	Reasoned	Interpersonal	Gregory
Attitude		✓	✓	✓
Intention	✓	✓	✓	✓
Subjective norm		✓	✓	✓
Social factors		✓	✓	✓
Affect			✓	✓
Habits		✓	✓	✓
Facilitating conditions	✓		✓	✓
Reflexes				✓
Awareness	✓			✓
Involvement				✓

The rational choice model has the fewest considered influences, yet it is widely used by western policy makers (Hassell, 2007). Triandis (1977) developed the interpersonal model, in response to the limitations in the rational choice model. The interpersonal model thereby incorporates habits, routines and cues as the well as facilitating conditions. However it does not consider the role of awareness or individual role of each component. The Gregory model combines several models to create a generalisation of the role of stimuli (awareness in pro-environmental fields), unreasoned influences, reasoned influences and situational influences in forming behaviour. Environmental decisions can be considered on a scale ranging from purely habitual to purely cognitive.

FUNDAMENTAL INFLUENCES IN DOMESTIC WATER USE

Water consuming behaviour is a mixture of self-interest and pro-social motives (Bamberg, 2007). This suggests that cognitive evaluations can be supplemented by habits and even override the attitudinal and subjective norms influencing behaviour (Thogersen & Moller, 2008). Therefore, the proposed research framework includes an additional relationship between cognitive evaluation and subjective norms. However, an understanding of the determinants affecting water consumption in domestic properties is required to develop a new domestic water behaviour framework. These can be broadly described under two categories; behavioural influences and environmental influences.

Behavioural influences

Behavioural influences consist of awareness, attitudes, habits, belief amongst other factors. According to Gregory (2003), an important first step towards understanding the impact of human behaviour on the environment is awareness. This enables an individual to consciously accept and process informational cues. The awareness of an individual can inform and alter the attitudes and habits of the individual. Whereas, Cottrell (2003) suggests that attitudes provide a better understanding of why people do what they do. Korfiatis *et al* (2004) determined that attitudes towards environmental issues were in fact reliable predictors of environmental behaviour. However, the knowledge itself does not automatically lead to environmentally conscious behaviour (Pelletier *et al*, 1998). It is also probable that habits, recurrent practice or patterns of behaviour (Aitken, 1992), impact on the knowledge to behaviour gap. Habits are developed by extensive repetition, and are so well-learned that they require limited cognitive processes conscious effort (Ronis, 1989).

Whilst awareness attitudes and habits form elements of individual influences, socio-demographics have been shown to play a critical role as a situational factor for water consumption in domestic properties (Renwick and Archibald, 1998; Willis *et al*., 2009). Thus should be considered as indicators of residential water consumption (Inman and Jeffrey, 2006). Likewise beliefs, firmly held opinions or convictions, have been shown to form a precursor to environmental behaviour (Niemeyer, 2010). It has also been previously established that the attitudes and beliefs of consumers directly impact on water use behaviours which are closely linked to water demand (Hassell and Cary, 2007).

The engagement of an individual within a process, or the individual's involvement with water issues has also been shown to result in a higher level of awareness in local concerns and lower water consumption in washing machines (Gregory and Leo 2003). It is clear that increased stakeholder involvement in environmental decision making does increase the effectiveness and implementation of environmental decisions (Newig, 2007).

Behavioural influences demonstrate how individual's differences in behaviour can be created through internal factors, such as awareness, habits and engagement. However behaviour can also be effected by external factors that enable particular behaviours, these are commonly referred to as environmental influences.

Environmental influences

Environmental influences are widely considered to be situational or enabling influences on water consumption. For example, the quality of water supplied to the dwelling can significantly influence domestic water consumption as this will influence multiple other factors such as; attitudes, habits and preferences (Tebbutt, 1998). Regulations, policies and ordinances (e.g., water restrictions, local government planning regulations) can change the water consumption (Klein et al., 2006). For instance a hosepipe ban can be enacted to reduce external water consumption in the south east of the UK but not in the North West. Restrictions have also been found to be closely linked to the price of water, with consumers less responsive to restrictions when the cost of water is low or the cost of fines is low (Kenney et al, 2008). Although it is noteworthy that Worthington (2008) found that there appears to be very little correlation between the pricing of water and the consumption of water. Essential water use is often considered the reason for price inelasticity (Arbu´es etal, 2003).

Situational influences such as property characteristics affect the overall water consumption as the kind of homes people live in and whether they own or rent, influence how they perceive their water use (Randolph and Troy 2008). For example, a colder bathroom may result in a longer shower, as the hot water flows it warms the room thus making the shower more comfortable (Scott et al, 2009). Water metering provides enables consumers to reconsider their habits by providing information of how much water they are consuming enabling them (Randolph and Troy, 2008). Fittings are the source of water within domestic properties; therefore they have a significant impact on domestic water consumption. For example the use of efficient water appliances has been found to influence residential water consumption (Inman and Jeffrey, 2006). Likewise the ability to upgrade existing fittings influences the penetration of water efficiency technologies.

Environmental and behavioural influences clearly have a role on water consumption behaviour. A framework would provide a better understanding of the relationships between factors is useful.

BEHAVIOUR FORMATION FRAMEWORK

The proposed framework, illustrated in Figure 1, utilises the previously explored models and influences on domestic water consumption. It demonstrates the relationship between the individual influences and the overall formation of water consuming behaviour. This framework builds in the Gregory model of behaviour (2003) altering the model into a framework suitable for water efficiency studies. The intention of the framework is for the framework to be adapted into a methodology, using case based evidence that can appraise and optimise the deployment of water efficiency interventions.

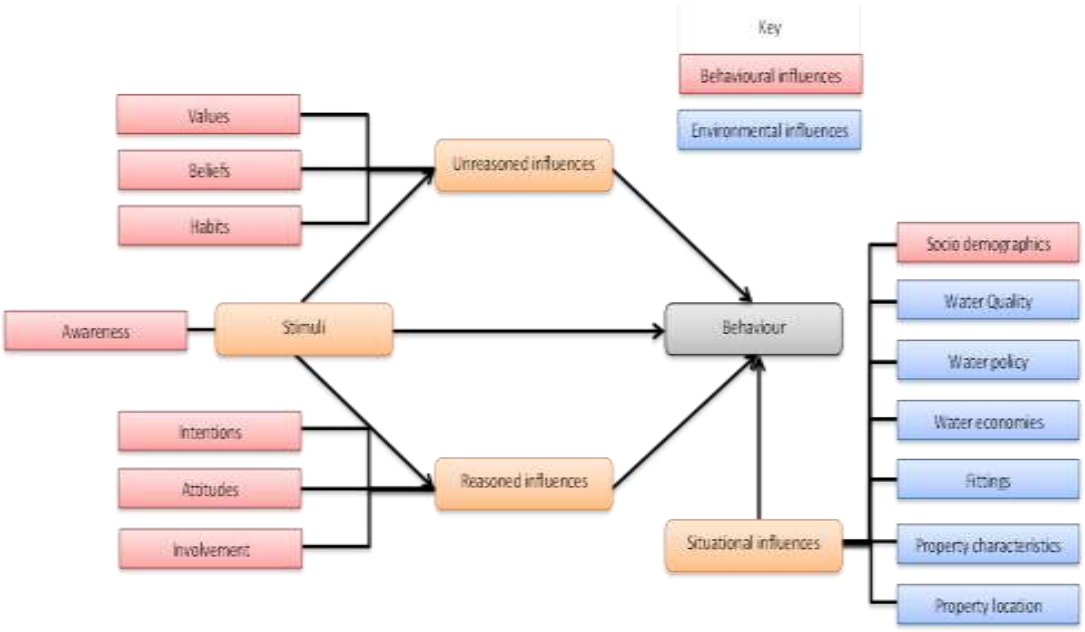

Figure 1- Proposed domestic water efficiency framework

The framework separates behavioural influences into two primary categories; behavioural and environmental, showing that situational influences are primarily formed of environmental influences, with the exception of socio-demographics which are considered situational influences as they are out of conscious control of the individual. However one limitation of this framework is that it focuses on an individual and not the relationship or water use behaviour of a multiple occupancy household, reducing its applicability to whole house end demand management.

However, it is considered that with the correct expertise, the framework could be utilised to align detailed and accurate water end use data with behavioural factors. It can also aid the development of improved water efficiency tools that are capable of revealing the determinants of water end use.

CONCLUSION

The proposed framework expands on existing assessment methodologies by providing an opportunity to integrate specific individual variances in anticipated water use patterns and characteristics. This framework provides a platform which should support behavioural and environmental considerations when appraising both water consumption and efficiency interventions. As evidence is collected, to support the framework a methodology can be developed such that a procedure can be followed to appraise water efficiency interventions.

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