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Energy saving behaviours among social housing tenants: Exploring the relationship with dwelling characteristics, monetary concerns, and psychological motivations

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ENERGY SAVING BEHAVIOURS AMONG SOCIAL HOUSING TENANTS: EXPLORING THE RELATIONSHIP WITH DWELLING CHARACTERISTICS, MONETARY CONCERNS, AND PSYCHOLOGICAL MOTIVATIONS

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Abstract

Increasing our understanding of the factors that influence energy saving behaviour could help in the development of more effective energy saving interventions. This paper describes the first phase of the EnerGAware project which aims to develop a serious game for social housing tenants in the UK. A survey was conducted to inform the design of the game, which investigated the relationship between psychological factors, context-specific factors (i.e. dwelling characteristics and monetary concerns), and energy saving behaviours. In total, 537 households completed a postal survey, with a response rate of 19.4%. The results showed that experiencing difficulty in keeping the home comfortably warm in winter related to behaviour. In particular, concerns about the affordability of heating seemed to be related to more frequent heating-related energy saving behaviours. Experiencing issues with overheating, damp, mould or condensation – and general concerns about energy bills, did not relate to energy saving behaviours. Overall, the psychological factors measured in the study related more strongly to energy saving behaviours; especially the ability to imagine energy use and strong social norms had a positive relationship with energy saving behaviour. The implications of the findings for the design of the serious game are discussed. Thus, the study uses a combined approach examining psychological and contextual factors to illustrate how important behavioural motivators relevant to a specific group of householders can be included in the design of an intervention.

1. INTRODUCTION

People engage in many behaviours in the home that influence domestic energy consumption. Occupant behaviour is thought to be one of the reasons why a building's energy use can be up to forty percent above expectations [1]. Rather than waiting for new technologies or regulations to change domestic lifestyles, addressing the behavioural dimension offers the potential for significant energy savings in the short term [2]. Technological solutions such as energy-efficient appliances and improving the energy performance of buildings are important tools in reducing energy consumption, but there is a key role of energy-related behaviour change as well [3],[4]. To understand how changes in behaviour can be achieved there is a need to investigate the factors associated with energy saving behaviours. Increasing our understanding of these factors can aid in designing more effective energy conservation measures.

Previous research into the determinants of energy saving behaviour have made a distinction between context-specific and psychological factors. With regard to the first, the context in which energy-related behaviour occurs has an impact on energy use as it directly influences the possibilities and constraints that people experience [3],[5],[6],[7]. For instance, the type of house people live in may limit the energy efficient technologies a household is able to afford or install [7],[8]. With regard to psychological motivators, these might be particularly important if contextual factors do not strongly limit behaviour [9]. Overall, it is clear from previous research that the influence of contextual and psychological factors on energy-related behaviour is strongly intertwined. However, many studies still examine each aspect individually rather than using a combined approach [8].

This paper responds to a call for studies examining the complex relationship between individual and context-specific factors for energy saving behaviours, specifically, there is a need to share knowledge between disciplines to tackle this complexity [10]. By combining insights from social sciences and building research relevant psychological and context-specific factors can be identified for a specific target group. In this case, our research will focus on residents of social housing (i.e. affordable or low-income housing) in South-West England. In the remainder of this Introduction we will discuss important psychological motivators identified in previous research. This will be followed by a section on the specific setting that will be the focus of this research and the contextual factors emerging from this.

1.1. Psychological factors

There are many psychological factors which could influence energy-related behaviour change, and it is not within the scope of this paper to provide a conclusive list. This section provides an overview of four factors that have emerged as important influences on energy saving behaviour: knowledge, imageability, perceived control and social norms. This is building on a framework discussed in [8] and [11].

An important first step to achieving energy saving behaviour is an understanding about how energy is being used in the home and what can be done to reduce energy use [8],[11]. Rather than generic knowledge on energy consumption, it has been suggested that people need household-specific and practical energy 'know-how' [12]. For the average householder it is

difficult to acquire this knowledge partly due to the invisible and tangible nature of energy use [5],[13]. Individuals tend to find it difficult to imagine how much energy is used by common household actions, and how much energy could be saved by changing certain behaviours. This invisibility is the result of a significant time-lag between behaviour and energy feedback (e.g. through energy bills), [13], as well as a disconnection between behaviour and energy in day-to-day life [14]. Recent research has shown that reducing the invisibility of energy use, by providing clear energy visualisations, can encourage energy saving behaviours [15],[16],[17]. Making energy use visible can support energy saving behaviour not only through providing 'know-how' and increasing the imageability of energy use, but also by empowering householders [18],[19]. That is, it can provide individuals with a sense of control over their energy use at home, and a feeling that they can easily engage in behaviours which can reduce energy use. Thus, fostering a feeling of perceived control, or self-efficacy; this has been identified as having a strong influence on energy saving behaviour [19].

Next to knowledge and understanding, for energy saving behaviour to occur, individuals need to feel motivated to save energy [8],[11]. One motivational factor which has received a lot of attention in the energy domain is social norms. Social norms reflect what is commonly done or (dis)approved [20]. To illustrate, what group members (e.g. friends, family) think or do with regards to energy consumption could influence an individual's energy-related behaviour. In fact, using social norms to encourage pro-environmental behaviour change (including energy conservation behaviour) has been found to be a successful approach [21],[22],[23].

Finally, a key factor influencing energy-related behaviour change is people's ability to conserve energy, to a large extent this is dictated by contextual factors [8],[11]. The next section will discuss relevant contextual factors in this study's sample of UK social housing residents.

1.2. Context-specific factors

Income has found to be related to energy use, with low income households generally using less energy [3]. But there is another aspect to the relationship between income and energy which is a key concern in the social housing sector: fuel poverty. People living in fuel poverty are not able to afford keeping their home adequately warm [24]. The UK has one of the highest rates of fuel poverty in Western Europe [25], and residents in the social housing sector are especially at risk of fuel poverty [26]. Apart from issues with comfort, not being able to heat the home effectively can also lead to problems with persistent cold, damp and mould which pose significant health and well-being risks, see [27] and [28]. Research has shown that housing problems such as cold housing, damp, mould and condensation are more common among social housing tenants than owner-occupiers [29]. In addition, similar issues that can lead to housing problems in winter (e.g. lack on insulation) can lead to overheating in summer [30],[31].

A warm home is seen by many as a basic need [32], and previous research has indicated that the need to have a comfortable home can be a reason to engage in energy saving behaviours [33]. Even so, relatively little is known about how these context-specific factors (i.e. concerns regarding the affordability of energy and dwelling characteristics) influence the energy-

related behaviours of the occupants, and how the influence of these context-specific factors compares to the psychological factors discussed previously.

1.3. The EnerGAware project

The current study used a large tenant survey to capture responses from social housing tenants and start exploring the relationship between dwelling characteristics (i.e. being able to keep the home comfortable warm/cool, the experience of damp, mould, and condensation), monetary concerns, psychological motivations and energy saving behaviours. The survey measured appliance-related and heating-related energy saving behaviours. Importantly, the results of this survey will feed into an energy saving intervention designed as part of the EnerGAware project (energaware.eu). This follows from the assumption that effective interventions should be tailored to the population or setting which is being targeted [15],[33]. The multi-disciplinary EnerGAware project aims to develop a serious game that can help social housing tenants to reduce their energy consumption by providing behavioural strategies and connecting to a household's own energy use. The field of serious games in general applies gaming principles beyond entertainment to train, educate, and/or change behaviour [34],[35]. The survey described in this paper is the first phase of this research project and provides an insight into the experiences, perceptions and behaviours of this sample of social housing tenants.

2. METHODOLOGY

2.1. Participants and design

A paper-based survey was sent out to 2,772 social housing tenants in a city in South-West England, along with a letter and flyer about the project which also informed tenants about the option to fill in the survey online. To encourage households to complete the survey, a prize draw was used as an incentive. In total, 537 (33 online) of the households completed the survey, giving an overall response rate of 19.4%. Respondents had a mean age of 58 (ranging between 18 and 96), fifty-three respondents did not report their age. Most householders who responded to the survey fell in the 55-64 (18%) or 65-74 (18%) age category. Out of the 537 householders who responded to the survey, 198 (37%) were male, 298 (55%) were female, and 41 (8%) did not provide their gender.

2.2. Materials

Firstly, to assess *dwelling characteristics* respondents were asked to respond to the following questions with a yes/no answer: During the cold winter weather, can you normally keep comfortably warm in your living room (an additional response option: 'yes, but it costs a lot' was included for this item); During the warm summer weather do you sometimes feel too hot in your living room; Do you have any problems with condensation, damp or mould in your home. In addition respondents were asked to rate on a 4-point scale (ranging from 1: a great deal, to 4: not at all) how much the issues with condensation, damp and mould affect them.
Secondly, to assess *monetary concerns* respondents were asked to rate on a 5-point scale

(ranging from 1: very easy to 5: very difficult) how easy or difficult it is for them to afford their energy bills; and on a 5-point scale (ranging from 1: Strongly agree to 5: Strongly disagree) whether they are worried about their energy bills.
Thirdly, four items were included to measure the *psychological factors* discussed in Section 1.1. The following statements were rated on a 5-point scale (ranging from 1: Strongly agree to 5: Strongly disagree) to measure energy understanding, perceived control, ability to imagine energy use and social norms, respectively: I don't understand how my home uses energy; I have control over how much energy is consumed in my home; I can easily imagine how much energy my home uses; My friends and family say it's important to save energy.
Fourthly, respondents were asked to rate nine *heating-related energy saving behaviours* (e.g. I make sure that the windows are closed when the heating is on; I wear very warm clothes in winter so I can keep the heating on low or off) and ten *appliance-related energy saving behaviours* (e.g. I make sure that no appliances are left on standby; I shut down my computer when it is not in use). Behaviours were rated on a 5-point scale (1: always, 2: often, 3: sometimes, 4: very occasionally, 5: never), in addition respondents could tick a 'not applicable' box. For the analysis reported in the results section two additional variables were computed in the dataset. These variables indicate the number of actions for which each respondent indicated that he/she conducts it often or always – so for the heating-related behaviours the maximum number of actions was nine, and for the appliance-related behaviours the maximum number of actions was ten.

3. RESULTS

Out of the nine heating-related behaviours, on average respondents indicated conducting M = 6.13 (SD = 1.98) actions always or often. When examining eligible actions only (excluding respondents who selected n/a for an action), the most common behaviours were: making sure that the windows are closed when the heating is on (always/often done by 92% of respondents), and making sure that the curtains are open when the sun is shining in winter (always/often done by 91% of respondents). The least common behaviours were: closing doors between rooms (always/often done by 57% of respondents), and adjusting the temperature on the radiators (always/often done by 46% of respondents).
Out of the ten appliance-related behaviours, on average respondents indicated conducting M = 6.27 (SD = 2.09) actions always or often. The most common behaviours were (again examining eligible actions only): making sure that the fridge and freezer doors are not open for longer than necessary (always/often done by 96% of respondents), and shutting down the computer when not in use or only using the washing machine when having a full load of washing (both always/often done by 85% of respondents). The least common behaviours were: using energy saving modes on appliances and making sure appliances are not left on standby (both always/often done by 60% of respondents).
The next step is to explore the relationship between the frequency of energy-saving behaviours (with regards to heating and appliances), dwelling characteristics, monetary concern and psychological motivations. The results are summarised in Table 1.

3.1. Relationship with dwelling characteristics

Approximately half (47%) of the respondents indicated that they were able to keep comfortably warm in winter, thirty-six percent of respondents were able to keep comfortably warm although it costs a lot, and twelve percent indicated they were not able to keep comfortable warm in winter. A marginally significant relationship was found between whether respondents could normally keep their living room comfortably warm in winter and the frequency of heating behaviours (see Table 1). Respondents who answered 'no' (M = 6.15, SD = 1.92), or 'yes, but it costs a lot' (M = 6.34, SD = 1.92), engaged in slightly more frequent heating-related energy saving behaviours compared to respondents who answered 'yes' (M = 5.91, SD = 2.02). Post-hoc comparisons[i] showed that only the difference between the 'yes' and 'yes, but it costs a lot' category was marginally significant, 95% CI [-.87;.01], p = .055. Follow-up analysis showed that, compared to the 'yes' category, respondents in the 'yes, but it costs a lot' category especially conducted the following behaviours more frequently (out of nine heating-related behaviours):

- *When no one is at home the heating is off*

  Always or often done by 82% in the 'yes, but…' category and 73% in the 'yes' category, χ^2 (1, N = 457) = 4.73, p = .030
- *I wear very warm clothes in winter so I can keep the heating on low of off*

  Always or often done by 76% in the 'yes, but…' category and 66% in the 'yes' category, $\chi 2$ (1, N = 456) = 4.69, p = .030
- *I close the doors between rooms*

  Always or often done by 61% in the 'yes, but…' category and 48% in the 'yes' category, $\chi 2$ (1, N = 456) = 7.70, p = .006

As shown in Table 1, no significant relationship was found with regards to appliance behaviours.

The majority of respondents did not have problems with overheating in summer (67%), about a quarter (29%) of respondents did experience issues. Whether respondents sometimes felt too hot in their living room in summer did not relate to the frequency of heating or appliance behaviours (Table 1). Problems with condensation, damp or mould were fairly common in this sample of householders, with forty-two percent reporting issues (55% reported having no issues). As can be seen in Table 1, no relationship was found between the frequency of heating or appliance behaviours and problems with condensation, damp or mould in the home. Respondents were also asked to what extend issues with condensation, damp or mould affect them (M = 2.48, SD = 1.09), this variable did not relate the frequency of heating or appliance behaviours either (see Table 1).

In sum, dwelling characteristics (in terms of issues with thermal comfort, condensation, damp and mould) did not seem to be strongly associated with the frequency of heating and appliance-related energy saving behaviours.

Table 1

[i] Games-Howell post-hoc tests were used to account for the different group sizes.

Relationship between Frequency of Energy-Saving Behaviours with Regards to Heating and Appliances – and Dwelling Characteristics, Monetary Concerns and Psychological Motivations

		Heating behaviour	Appliance behaviour
Dwelling characteristics	Perceived comfort in winter	$F(2,514) = 2.67$, $p = .070$, $\eta^2 = .01$	$F(2,514) = 2.37$, $p = .094$, $\eta^2 = .01$
	Perceived comfort in summer	$t(513) = -0.28$, $p = .782$	$t(513) = -1.61$, $p = .107$
	Issues with damp/mould	$t(513) = 0.94$, $p = .348$	$t(513) = 1.08$, $p = .279$
	Impact of damp/mould issues[1]	$r = .03$, $p = .690$	$r = -.10$, $p = .125$
Monetary concerns	Easy/difficult to afford[2]	$r = .08$, $p = .076$	$r = .05$, $p = .269$
	Worries about energy[3] bills	$r = -.07$, $p = .138$	$r = -.04$, $p = .416$
Psychological motivations	Energy understanding[3]	$r = .03$, $p = .621$	$r = .02$, $p = .715$
	Perceived control[3]	$r = -.08$, $p = .067$	$r = -.06$, $p = .207$
	Ability to imagine use[3]	$r = -.13$, $p = .007$	$r = -.14$, $p = .004$
	Social norm[3]	$r = -.15$, $p = .001$	$r = -.20$, $p < .001$

Note: [1]Response scale 1 (A great deal) – 4 (Not at all); [2]Response scale 1(Very easy) – 5 (Very difficult); [3]Response scale 1(Strongly agree) – 5 (Strongly disagree).

3.2. Relationship with monetary concerns

On average, respondents found it neither easy nor difficult to afford their energy bills (M = 2.82, SD = 1.03). Respondents who found it difficult to afford their energy bills did not report more frequent energy saving behaviours (heating or appliances). Respondents tended to be fairly worried about their energy bills (M = 2.78, SD = 1.19), agreement with this statement was not associated with more frequent energy saving behaviours (heating or appliances).

3.3. Relationship with psychological factors

Overall, respondents were undecided whether they understood how their home uses energy (M = 3.05, SD = 1.22). Self-reported energy understanding was not associated with the frequency of energy saving behaviours (heating or appliances; see Table 1). Furthermore, respondents felt they had some control over the energy consumed in their home (M = 2.32, SD = 1.12). A relatively weak correlation was found between perceived control and the frequency of heating-related behaviours. This correlation suggests that respondents who indicated that they had control over how much energy is consumed in their home tended to report more frequent heating-related energy saving behaviours. A similar correlation was not found for appliance-related energy saving behaviours (see Table 1). Next, respondents indicated they could imagine how much energy their home uses to some extent (M = 2.59, SD = 0.97). As shown in Table 1, a significant correlation was found for both types of energy saving behaviours and respondents perceived ability to easily imagine how much energy their home uses. The more confident respondents were in their ability to imagine energy use, the more frequent energy saving behaviours they reported. Finally, respondents tended to agree with the statement ‘My friends and family say it’s important to save energy’ (M = 2.19, SD = 1.00). This measure of social norms was quite strongly related to the frequency of appliance-related energy saving behaviours (see Table 1). If respondents indicated that their friends and family say it is important to save energy, they were more likely to report frequent appliance-

related energy saving behaviours. A similar, but somewhat weaker, correlation was also found for heating-related energy saving behaviours.

4. CONCLUSION

Understanding what drives energy-related behaviour change remains an important area of research which can support the design of effective interventions. In response to calls from the literature for combined research into psychological factors and contextual factors, [3],[10], this research directly compared the relationship between psychological factors (i.e. energy understanding, perceived control, imageability, social norms) and energy saving behaviour on the one hand, and the relationship between context-specific factors (i.e. dwelling characteristics, monetary concerns) and energy saving behaviour on the other hand. Behaviour does not happen in isolation and context-specific influences are important to acknowledge. In this case, the research focused on a sample of social housing tenants in South-West England.

Our sample of householders reported frequently engaging in energy saving behaviours; appliance-related behaviours were slightly more common than heating-related behaviours. Out of the context-specific factors assessed in this study only the ability to keep comfortably warm in winter was weakly associated with heating-related energy saving behaviour. Interestingly, householders who indicated that they could keep their home comfortably warm, although at considerable costs, engaged in more frequent heating-related energy saving behaviours compared to householders who reported no issues with keeping their home at a comfortable temperature. A similar pattern was found between the latter group and respondents who could not keep their home comfortably warm in winter, but the difference was not significant. Given the relatively weak effect it is difficult to draw any firm conclusions from this finding, but it could suggest that for this group of householders, affordability concerns regarding heating drive them to engage in more frequent energy saving behaviours. Although this may point towards a role for affordability concerns in energy saving behaviour, more general concerns with regards to energy bills did not relate to energy saving behaviour (heating-related nor appliance-related).

Finally, the relationship between energy saving behaviours and psychological factors was explored. Energy understanding did not relate to the frequency of energy saving behaviours, but respondents tended to report slightly more frequent heating-related energy saving behaviours if they felt they had control over how much energy is consumed in their home. However, being able to imagine energy use and support from friends and family (i.e. social norms) seemed particularly important. Being able to easily imagine how much energy the home uses was associated with more frequent energy saving behaviours. This seems to be in support of a growing literature highlighting the need to ‘make the invisible visible’ when it comes to visualising energy [15],[16],[17],[36]. In addition, if respondents indicated that their friends and family say it is important to save energy, they were more likely to report frequent energy saving behaviours. This finding is in line with previous research on the strong influence of social norms on our behaviours [21],[22],[23].

A few points need to be taken into account when interpreting the results. Firstly, most of the variables included in this study were measured using only one item. This is because the

survey needed to be kept as short as possible to encourage many householders to respond. There are limitations to single-item measures, but this issue is difficult to overcome in field studies such as these – still these limitations need to be acknowledged. Secondly, respondents reported fewer worries about energy bills and problems with keeping their home comfortably warm than expected. The relative lack of variance in this sample could explain some of the weak relationships that were found. Other studies could consider recruiting a more varied sample of householders.

As may be recalled, the findings of this study will feed into the design of a serious game to encourage energy-related behaviour change, which will be distributed among the social housing tenants. Following the results of the survey, it seems that the design of the game should especially focus on ensuring that tenants are able to imagine the energy use in their home and ways to foster support for energy conservation among friends and family. At the time of writing, the game developers are in the process of linking up energy metering data from the homes to the energy game so users will be able to have easy access to their energy consumption. Real-life energy consumption will also have consequences in the game to increase the visibility of energy use, in line with recent insights on energy visualisation [17]. Efforts are also being made to build an energy community and foster social norms to conserve by linking the game to social media platforms so users can share their progress and see how others are doing. In addition, missions within the game will also aim at encouraging conservations among household members about energy use.

In conclusion, in this study psychological motivators were found to have a stronger association with energy saving behaviour than factors especially relevant to the social housing context: dwelling characteristics and monetary concerns. However, with this case study we attempted to highlight that these context-specific factors should not be overlooked when examining energy-related behaviour change, especially when studying very specific samples of householders. Moreover, it should be noted that even the significant relationships were relatively weak. This highlights the complexity of energy saving behaviours and the fact that they are unlikely to be explained by one factor: it is a combination of factors that leads individuals to engage in certain behaviours.

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